THURSDAY, JULY 28, 1887.

THE GEOLOGY OF NORTHUMBERLAND AND DURHAM.

Outlines of the Geology of Northumberland and Durham. By Prof. G. A. Lebour. (Newcastle-upon-Tyne: Lambert and Co., 1886.)

THE normal guide-book cannot be said to be as a rule very entertaining reading, and a work like the one before us is essentially a geological guide-book. But the guide-book may be so treated as to present points of interest even to the reader who never puts it to the use for which it was primarily intended. Such a guide-book has been produced by the joint labours of a great poet and a great geologist; and a great historian, when he leads us round towns and cities thick with objects full of historical associations, puts into our hands a guide-book of this type. No one, least of all the author, would for a moment think of placing the unpretending little volume on the geology of Northumberland and Durham in the same class as the books to which allusion has just been made, but it is very curious to note how many questions of interest are started during the perusal of what at first sight looks like nothing more than a rather dry description of local geology. Some of these points may now be noticed.

The fact that peat-lakes have often more than one outlet, though it is coupled by the rather questionable statement that "ordinary lakes with two outlets do not exist," throws light on a much disputed question in physical geography. For two outlets to co-exist for any length of time in a lake, it seems necessary that the outflowing streams should have the same eroding power, and this will be the case if these streams have the same fall, and if their beds are composed of the same material. A lake in Arran which has two outlets is wholly surrounded by granite, and in its case the two conditions mentioned are probably satisfied. The eroding power of the sluggish outflows from a bog must be very small, and the material on which it is exerted is everywhere peat. Here it is easy to realize the possibility of there being several outlets. But there are few cases in which the balance of power could be exactly maintained, and hence lakes with two outlets must be rare.

It is extremely interesting to find a *Lingula* recorded from beds high up in the Coal-measures. New cases of marine bands in the upper portion of the Coal-measures are constantly being brought to light, and each fresh discovery strengthens the belief that the occasional presence of marine forms is not confined to the Lower Coal-measures or Ganister Beds, or is even commoner there than in the Middle Coal-measures. If this be so, the attempts which have been made to draw on palæontological grounds a line between the Lower and Middle Coal-measures, at once fall to the ground. Marine bands seem to be less plentiful in the Coal-measures of Durham and Northumberland than in those of Lancashire and Yorkshire. This accords well with the hypothesis that the outlets which connected the Coal-measure lake or estuary with the open ocean lay to the west. It was through these openings that marine forms now and again migrated into the area, and the further a spot was from the door of entry, the fewer would be the immigrants which reached it.

Under the head of "Millstone Grit" we are told that the rocks, which in Lancashire and Yorkshire are conspicuous under this name, are in Northumberland in no wise distinguished from the Coal-measures proper, that they have no distinctive fossils—in short, nothing peculiar to them but their position. But the contrast between Lancashire and Yorkshire on the one hand, and Northumberland on the other, is really by no means so great as these words would seem to imply. It is true that in the first-named and adjacent counties a portion of the Carboniferous rocks has certain lithological peculiarities so strongly marked, that it is convenient to separate it from the beds above and call it Millstone Grit, but the distinction rests solely on the comparatively unimportant points of coarseness of grain and massiveness, and when we look to points of real importance, such as conditions of deposition, fossils, and the like, Millstone Grit, Ganister Beds, Coal-measures, and other similar groups are seen to be arbitrary, though very convenient, subdivisions of a formation that is essentially one from top to bottom.

Prof. Lebour has happily seized on the only line of demarcation among the Carboniferous rocks which can have any real significance; that, namely, which separates rocks in which the fossils are all practically marine from rocks in which marine fossils are the exception, and in which they are the *exuviæ* of marine creatures which paid occasional visits to the area, but whose stay there was short.

And this brings us to the lower and marine portion of the Carboniferous system, which is divided in the present work into two members, named respectively the Bernician and the Tuedian. The contrast between the Mountain Limestone of Derbyshire and Yorkshire, almost pure limestone from top to bottom, and the beds in the south of Scotland, which we must look upon as its time-equivalents—shales and limestones in which it is often difficult to find limestones at all, and more difficult still to recognize them when they are come across—this contrast has become one of the hackneyed instances of geology. The name Bernician is applied by Prof. Lebour to beds on the same geological horizon in the north of England. They are in a general way intermediate in character between their equivalents on the north and on the south; but in a work intended mainly for the use of young students the author has wisely warned his readers that they will not find in Nature that regularity and uniformity of change that some geological diagrams might lead them to expect. The limestones are not all wedges with their sharp edges pointing north, and, moreover, the total thickness both of the whole group and of its various subdivisions varies very much from place to place. We would suggest, in the interest of those students who have not yet got beyond books, that it be pointed out in the next edition that this is only what was to be expected; that in a subsiding area it is almost certain that sinking will go on faster at some spots than at others; that pits and holes will be thus formed in the sea-bed; and that in a deposit laid down under such conditions great variations in thickness and character must necessarily arise. It would not be amiss to call attention also to the bearing such considerations have on the attempts which are occasionally made after minute correlations and identifications of individual beds in such a group of strata. The example set in this matter in the present work is excellent, for a clear distinction is drawn between those limestones or other beds about whose continuity there can be no question, and those whose occurrence is local; but example may be usefully enforced by precept.

The same wholesome refusal to draw hard and fast lines where none have been drawn by Nature is seen when we come to the chapter on the Tuedian beds. Special attention is drawn to the fact that, though these can be separated, as far as lithological character goes, from the overlying Bernicians, the line of demarcation is by no means everywhere of the same geological age. The Tuedian beds resemble so closely the "Cement Stone Group" of the central valley of Scotland, that they are doubtless the southern continuation of that subdivision. The Scotch beds, as is well known, were laid down in an assemblage of ponds, creeks, and lagoons separated by banks of sand and muddy shoals. The Tuedians of the north of England do not seem to show quite such rapid changes horizontally as are common in their Scotch equivalents, but they must have been formed under very similar conditions. Beds thoroughly Tuedian in character occur on the west of the Cross Fell Range near Shap: they are very thin, and we are there probably close to the southern boundary of the area over which these peculiar beds were laid down.

Very interesting are the accounts of the somewhat peculiar group of rocks discovered in the deep borings for rock salt alongside the Tees. First came more than 1000 feet of Red Marls and Sandstones, which may be very safely assigned to the Trias. Judging by what is seen at the outcrop, we should have expected the main mass of the Magnesian Limestone to follow; but such was not the case. The hole then entered a group of rocks consisting of gypsum, anhydrite, rock salt, and beds of limestone. Prof. Lebour is of opinion that the Magnesian Limestone was not reached by any of the holes. Hereby several questions may be started. Are the 1000 feet of red marl and sandstones to be assigned to the Red Marl or the Red Sandstone? A nice difficulty for the system-mongers; but before we try to solve it, we may ask whether these two subdivisions are as sharply marked off from each other in Yorkshire and Durham as in other parts of England. There is no reason why they should be; and if they are not, we may well content ourselves with calling the whole Trias. Then how are we to account for the presence of the rock salt and gypsum, which, as far as is known, is never seen along the outcrop, or indeed anywhere else in England? It seems likely that towards the end of the Permian period unequal subsidence produced hereabouts a depression in the bed of the water; that, as now happens elsewhere under similar conditions, the Permian lake became largely laid dry, so that water remained only in this and perhaps other similar basins; and that, from the highly concentrated solutions which remained in these lakelets, local deposits of a strongly chemical character were precipitated. The author remarks on the close resemblance which these deposits bear to the subdivision of the Permian called "Rauchwacke" in Germany, and would apply this name to them. That they and the German "Rauchwacke" were formed under very similar conditions there can be little doubt, but there is no proof that the two were formed at the same time, and this is almost necessarily implied if we give them the same name. In a group of rocks like the Permian, formed in so many distinct basins, and under changing conditions the order and nature of which were probably never the same in any two basins, the minor subdivisions must necessarily be totally different in different areas, and any attempt to correlate these minor subdivisions can be little better than guess-work. If the subdivisions are to have distinctive names, it seems better that the beds of each basin should each have a set of names to itself. Similar objections apply to the habit of designating the subdivisions of the English New Red Sandstone by German names; it is the practice to look upon the New Red Marl as the time-equivalent of the Keuper, and the New Red Sandstone as that of the Bunter, but there is absolutely no proof of this. It is worse when a statement is made that the Muschelkalk is absent in England, and a fictitious unconformity is postulated between the New Red Marl and the New Red Sandstone to account for its absence. Who can say whether the lower part of the New Red Marl, or the upper part of the New Red Sandstone, or both, were not forming here while the Muschelkalk was being deposited in Germany?

The peculiarities of structure exhibited by the Magnesian Limestone are shortly but clearly described. They have been long known, but little has been done towards explaining how they were produced. The problem is one of extreme complexity, but a persevering attack on it, even if it did not lead to a complete solution, would almost certainly throw great light on what we in our ignorance call concretionary action. Sundry structures, formerly referred to this mysterious cause, have been shown to be due to simpler and less recondite processes, but there is a large residuum of cases still awaiting explanation.

We have by no means exhausted all the questions and suggestions which this little book will prompt; but we hope we have said enough to show that it will prove to the attentive reader far more interesting than might at first be supposed. And we may learn from it that in Great Britain, the very motherland of geology proper, ransacked as it has been for now well-nigh a century by the ablest of geologists, there is still many a corner, full of unsolved problems, awaiting the attention of those geologists who cannot wander far from home but are yet anxious to win their spurs.

A. H. GREEN.

PHYSIOLOGICAL PSYCHOLOGY.

Elements of Physiological Psychology. A Treatise on the Activities and Nature of the Mind from the Physical and Experimental Point of View. By George T. Ladd, Professor of Philosophy in Yale University. (London: Longmans, Green, and Co., 1887.)

THE aim of this volume is twofold: first, to give a clear, accurate, and up-to-date account of the psycho-physiology of man; and then to enter a protest against a merely materialistic interpretation of the phenomena. Such a protest, coming from one who is well abreast of modern physiology, is likely to carry weight which could not but be lacking to the opposition of a thorough-going disciple of the "old psychology" school. No one can say that Mr. Ladd's conclusions are reached in and through his ignorance of the real nature and value of the facts on which materialists base their arguments.

The work consists of a short introduction and three parts, of which the first deals with "The Nervous Mechanism," the second with "The Correlations of the Nervous Mechanism and the Mind," and the third with "The Nature of the Mind."

The first part opens with a chapter on the elements of the nervous system, and then proceeds to show how these elements are combined into a systematic whole. The morphology of the nervous mechanism having thus been described, its general physiology is dealt with in the next two chapters, and the automatic and reflex-motor functions of the central mechanism are successively brought under review until, in ascending order, we reach the cerebral hemispheres, the special functions of which are reserved for the second part. The reasons the author gives for adopting this plan are: (1) that nothing is known as to the molecular structure of these hemispheres, or as to their automatic and reflex-motor centres and activities which adds anything of importance to the description of the nervous system as a mechanism or to the mechanical theory of its action; and (2) that the correlations which exist between the structural condition or physiological function of the nervous system and the phenomena of mind are chiefly (if not wholly) capable of study as illustrated in the cerebral hemispheres. An important chapter on the end-organs of the nervous system then follows, and is succeeded by one on development. A concluding chapter in this part is devoted to the mechanical theory of the nervous system, in which, while the author admits that the changes which take place in the brain are essentially the same as those with which the science of molecular physics has elsewhere to deal, he reaches the conclusion that "it cannot be pretended that even a beginning has been made toward a satisfactory theory of the functional activity of the central organs considered as a special case in molecular physics."

In this part, together with much that is familiar, there is not a little that has hitherto seen the light only in scattered publications.

The second part opens with two long chapters on the localization of cerebral functions. The experiments and conclusions of Fritsch and Hitzig, Exner, Ferrier, Munk, Goltz, and others are carefully described and considered. The conclusions to which the author is led by his review of these labours are as follow:—

"Three principles may be laid down as summing up the results reached by inference upon the basis of experiment with respect to the localization of function in the cerebral cortex. The first principle is to be accepted in the form of a general postulate derived from a study of the other parts of the nervous system, and confirmed on attempting to apply it to the cerebral hemispheres. It may be stated as follows: the different elementary parts of the nervous system are all capable of performing its different specific functions when, and only when, they have been brought into the proper connexions and have been exercised in the performance of those functions. This principle includes two important laws which, we know, hold good throughout the nervous mechanism, and which lie at the physical basis of important psychical facts and laws; they are the *law of Specific Energy* and the *law of Habit*. The remaining two of the three principles alluded to above may be said to follow from the first: they are the principle of *localized function* and the principle of *substitution*. The former asserts that, in the normal condition of the nervous system, all parts have not the same definite functions. Everything in both its anatomy and physiology indicates that the principle of localized function does apply, in some sort, to the cerebral hemispheres. So-called 'centres,' however, are in no case to be regarded as portions of the nervous substance that can be marked off by fixed lines for the confinement of definite functions within rigid limits. These areas are somewhat different for different brains of the same species; they widen when a heightened energy is demanded of them; their centres are neither mathematical points nor very minute collections of cells. Nor are these areas perfectly isolated localities; on the contrary, they obviously overlap each other in certain cases. Furthermore, the functions of the cerebrum are not absolutely confined to those centres with which, under ordinary circumstances, they are chiefly or wholly connected; in which, that is to say, they are localized. If such centres, for any reason, become incapacitated or relatively unfitted to perform their normal functions, the same functions may be performed by other areas of the cerebral cortex, provided these areas also stand in the proper connexion. This is the principle of substitution."

In the remaining chapters of the second part we are led to consider sensations in their qualitative and quantitative relations, the nature of "things," or the presentations of sense (which introduces us to "space-form"), and the time-relations of mental phenomena (which introduces us to "time-form"). Then we are conducted, through feeling, to the higher faculties—memory, will, conception—the physiological basis of which is sought in vain. The concluding chapter of this part gives a summary of the general correlations of body and mind. The author seems to intend that two points shall stand out prominently: first, the essentially synthetic activity of the mind in constructing those presentations of sense which we call things or objects; and secondly, notwithstanding a vague correlation, the inconceivability of any physiological basis thereof. "For that spiritual activity which actually *puts together* in consciousness the sensations, psycho-physics cannot even suggest the beginning of a physical explanation." And again: "When we speak of a physical basis of memory, recognition must be made of the complete inability of science to suggest any physical process which can be conceived of as correlated with that peculiar and mysterious *actus* of the mind, connecting its present and its past, which constitutes the essence of memory."

In the third part the conclusion to which especial prominence is given is this: that the subject of all the states of consciousness is a real unit-being, called mind; which is of non-material nature, and acts and develops according to laws of its own, but is specially correlated with certain molecules and masses forming the substance of the brain. The nature of this correlation is considered at length. To speak of mental states and processes as the "product" of the nervous mass of the brain in any sense of the word corresponding to that which we rightly apply to the various secretions of the body, involves us at once, it is held, in the grossest absurdities; while the theory that claims that *all* mental phenomena, whatever their varied characteristic shading, have exact equivalents, as it were, in specific forms of the nerve-commotion of the living brain is marked by its "surprising audacity." "Standing on a slender basis of real fact, it makes a leap into the dark which carries it centuries in advance of where the light of modern research is now clearly shining." The author, however, by no means rejects, he strongly contends for, a causal nexus as existing between brain and mind. He regards the term organ (or instrument) of the mind, as applied to the body, as particularly calculated to emphasize the relation of the ideas and volitions which arise in consciousness to the control of the muscular apparatus. He will have nothing to do with monism, but contends that psycho-physical science, simply observing the facts and building on them, establishes the dualism of brain and mind. "We affirm, then," he says, "that we are entitled to say: The changes of the brain are a *cause* of the states of consciousness; and the mind behaves as it does behave, *because* of the behaviour of the molecules of the brain." "We affirm also that we are equally entitled to say: The states of consciousness are a cause of the molecular condition and changes of the nervous mass of the brain, and through it of the other tissues and organs of the body."

So far, in dealing with the third part, we have perhaps made it appear that, in the author's view, the correlation is complete. And the passages we have quoted seem to justify this view. But many other passages reject such an interpretation with scorn. "In investigating the correlations which undoubtedly exist between the nervous mechanism and the phenomena of consciousness, it is found that some of these phenomena imply activities of the mind which do not admit, in any sense of the word, of being thus correlated." "Judgment itself is a form of mental phenomena for the essential part of which no physical equivalent can be discovered or even conceived of." "To account for this boundless expansion of the activities of consciousness (in the early years of childhood), with its surprising new factors and mysterious grounds of synthesis and assumption, by proposing an hypothesis of 'dynamical associations' among the particles of nervous substance in the brain, is a deification of impotency." "Not one of the higher acts of feeling, knowing, or willing, so far as its *sui generis* character is concerned, admits of being correlated with, or represented under, any of the conceivable modes of the motion and relation of molecules of nervous substance."

It would seem, then, that the author plays rather fast and loose with this correlation, as indeed is apt to be the fashion with dualists. We doubt whether he is justified in saying that psycho-physical science establishes the dualism of brain and mind. Here, it seems to us, the writer's usual caution forsakes him. Idealism, materialism, occasionalism, dualism, monism, are none of them theories that are in any likelihood of being "established" for many a long day. They are of the nature of *beliefs*; and strong as is his advocacy of the dualistic creed the author falls into error if he dreams of its speedy establishment. We could wish that he had squarely faced the difficulties which the acceptance of the dualistic hypothesis entails, a few of which are but barely mentioned on page 597. These and many others may not be difficulties to him; but surely he who would establish a doctrine should meet half-way such difficulties as are likely to trouble unbelievers. We could wish, too, that he had given us a more detailed criticism of the monistic creed which he rejects. To ask *why* the double-faced unity (the human being) manifests itself both in physical and mental states—"one being, in two wholly incomparable modes of manifestation"—and to say that monism has to undertake the task of showing *how* the one reality can appear under these two phenomenal forms of being—matter and mind—is surely not a very powerful or acute criticism. There are many *hows* and *whys* which can only be answered by quietly pointing to the facts. We do not say that monism can in this way be "established"; but we regard the criticism as weak.

Nor are we impressed with the force of the argument upon which so much stress is laid, that for certain higher mental activities no physiological correlate can be conceived. It seems to us that, if anywhere, the inconceivability comes in at the very beginning. If once the conceivability of a correlation between a nerve-commotion of any kind and a state of consciousness be admitted, there need be no further talk of inconceivability in the matter. *There* lies the rub: elsewhere we only find questions of degree and of relative complexity.

We cannot take leave of this valuable and important work without expressing our sense of its ability, its thoroughness, and its candour. There is no other book in the English language that covers its ground.

C. LL. M.

OUR BOOK SHELF.

The Essentials of Histology. By E. A. Schäfer, F.R.S. Second Edition. (London: Longmans, Green, and Co., 1887.)

THIS edition is, in several respects, an improvement on the first. The volume is less bulky, and there are some useful additions to the text so as to bring this up to date, especially as regards the methods of histological study. There are seventeen valuable illustrations added. The omission in the first edition of references to the authors of the illustrations has, we are glad to see, been corrected in this edition.

On the whole, we think the book a clear exposition of the present state of human histology, and, as such, it will prove useful to students and teachers. E. KLEIN.

Aluminium: its History, Occurrence, Properties, Metallurgy, and Applications, including its Alloys. By Joseph W. Richards. 12mo, pp. 346 (Philadelphia: Band. London: Sampson Low and Co. 1887.)

THIS volume is mainly a compilation based upon the late H. St. Claire Deville's treatise published in 1858, and the newer work by Dr. Mierzinski in Hartleben's "Chemisch-Technische Bibliothek," which appeared in 1883. As no special work on aluminium had previously appeared in English, we agree with the author that no apology is necessary in presenting it. The subject has been systematically treated both from the scientific and technical points of view, and as regards the latter the information has been brought up to date by including notices of Webster's improvements in the Deville process, Messrs. Cowles Brothers' electrolytic method of producing aluminium alloys, and the Castner process of reducing sodium from caustic soda at a low temperature, which, in conjunction with Webster's processes, seems likely to render the production of cheap aluminium commercially possible.

The author has contributed to the appendix a series of experiments made by himself on the formation and reduction of aluminium sulphide, which are of interest, although the results, in the reduction experiments at any rate, appear to have been mainly negative. Iron, tin, copper, and antimony were employed as reducing agents, but only with the first two metals was any reduction effected. The concluding paragraph, therefore, reads rather oddly:—"These processes have been covered by patents, but have never been made successful. It appears that if rightly managed they will give good results and produce aluminium alloys cheaply."

Questions on Physics. By Sydney Young, D.Sc., F.C.S., Lecturer on Chemistry, and Tutorial Lecturer on Physics in the University College, Bristol. (London: Rivingtons, 1887.)

ASSUMING that books consisting of a series of questions with their answers collected together at the end supply a legitimate want and do a real service in the cause of scientific education, Dr. Young's "Questions on Physics" is a valuable addition to those already existing. It is as free as it is possible to make such a book from the charge of encouraging "cram," as the questions are many of them not adapted to rule-of-thumb methods of solution. Many of them also are descriptive of some instrument or principle, in which case, of course, answers are not given. The author takes in succession mechanics, acoustics, heat, magnetism, electricity, and optics. After the answers he gives a series of tables which will be found useful. There are no questions on moment of inertia, or on the ballistic galvanometer. One sentence—the last part of question 155—may vex the student: "Calculate the focal length of a concave lens which gives a magnification of three diameters at a distance of three inches."

The book is intended for the intermediate examination in science and preliminary scientific examination of the London University.

Eminent Naturalists. By Thomas Greenwood, F.R.G.S. (London: Simpkin, Marshall, and Co., 1886.)

THIS is a little book (200 small 8vo pages) intended, as the preface says, to furnish "short yet comprehensive sketches of some leading naturalists." The sketches are certainly "short," but can only be said to be "comprehensive" in the sense that this term may be applied to an epitaph. It is difficult to understand what object such very sketchy biographical sketches can be supposed to serve. Moreover, in this case the subjects appear to have been selected at random; the result being that the portrait gallery, such as it is, presents a somewhat incongruous assemblage—to wit, Linnæus, Lubbock, Thomas Edward, Louis Agassiz, Cuvier, Buffon, Lyell, and Murchison. Whether this curious arrangement is intended to express the writer's idea of the order of merit of these men, or whether, like his choice of naturalists, it is purely haphazard, we are not informed. But surely, if a biographer goes back as far as Linnæus for his material, and carries down his survey to the present generation, even the most popular of popular readers might have expected him to supply a less deficient index of "eminent naturalists."

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Carnatic Rainfall.

IF I have rightly interpreted General Strachey's courteous criticism of my paper on the Carnatic rainfall, the gist of his objections may be summed up by saying that the method by which I endeavoured to estimate numerically the genuineness of the apparent cyclical variation of that rainfall, as a recurrent phenomenon, is logically invalid. This, I must frankly admit, is really the case; my error has been somewhat of the nature of a *petitio principii*, and is indefensible. I have reasoned upon a series of values directly obtained from the observations, as if they had been obtained deductively from some independent source, and had been found, on trial, to agree, within certain allowable limits, with the results of the observations. This procedure, as General Strachey has shown, is manifestly illogical; and the inferred "high probability that the apparent undecennial fluctuation of the Carnatic rainfall is no chance phenomenon," in so far as this conclusion depends on the above erroneous reasoning, necessarily falls to the ground. But only in so far. The validity of the data afforded by the registers remains, of course, unaffected; and these data, as they stand, seem to me to furnish evidence of so pronounced a character that it is at least improbable that the apparent fluctuation is fortuitous. The considerations on which I base this opinion are:—

(1) That each series of eleven years, taken separately, shows a dominant fluctuation of that period, and these fluctuations show much accordance, both in their ranges and in the epochs of their critical phases. Simple inspection of the tabulated annual means is sufficient to convince one that there is no regular fluctuation of anything like the same magnitude, differing much from the eleven-year period.

(2) The range of the fluctuation as educed by the harmonic formula (restricted to two periodical terms), is four times as great as the mean deviation of the recorded amounts from the corresponding computed values. And this fact fulfils a condition which, in a less rigorous form, General Strachey suggested, I believe,[1] as a test in his discussion of the Madras rainfall registers, communicated to the Royal Society in May 1877, and the failure of which he rightly assigned as a reason for doubting the reality of the supposed cyclical fluctuation of the Madras rainfall.

That the second of these considerations is valid has been established in my former communication. The computed range of the fluctuation was shown to be 14 inches, and the mean annual deviation of the observed from the computed values ± 3·5 inches. To render the first more obvious, I have computed the harmonic constants, separately, from each of the two undecennial series, and therefrom the annual values in each case. The constants are:—

1st Cycle.		2nd Cycle.	
$u' = 7{\cdot}23$	... $u'' = 0{\cdot}66$	$u' = 4{\cdot}22$	... $u'' = 5{\cdot}44$
$U' = 190° 16'$	... $U'' = 322° 10'$	$U' = 233° 59'$	... $U'' = 240° 14'$

and the computed annual values—

1st Cycle.	Inches.	2nd Cycle.	Inches.
1864	− 1·70	1875	− 8·14
1865	− 4·62	1876	− 8·63
1866	− 6·35	1877	− 2·61
1867	− 6·62	1878	+ 3·46
1868	− 4·99	1879	+ 3·69
1869	− 1·39	1880	+ 0·07
1870	+ 3·18	1881	− 1·46
1871	+ 6·79	1882	+ 2·11
1872	+ 7·23	1883	+ 6·71
1873	+ 5·81	1884	+ 5·97
1874	+ 2·12	1885	− 1·04

[1] I quote from memory, not having the Proc. Roy. Soc. at hand.

the average annual rainfall being, as before stated, about 35 inches.

These figures have, in themselves, as General Strachey truly observes, no physical signification, but they show that there is a very pronounced harmonic element, with a period of eleven years, underlying the observed quantities, and that in some of its most salient features it seems to be recurrent. Physical considerations only come in when, and in so far as, its features can be correlated with those of the solar variations; a point already noticed in my former paper, and on which I need say nothing further. But of course it is the supposed connexion of the two classes of phenomena that constitutes the chief interest of the subject under discussion. HENRY F. BLANFORD.

Folkestone, July 25.

The Progress of the Scottish Universities.

YOUR issue of July 14 (p. 252) set forth in vivid graph the rapid increase in size of the Scottish Universities. But as we must not forget that in progress, advance of type or improvement in quality is more important than increase of quantity, it behoves us to test the qualitative change of the Scottish Universities, and to make sure that they are not of the nature of malignant tumours—rapidly-growing masses with tissues of an embryonic type.

The test is not hard to find in the case of organisms with a unction so definite as the Universities. Increased efficiency

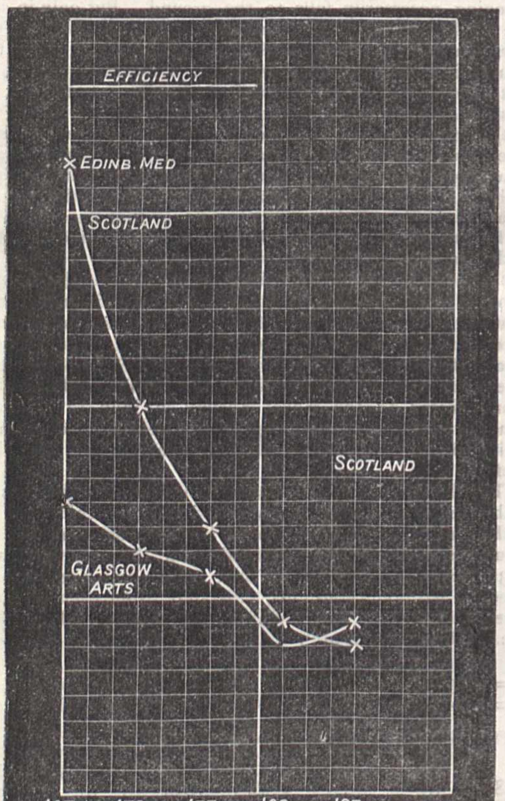

FIG. 1.—Efficiency.

and decreased cost must be the tests, and the results are startling, as shown by the accompanying graphs of the official returns.

The first shows the efficiency in the Arts Faculty in Glasgow, the Medical Faculty in Edinburgh, and for two points the whole of Scotland as tested by the fraction $\frac{\text{Professors}}{\text{Students}}$.

The second shows the quantity, in seconds, of Professor of Anatomy which the students can have for £1 in Edinburgh.

The result is an entire reversal of the usual optimistic picture of progress by growth in quantity, and as I am both hopeful and

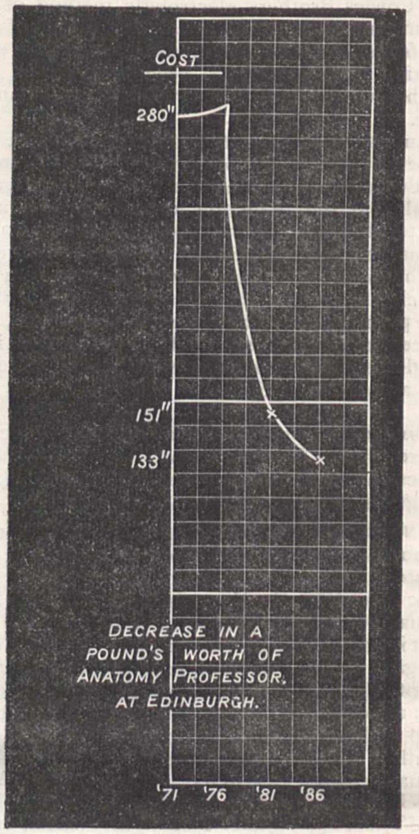

FIG. 2.—Cost.

anxious for the advance in quality of the Universities in which I have spent many years, I hope you will allow me to call attention to its urgency. M.A. ET MEDICUS.

Floating Eggs.

THE floating eggs which a correspondent in NATURE of July 14 (p. 245) describes and refers to *Orthagoriscus*, are apparently those of the angler or frog-fish (*Lophius piscatorius*), which are known to naturalists. They are laid, as Agassiz states (Proc. Amer. Acad. Arts and Sci., vol. xvii. part iii. p. 280), "embedded in an immense ribbon-shaped band, from 2 to 3 feet broad, and from 25 to 30 feet long." The ova of *Orthagoriscus* do not appear to have been yet obtained, and Mr. Green's description accords essentially with the features presented by the eggs of *Lophius*, though no colour is mentioned, whereas the eggs of the frog-fish are of a light violet-gray tint, and when the dark pigment develops in the young embryos the band assumes a blackish hue resembling crape. Examples, I may add, have been obtained on the west coast of Scotland; but, though *Lophius* is extremely abundant at St. Andrews, and on the east coast generally, the ova have not been procured here, as yet. EDWARD E. PRINCE.

St. Andrews Marine Laboratory, Scotland, July 16.

Expression of the Emotions.

IN reading the very interesting letter of "J. M. H." (NATURE, July 14, p. 244), I was much struck with the similarity of purpose and singularity of expression in the robin and in a cat of mine, of which can equally be said, it "invented a note by which it called me to feed it. It was quite peculiar—hushed, short, and muttered, as it were." This note is also used on other occasions, when searching for me, or when exceeding joyous or high-spirited. It is a kind of "crowing," and quite distinct from purring. Darwin, in his "Expression of the Emotions," does not mention it. Is it exceptional? J. L.

Driffield.

EDUCATION IN AMERICA.[1]

IN the Report of the American Commissioner of Education it is shown that the stimulating influence of the educational exhibits and conferences that formed a feature of the New Orleans Exposition is manifest in almost every department of education. A special Circular of Information respecting the Exposition is in preparation by General Eaton, who is at the head of this wide system. His successive Reports are mines of educational wealth; they have aroused and stimulated educational workers everywhere.

In the collection of essays included in Parts II. and III. of "Educational Exhibits and Conventions," many educational subjects are dealt with by specialists. It is claimed on behalf of Massachusetts that it published the first periodical in the English language devoted to the advancement of education, viz. the *American Journal of Education*, started January 1, 1826. The very broad views it set out with are still urged in the United States: that education should be regarded as the means of fitting man for the discharge of all his duties, and that it accordingly includes much that is generally left to home influence. The editor of the *New England Journal of Education* now carrying on the work there observes that "a history of educational journalism in New England culminates in *Barnard's Journal of Education*, full of instruction as to systems, institutions public and private, technical and special schools, history, biography, philosophy, &c., &c." The annual Reports of Horace Mann are "the very gospel of the new education, and are found in the libraries of every country," and the acts of this apostle form an interesting chapter here. It is to be observed that in this model State, where less than two-fifths of 1 per cent. of its native children belong to the illiterate class, no technical education is supplied in the State schools, the old aim of widening the scholar's mind being preferred to that of imparting information. A "noble showing," observes General Eaton, though this last Report records a very small falling off.

Massachusetts is, however, far ahead of some other States. With all the matter for congratulation which follows, and although education is so popular that in Texas the enforcement of it among the few who need compulsory measures may be placed in the hands of the police, surveyors have to own to an increase of even the *proportion* of ignorance in the United States, which is nearly as alarming as ever it was in England. Over 2,000,000 voters, one in every five, are unable to read the ballots which they cast. As an effort to meet this illiteracy, it was suggested in the Congress of Educators that some 65,000,000 dollars should be allowed to various States from national funds, and the proposition of Dr. T. W. Bicknell, of Boston, was that the money should be allotted in proportion to the number of illiterates in every State between the ages of ten and twenty years, diminishing from four dollars a head for the first three years, to one dollar the tenth, eleventh, and twelfth years, when all such illiteracy ought to be overcome.

The highest class of education does not seem to be gaining ground. Dr. Payne, of the Ohio Wesleyan University, urged the importance of increased College education, and of the personal example and influence of high-class teachers, calling attention to the fact that not 15 per cent. of either doctors or lawyers in the United States are graduates of any University. He explains this unpopularity of College education by the great length of time which is given there to unpractical classics, which might easily be made familiar in a shorter way, more economical of time. He asserts that two years and a half might be made sufficient for the work done in a College in four years. Clever and painstaking pupils are yoked together with the idle and stupid; and the same energy and thrift of time by which the former would attain this result makes them reject a University education altogether. A similar reform is required with the object of economy in expenses.

This same "commercial spirit of the age," Prof. Garnett laments, has caused the number of pupils in the University of Virginia to fall off during the last twenty years. This institution is divided into nineteen distinct schools, and each pupil chooses from which he will make up his course of studies. Each school gives a certificate of proficiency or a diploma of graduation, and the University gives the various titles of Bachelor or Doctor of Letters or of Science, of Philosophy or of Arts: also of Bachelor of Law or of Scientific Agriculture; of Doctor of Medicine; of Civil Engineer and of Mining Engineer. With the same desire for higher results, also, Colonel W. P. Johnston, President of the University endowed by "that princely benefactor of education in Louisiana, Paul Tulane," under the roof of which the papers were read, urged the need of a University doing what it could, if it could not do what it would. Much work, he pleaded, was required in a Louisiana University that a German University would reject.

However, General Eaton remarks that 1884–85 was characterized by great activity in all departments of College and University work, and by full and earnest discussion of important questions pertaining to the conduct and development of these institutions, and especially as to the separate functions of Colleges and Universities. Apparently many enthusiasts have convinced themselves that the teacher now stands, not only in the place of the parent, but also of the State and of all guiding influences. Other writers here, besides General Eaton, Canadian as well as those of the United States, describe education as if the school-master would soon have the entire bringing up of the young, starting from the kindergarten school, superintending their games as well as their studies, and maintaining a hold over them till the technical school, seen already to be very near by General Eaton, has turned them out self-supporting citizens. Doubtless the wonderful division of labour and of knowledge into special departments makes it possible for teachers to bring up children with more science than formerly; but surely the human race cannot afford to release parents from the duties which fall so naturally to them, and to waste the zeal and enthusiasm with which mothers especially enter upon these duties. General Eaton has much to say about the responsibilities of teachers. Dr. Mayo cautioned them that the United States were determined to have the best of everything. As the old coaches had been superseded by the Pullman cars, so inferior teachers must make way for superior. But to read these enthusiastic educationalists' views of the duties of teachers, "the burden laid upon them seems greater than they can bear."

None urge the almost boundless importance and dignity of the office of teacher of the young with such fervour and consistency as Brothers Maurelian, Justin, and Noah, of the Christian School. All that they say is quite true except the idea that the ordinary assistant is able to judge of and then to guide the character of every child under his care. It is more than "fond" parents can do for their own children even; and happy must the child be who finds a teacher more devoted than its own parents!

[1] "Educational Exhibits and Conventions at the World's Industrial and Cotton Centennial Exposition, New Orleans, 1884–85." Part II. Proceedings of the International Congress of Educators. Part III. Proceedings of the Department of Superintendence of the National Education Association, and Addresses delivered on Education Days. (Washington: Government Printing Office, 1886.)

"Report of the Commissioner of Education for the Year 1884–85." (Washington: Government Printing Office, 1886.)

Nowhere is the importance of high-class teachers better understood than among the Japanese. A short address given here by their Commissioner describes their eager search after European knowledge for several generations before the present reformed Government came into power, and now the rule is that all employed in instruction—normal teachers at the end of seven years, ordinary teachers at the end of five—must be re-examined to ascertain whether they are keeping up with the progress of the age. But great efforts are made to render the profession in every way attractive. Teachers are exempt from military conscription. Titles, quasi-offices, and ranks are given to them, so that the profession may not be treated as a low or unimportant one. For a similar encouragement of learning, University men are also freed from military service; and even the students of the middle-class schools are exempt from conscription for six years. One speaker, who had been resident in Japan, but had travelled through Europe, claimed for Tokio also the best Froebel kindergarten that he had ever seen. It would not be surprising if the great experiment referred to above were really tried in Japan—such a system of school work as that described by Prof. Hailmann, competent to supersede home teaching altogether. He rather naïvely remarks that his mother was a natural kindergartner. The kindergarten work is a system of technical instruction in which the scientific teacher undertakes to inculcate systematically what parents have hitherto taught as amateurs. Little science and little system are shown in most homes; in fact the kindergartners complain of home influences thwarting their teaching, and urge that young women should attend their schools to learn how to bring up their own families; and one cannot read the principles laid down for a kindergarten school without feeling how appropriate they are for home rule.. In the case therefore of those who can afford such a training, this seems the most efficient and desirable way of carrying the work out; where, on the other hand, a mother has been debarred from such a training, the school may really supersede her home work with advantage. Kindergarten schools accordingly, from every State, were represented at the New Orleans Exposition. The system can hardly, however, become universal, for each child is to be taught in some different way, according to its character, and it is urged by Mrs. Ogden, "if we must crowd, let us crowd the big children, and not the little ones."

As illustrating the principles of kindergarten schools, Prof. Spring, of the Chautauqua School of Sculpture and Modelling, showed, in an experimental address, how much of science could be illustrated by moulding a lump of clay; affirming that a young child caught at the character of various shapes as quickly as an adult. The Commissioner in his Report remarks a large increase in these schools in 1884–85—28 in Pennsylvania alone, 33 in the south and west. Few are supported at public expense, yet the system has had a marked effect in improving the methods of teaching employed.

Prof. W. Hudson, of Texas, lays it down that the interest which a lad can be induced to take in his lessons is a measure of the extent to which his perception, reason, and judgment will be drawn out. More life and reality can be put into a lesson in natural history or botany, and they are therefore more valuable school subjects, and far more useful, than classics. Such pursuits are interesting in leisure hours also, and will keep him out of the mischief to which unemployed energy is so prone. Many experiments in different schools are reported by General Eaton, but so far the only exercises of this kind that it has been found practicable to bring within the reach of the entire school populations are drawing, clay-modelling, and sewing.

A paper was read by Mr. E. M. Hance, Clerk to the Liverpool School Board, on the experimental science instruction first introduced into English elementary schools by that Board. Colonel W. P. Johnston tried to show that technical education is the most beneficial that can be given to the black population. In, we fear, a rather too hopeful simile he compares these latter to the chosen people educated in all the wisdom of the Egyptians before their return to independence. He trusts that one of their great destinies is to re-people with a civilised race their old continent of Africa. Prof. W. J. Thom also urges a technical education for the Negro—not a high-school education, but a farm-labourer's and domestic servant's training. "Unless they know how to work and how to do work, their destruction seems a natural consequence." He, however, looks forward to the black population reaching ten times its actual number, and its present far more rapid increase than that of the white race renders this probable enough. Presidents Fairchild and Long, on the other hand, think that uniform education will heal the breach between the races: the former predicting that twenty-five years of mixed schools would set coloured men on a full equality with the most eminent whites, and hardly leave a vestige of the present "constitutional ineradicable antipathy," which latter epithet we are inclined to judge from the past history of races gives the truer view. He thinks it is a relic of slavery, and asserts that the objection to mixed schools is, not that the antipathy will injure the schools, but that the schools will annihilate the antipathy and bring about an undesired social equality. Strongly pointing against the above hopeful opinions is General Eaton's reference to a tendency among some trade-unions to exclude coloured citizens from industrial training and employment. He accordingly urges that all parties should promote this industrial training by every means, both on the above account and also as the best preparation of Negroes for new and remunerative occupations which must spring up round them. The religious education of the Negro is becoming a special difficulty, and Prof. Thom fears the spread of Mormonism among a race which has neither tradition, habits and customs, nor reverence for law and religion. One matter to which he calls attention may perhaps be a sign that there are influences telling against the blending of the races, viz. that already there is a divergence of Negro dialect from the standard of the vernacular so great as partially to "destroy the uplifting idealism contained in the English tongue."

A most interesting paper, to an English reader especially, bearing on this matter is an account of the present condition of the Negroes in Jamaica after fifty years of freedom. They have nearly doubled their number in the time, and are in more comfortable circumstances. Their dwellings compare favourably with those of Ireland or Scotland. Improvements are recorded of the island generally, exactly answering to the improvements in an English town during the same time, and all done voluntarily and with far less labour than in the old slave times. If they do not love work, still as much voluntary labour was forthcoming as was required to make a railway, without any difficulty on the part of the contractors. Cambridge Local Examinations are held in the island, and some high honours have been taken. Such a sketch must be set against the dark pictures usually drawn. General Eaton, too, in his Report, we are glad to see, thoroughly endorses the accounts of energetic improvement in education still taking place.

A striking feature of the wide views of their duties and responsibilities which are now making their way among educationalists is well brought out in this compilation. There are careful and interesting papers upon all the physical aspects of education; and much is laid down about bodily exercises and training which, though excellent in itself, seems hardly yet to belong to the department of the schoolmaster. The Commissioner urges in his Report that a gymnasium should be attached to every city system of schools, and quotes Germany's example, followed by Austria after Sadowa. Credit is given also to the Germans for leading the way in ventilating school-rooms scientifically. In 1858 Pettenkofer's method of testing the impurity of the air in a room came into use, and a description is here given of a different simple apparatus for the same purpose. The conclusion is drawn that organic matter in "bad air" is more frequently the dangerous part of it than superabundant carbonic acid. England, while at the higher schools formally ignoring this branch of education, nevertheless really recognises it in the games which make themselves of so much importance at the Universities and the great schools that feed them. Physical training was despised and repressed by the monks of old, who founded these schools, and taught that the body was at enmity with the soul, and that the more the former was weakened the more the latter was strengthened and purified; and if with Mr. Galton we regret that all the softening elements of human nature were eliminated by monastic celibacy, we may also console ourselves that, but for it, many injured constitutions must have been handed down as the result of such tenets. Schoolmasters now know that the difficulties of teaching are immensely increased by any physical disorder, and that an absolute incapacity to learn follows some bodily ailments. Imperceptibly increasing from the sleepiness which follows upon a good dinner comes the dulness caused by the bad air of ill-ventilated rooms. There is a long and full paper on this latter subject prepared for independent publication by the Bureau of Education, of great value but too general in its teaching to be epitomised here.

Another cause of what to thoughtless teachers seems irritating stupidity is partial deafness. Interesting observations upon the varieties of this infirmity among school children have been made by Dr. Sexton, of New York. Careful estimates show that only 5 per cent. of the entire population of the United States have normal hearing. Ten per cent. of pupils have such defective hearing as to make special placing and such like care for them in schools necessary. If a teacher has not made himself fully acquainted with the amount of this deafness, a very slightly deaf pupil will either be liable to be sent to the deaf-and-dumb school, or he will leave the ordinary school in disgust at the teacher's harsh and unfair reprimands. Prof. Graham Bell's audiometer is found to answer well in the work of classifying defective hearers. On behalf of the deaf-mute school Mr. Dobyns boasted that theirs was the only universal language: when he met an educated deaf-mute not only from America but from France, Germany, England, or Japan, he could hold communication with him.

From an examination of about forty thousand cases, a Committee on the subject draws the important conclusion that, while very few pupils indeed are short-sighted when they first enter school, "the number afflicted, and the degree or intensity of the disease, gradually but surely increase through the entire school life, from class to class, from year to year, until, when the Colleges and Universities are reached, in many cases more than half the students are near-sighted." This Committee strongly recommends increased use of the black-board and less use of books. This practice has been found to reduce the amount of myopia to one-half. A Report of a second Committee on the causes of it recommends that the head should not be bent forward too much over a desk. Near-sightedness has increased in Alsace since German letters have been used there. There is a special danger of its being brought on at about fifteen years old, the age of puberty.

While these deficiencies are to be found in so large a proportion of children, however, Mr. Jepsen, teacher of music in New Haven, limits the number of children who have really what is called "no ear" for music to less than 4 per cent., and he urges that it may profitably be taught in a thoroughly scientific way to be familiarly read. The Commissioner has felt the importance of this matter so much that through the co-operation of a Music Teachers' Association the heavily burdened Bureau has been already able to draw up and issue a Circular of Information on the study of music in public schools. It is remarked that singing seems to be despised as a school pursuit in the United States, and to be less popular and more neglected than in England. It is taught that mental culture comes chiefly through the eye; moral culture through the ear and voice. Sounds can be taught to children much more easily than numbers. To read music, again, is as great a superiority over singing it by ear as being able to read is better than having learnt a few pieces by heart.

Bearing upon the same question of classifying children according to their powers is a short paper read by Mr. E. Chadwick, of educational celebrity in England, who urges the economy of dividing the bright children from the dull, so as to educate them in less time—a most desirable arrangement for all parties, where it is practicable.

Two papers, one of them also by Mr. Chadwick, take up the subject of rewards and punishments. Mr. Chadwick protests against the use of the stick, while Prof. Barbour urges first the needlessness, and then the danger, of giving prizes, which may breed a sordid character, supply unworthy and therefore unstable motives. They are, he thinks, of no value at all to any but a very few in each class. But in each case it is necessary to supply a motive which the very young can fully appreciate; some terror must be held over the young transgressor's head, and so long as terror is the motive power, the stick is as fair as any other, with the advantage that each culprit is an example to all who see his discomfort, and the influence upon them is nearly equal to that of being caned themselves. The refined torture of solitary confinement, which is considered less degrading, has not this advantage. In like manner, everything in this world is done for a prize, even if that prize be a "high calling," and school-boys require some outward and visible sign of successful labour, books, marks, or class-places. The grosser methods of marking it might well be dropped as the children get older. But rewards we all strive for, and it is untrue that no higher and wider valuation of knowledge replaces the ambition to take home a prize which first led to a laborious pursuit of it.

W. ODELL.

ABSTRACT OF THE RESULTS OF THE INVESTIGATION OF THE CHARLESTON EARTHQUAKE.[1]

II.

LET us suppose an elastic wave to originate at a point C (Fig. 1) situated at the depth q, below the surface. Let the intensity of the shock (amount of energy per unit of wave-front) at the distance unity from C, be denoted by a. Since the intensity is inversely proportional to the square of the distance, the intensity at the epicentrum would be $\frac{a}{q^2}$. Take any other point on the surface of the earth at the distance x from the epicentre, and connect it with C by the line $Cx = r$. The intensity at any such point will obviously be equal to $\frac{a}{r^2}$. If we denote the intensity by y, we shall then have the equation—

$$y = \frac{a}{r^2} = \frac{a}{q^2 + x^2}.$$

This equation expresses a curve which will serve as a

[1] Paper read before the National Academy of Sciences at Washington, on April 19, 1887, by C. E. Dutton, U.S.A., and Everett Hayden, U.S.N., U.S. Geological Survey. Continued from p. 273.

graphic representation of the way in which the surface intensity varies along a line radiating from the epicentre.

The first noteworthy feature of this curve is the contrast between the rapidity with which the intensity diminishes near the epicentre and the slowness with which it diminishes at remote distances. Thus, at a distance from the epicentre equal to the depth of the focus, the intensity has fallen one-half; at twice this distance it has fallen to one-fifth; and at three times the distance to one-tenth of

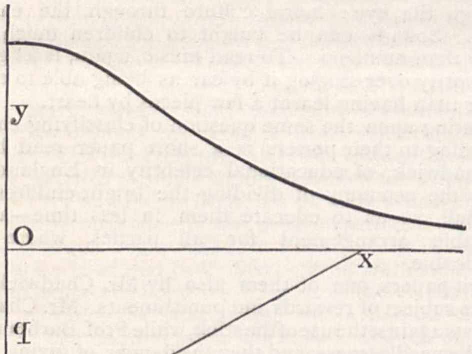

Fig. 1.

the intensity at the epicentre. This suggests at once the possibility of making an approximate estimate of the depth of the focus, based upon the rate at which the intensity of the shock at the surface diminishes in the neighbourhood of the epicentre. If we were able to construct upon any arbitrary scale whatever a series of isoseismal curves around the central parts of the earthquake with an approach to accuracy, this depth would follow at once from the relations of these isoseismals to each other. In the case of a very powerful earthquake in

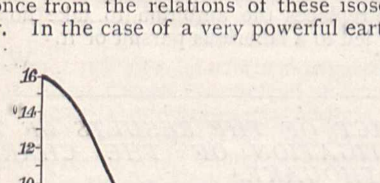

Fig. 2.—Energy constant, depth varying in ratios 1, 2, 3, and 4.

a region which is so flat and uniform in its features as the vicinity of Charleston, this can be done with a rough approach to accuracy.

To appreciate more fully the validity of this mode of reasoning, let us take a series of these intensity curves and vary the values of the constants. And first let us suppose the total energy of the shock measured by the constant, *a*, remains the same, while the depth of the focus varies. The first series of curves (Fig. 2) will enable us to make a comparison of the effect of two or more shocks of the same total energy but originating at different depths. The intensity at the epicentre being inversely proportional to the square of the depth, the shallower shock would be much more energetic than the deeper one; while at a great distance from the epicentre the two would be approximately equal in their effects. The rate of diminution of intensity would be correspondingly varied, and we might commit large errors in estimating these ratios on the ground, while the error of the depth deduced for the focus would be less than our errors of estimate. In short, the method is not sensitive to small or moderate errors of observation.

The second series of curves (Fig. 3) is conditioned upon the assumption that the depth remains constant while the

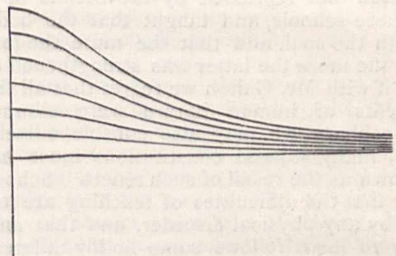

Fig. 3.—Depth constant, energy varying from 1 to 6.

energy of the shock varies. In these curves, the ordinates corresponding to any abscissa are proportional to each other in a simple ratio. In the first series they are proportional to each other in a duplicate ratio.

The third series (Fig. 4) represents the effect of varying both the energy and the depth in such a way that the intensity at the epicentre is constant.

It will appear, therefore, that every shock must have some characteristic intensity curve, depending upon the total energy and the depth below the surface. The intensity at any point along the surface will therefore depend upon these two quantities: energy and depth. It still remains to find some means of discriminating whether the intensity at any point is due to a more energetic

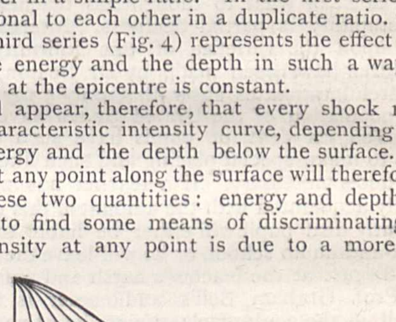

Fig. 4—Depth and energy both varying, but with constant intensity at the epicentrum.

shock deeply seated, or to a less energetic one nearer the surface. The criterion is soon given.

It is obvious that in any shock there is some point at some particular distance from the epicentre at which the rate of diminution of surface intensity has a maximum value. As we leave the epicentre and proceed outwards in any direction, the intensity diminishes at first more and more rapidly, but further on diminishes less and less rapidly. We wish to find the point at which the rate of decline changes from an increasing to a decreasing rate. In the curve this point is represented at the point of inflexion where the curve ceases to be concave towards the earth, and begins to be convex towards it. To find the co-ordinates of this point we differentiate the equation of the curve twice, and equate the value of the second differential coefficient to zero, and deduce the corresponding value of the abscissa x—

$$\frac{d^2y}{dx^2} = \frac{8ax^2 - 2a(q^2 + x^2)}{(q^2 + x^2)^3} = 0 ;$$

which equation is satisfied when

$$8ax^2 = 2a(q^2 + x^2),$$

whence

$$\pm x = \frac{q}{\sqrt{3}}.$$

In this value of x, it is seen that the constant, a, has disappeared, and the abscissa of the point of inflexion is therefore independent of the energy of the shock, and dependent upon the depth alone. The meaning of this is that the distance from the epicentre to the point where the rate of decline of the intensity is greatest is simply proportional to the depth of the focus, and is the same whether the energy be greater or less. This property of the intensity curves makes us independent of any absolute standard of measurement of the intensity, and all that we require is to find with reasonable approximation the points where the intensity falls off most rapidly. The depth of the focus follows at once.

The determination of the epicentral tract is chiefly the work of Mr. Earle Sloan, of Charleston, a young civil engineer who immediately after the disaster made an extensive series of observations. In the brief time at his disposal he accumulated a surprisingly large amount of detailed information, and in searching for it exercised a discrimination and sagacity which would have been highly creditable to the most experienced and learned observer. It is to be regretted that his business engagements prevented him from continuing the work. As it is, he has located with considerable precision the epicentral tract, and has furnished data which show well the variation of intensity along several lines radiating from it.

The summary obtained from the examination of Mr. Sloan's data is as follows:—The tract which includes the most forcible action of the earthquake is an elliptical area about twenty-six miles in length, and with a maximum width of about eighteen miles. The major axis of this area is not a straight line, but a curve which is concave towards Charleston, and is situated from fourteen to sixteen miles west and north-west of that city. Along this line there are three points each of which has all the characters of an epicentrum, determined by as many distinct shocks, each having a focus of its own.

Much of the most powerful shock centres in the northernmost focus, though the other two were of sufficient energy to have occasioned great havoc if either of them had occurred alone. The southernmost was also considerably more energetic than the middle one. The distance between the northern and southern epicentres was about twelve miles. Within this tract, except near the edges of it, the motion was most conspicuously of subsultory character, *i.e.* motion in which the vertical component predominated over the horizontal. The marginal portions of this area, where the character of the movement changes, and where the intensity falls off most rapidly, seem to be very well indicated. The positions where the intensity most rapidly declines may be confidently located with an error not exceeding one or two miles on both sides of the epicentres. The South Carolina Railroad crosses the tract in a straight line very near the most forcible seismic vertical. The first point where the intensity falls off with greatest rapidity is near the ninth mile-post, measuring from the railway depot in Charleston, and so well marked upon the ground are the indications of this change, that it seems very improbable that this point is more than a mile distant either way from the precise point we seek to locate. Passing north-westward through Summerville to the opposite side of the tract, we find the corresponding point of most rapid decline in the vicinity of the twenty-third mile-post. This gives us a base-line with which to measure the depth of the focus of the principal shock. The computed depth is twelve miles, with a probable error of one or two miles. The computed depths of the other foci are about the same, but the probable errors are somewhat larger.

In speaking of a focal point of a shock, it must be understood as referring to the centre of all the forces, considered with reference both to amount and direction, which constitute a great seismic impulse. The presumption is that this impulse originates in a large subterranean tract, of which this ideal focus is merely the central point, or nearly so. The form of the subterranean tract may be anything; and, within limits, may have its three dimensions, length, breadth, and thickness, of any magnitude, and bearing any ratios to each other. The form and dimensions of it we cannot of course determine, though it may be possible to obtain some notion of its most general features if the data are sufficient.

This method of computing the depth of a seismic focus is here proposed for the first time. The method employed by Mallet, which consists in finding the angle of emergence of a wave front from the earth by studying the configuration of cracks in buildings is believed to be valueless by nearly all seismologists. There is no definite angle of emergence of the nature he contemplates disclosed at the surface. Certainly in Charleston there was nothing of the kind to be found. The method employed by Seebach is sound in theory, but it requires such extreme accuracy of time determinations that very small errors of time give very large errors in the result. Our own method consists of finding two points on opposite sides of the seismic vertical, at which the changes in seismic action along a given line are most strongly marked. These points ought to be indicated in powerful earthquakes with a fair approach to precision, and the probable errors of determination should not usually exceed one or two tenths of the distance between the two points. The feebler the shock, however, the less is the degree of precision to be expected. Whatever may be the errors in the estimate of this distance, the resulting error in the computed depth is smaller than the error of observation in the ratio of the square root of three to two. How much the estimate may be vitiated by want of homogeneity in the superficial strata we have no means of determining, but we do not believe that it would be so affected to any great extent in such a region as South Carolina. Being independent of any absolute measures either of the surface intensity or of the total energy of the shock, the greatest difficulty of all is at once eliminated. Our opinion of this method is that it is incapable alike of very great precision and of very great errors

Probably the first thought occurring to anyone examining this method will be that the determination of the two required points would be liable to very large errors. But if he will examine the varying values of the ordinates of the curve corresponding to varying values of the abscissæ, and of the depth, we think he will be satisfied that the limits within which each of the two points of inflexion must fall cannot be wide apart, and that an error in the determination of the base-line greater than two-tenths of its estimated length would, in such a country as Carolina, be very improbable. It will appear that the relations of these variables are such as to restrict the locus within which the desired points are to be found to a very narrow annulus around the epicentrum. We think the method will greatly improve on acquaintance.

We have endeavoured to apply our method of computing the depth of the focus to other earthquakes, but have found difficulty in obtaining anything more than very general results, such as the following:—The depth of the

Charleston earthquake was relatively great, and we find reason for believing that, among those great earthquakes of the last 150 years of whose effects we possess any considerable knowledge, none have originated from a much greater depth, and few from a depth so great. Our reasoning is this:—Very few earthquakes have been felt at a distance from the origin so great as 1000 miles. But the greatest distance at which the tremors are felt is the best measure of the total energy of the shock. On the other hand, the intensity of the Charleston earthquake in the epicentral tract was relatively low in comparison with other great earthquakes. If, then, any shock is more intense at the epicentre, without extending to a greater distance than that of the Charleston earthquake, it is certain that its focus was nearer the surface. This is true of the vast majority of recent earthquakes which have been sufficiently investigated. It is suggested that all estimates of the depth of foci much exceeding that of the Charleston earthquake are in need of re-examination.

The city of Charleston is situated from eight to ten miles outside of the area of maximum intensity, and did not experience its most destructive power. Following the law which we have laid down, the intensity of the shock at Charleston was only three-tenths what it must have been at the epicentrum and about one-third the intensity at Summerville. The diagram showing the long intensity curve stretching from Charleston to a point

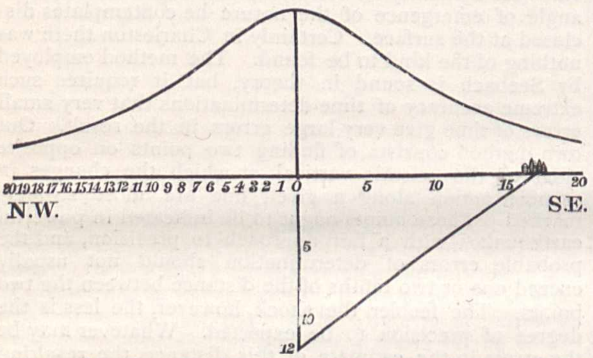

FIG. 5.—Intensity curve of maximum shock twenty miles each side of epicentrum.

forty miles north-west of it will illustrate the position of the city with reference to the varying force of the shock.

Had the seismic centre been ten miles nearer to Charleston, the calamity would have been incomparably greater than it was, and the loss of life would probably have been appalling. Another circumstance greatly broke the force of the shocks. All the coastal region of the Carolinas consists of a series of clays and quicksands, which have been penetrated by artesian borings to a depth of 2000 feet, and which are believed to have a much greater thickness. These beds of loose material no doubt absorbed and extinguished a considerable portion of the energy of the shocks. We have already remarked that a wave passing from firmer and more elastic material into material less firm and elastic produces at first an increased amplitude of wave-motion, which is liable to be more destructive or injurious to buildings. But if the mass of less consistent strata be very great, the reverse result is produced by reason of the rapid extinction of the energy in passing through a considerable length or thickness of very imperfectly elastic material. We cannot but think that Charleston owes in some measure its escape from a still greater calamity to the quicksands beneath the city.

Another aspect of the same fact, if such it be, is found 100 miles west and north-west of Charleston. Here the loosely-aggregated sediments of Tertiary and Cretaceous age which cover the Carolina coastal plain have thinned out, and the crystalline rocks appear at the surface, thinly covered with soil and alluvium. All along the junction of these loose strata and superficial material with the metamorphics the intensity of the shocks was conspicuously greater than to the eastward and southward. The loose covering of these firm rocks is just thick enough to give full effect to the increased amplitude of vibration which occurs when the wave passes from very solid and elastic rocks to those which are less so.

We have also endeavoured to reach some trustworthy estimate of the amplitude of movement at the surface, but the results are meagre and far from satisfactory. The "amplitude of the earth particle" in any earthquake is a question of great practical importance, and it is much to be regretted that no better facilities for determining it can be obtained. There were, however, many occurrences at Charleston bearing upon this question, which are extremely difficult to explain upon any valuation of the amplitude less than 10 inches to a foot. Such amplitudes, however, were most probably limited to spots here and there, while in other spots it was probably much less. That within a small area the amplitude of movement in the surface soil varies between very wide limits seems to be a practically certain conclusion from the observations. In Charleston it appears to have been greatest in the "made ground," where ravines and sloughs were filled up in the early years of the city's history. The structures on higher ground, though severely shaken, did not suffer so much injury.

With regard to the time data from which the speed of propagation must be computed, we are not yet in a position to give final results, but can only state how the problem stands at present. The time reports have been placed in the hands of Profs. Rockwood and Newcomb, with the request that they would scrutinize and discuss them. But neither has been able to finish as yet the task he has so courteously undertaken. Probably the greatest difficulty in the way of determining the speed of propagation arises from the ill-defined character of the disturbance at considerable distances from the origin and from the very considerable duration of it. Wherever a time observation seems to be well authenticated, there still remains in most cases the difficulty of deciding to what particular phase of the earthquake the record refers. And this difficulty is a very serious one. At Summerville the first shock came almost like an explosion. Before people had time to think, they were pitched about like ten-pins. At Charleston there was a perceptible interval estimated at from five to eight seconds from the first note of warning to the maximum of the great shock. At Savannah (ninety miles distant), the interval from the beginning to the first maximum was considerably longer—probably ten to twelve seconds; at Augusta (115 miles), the interval was still greater. And, generally speaking, the greater the distance the more the phenomena were "long drawn out." The duration of the earthquake at Charleston will probably never be known with accuracy. But the general testimony ranges between fifty and ninety seconds. At Washington (450 miles), Prof. Newcomb with his watch in his hand observed a duration of perceptible tremors, with two maxima, lasting about five and a half minutes. Prof. Carpmael's magnetographs recorded the disturbance, and he interprets their photographic traces as showing a duration of about four minutes. Mr. G. W. Holstein, of Belvidere, New Jersey, gives five minutes very nearly as the observed duration. From other localities come well-attested observations showing durations of several minutes, though few of these pretend to give the whole time with any accuracy. This progressive lengthening of the shocks is a well-marked feature of the testimony. The explanation suggests itself at once. The elastic modulus of compression being greater than that of distortion, the speed of the normal waves is the greater while the waves of distortion lag behind.

It is obvious that the phase which it is desired to observe should be the arrival of the first impulses. But the great duration of the tremors has left much doubt on this point. Stopped clocks were plentiful all over the country, but at what phase of the earthquake did they stop? So great, indeed, are the uncertainties on this point that the observations of intelligent men, with watches in their hands measuring a part of the shock and estimating the beginning, are in most cases to be preferred to stopped clocks, even though we know with certainty that the clocks had been accurate to the second. It matters little how we twist and turn the time data: the smallest estimate we can put upon the speed of propagation must prove to be a great surprise to seismologists.

The time at Charleston of the occurrence of the main shock has been fixed at 9h. 15m. 10s. p.m., 75th meridian or Eastern standard time.[1] (All times in this paper, unless otherwise specified, are reduced to that meridian.) The uncertainty does not exceed ten seconds. The beginning of the first tremors at Charleston was from six to eight seconds earlier. The time at Summerville was probably less than four seconds earlier than Charleston. For all localities within 200 miles the time observations are of little value. So swiftly did the waves travel that a small error in the time record gives a very large uncertainty in the resulting speed.

The nearest point which yields a valuable record is Wytheville, Va. (286 miles).[2] Mr. Howard Shriver was sitting at a transit instrument, waiting for the passage of a star, and at once noted the time at 9h. 52m. 37s. (reduced to 75th meridian), giving a speed of about 3·3 miles (5300 metres) per second. There is some slight uncertainty about the precise phase of the shock corresponding to the observation.

The Signal Service Observer at Chattanooga (332 miles) gives only the nearest minute for the principal shock at 9h. 53m., corresponding to a speed of 3·02 miles per second, or 4860 metres.

The best observation in our possession is that of Prof. Simon Newcomb himself, at Washington (450 miles), who gives the time of the beginning of the shock at 9h. 53m. 20s., with an uncertainty not greatly exceeding ten seconds. The resulting speed is 3·46 miles per second, or 5570 metres.

From Baltimore (486 miles), Mr. Richard Randolph, C.E., reports a very intelligent and carefully verified observation of 9h. 53m. 20s. as the beginning of the shock—exactly Prof. Newcomb's time for Washington, giving a speed of 3·74 miles, or 6000 metres, per second.

At Atlantic City, N.J. (552 miles), a large pendulum clock in the Fothergill House stopped at 9h. 54m., very nearly. If this may be taken to be the beginning of the shock, the speed would be 3·26 miles per second, or 5250 metres.

George Wolf Holstein, Belvidere, N.J. (622 miles), gives 9h. 54m. for the beginning of the shock and 9h. 59m. for the end, and compared his watch next morning with the time of the Pennsylvania Railroad. The gradual and uncertain character of the beginning and end would not admit of precise determination to seconds. The speed, taking 9h. 54m. for the beginning, would be 3·66 miles, or 5900 metres.

From New York City (645 miles) and its suburban towns and cities come many reports, all of which give either 9h. 54m. or 9h. 55m. as the nearest minutes. If we take, as a mean, 9h. 54m. 25s. at New York and Brooklyn for the beginning of the shock, the speed would be 3·31 miles, or 5330 metres.

At distances greater than 600 miles the difficulty of associating the time records with particular phases of the shocks becomes very great. In most cases the motion was the swaying movement, with only faint tremors of the rapid kind, and those who felt them were slow in recognizing their character. Readers must form their own opinions as to the degree of approximation to the time of the earliest movements from the following records We give them only as we received them, without attempting any discussion.

J. O. Jacot, watchmaker and jeweller, at Stockbridge, Mass. (772 miles), was sitting by his regulator clock; distinctly recognized the nature of the movement, and noted the time as 9h. 56m. The phase of the shock is uncertain.

At Albany, N.Y. (772 miles), Mr. J. M. Clarke, of the New York State Museum of Natural History, heard the mortar falling down the chimney, and the creaking and straining of the building. As soon as he appreciated the character of the disturbance he noted the time by his watch as 9h. 56m. 30s. He did not ascertain the error of his watch. In the same city, Dr. Willis G. Tucker says he instantly looked at his watch, and after comparing it next morning with the time of the Dudley Observatory, and making correction of the error, gave 9h 55m., very nearly, with an error probably not exceeding twenty seconds.

From Fonda, N.Y. (780 miles), Francis L. Yates reports 9h. 55m. (no particulars).

At Ithaca, N.Y. (695 miles), the regulator clock on the wall of the railway depot stopped at 9h. 55m. "exactly."

At Gowanda, N.Y (666 miles), where the shocks were faintly felt, W. R. Smallwood, watchmaker and jeweller, noted the end of the perceptible shocks at 9h. 55m. 30s. by his regulator clock.

At Toronto (753 miles), the earthquake was recorded automatically upon the magnetographic traces in the observatory of Prof. Chas. Carpmael, Superintendent of the Meteorological Service of Canada. In his letter of September 14 he says:—"I may state that at 9h. 55m. p.m. all our magnetic needles were set in motion by earth tremors. The vibrations of the magnets were continued for about four minutes. I would say that from later and more careful measurements from our magnetic curves I make the time of the earth tremor at Toronto to be 9h. 54m. 50s. p.m., standard; this time, I should say, would not be astray more than a few seconds." As this record was automatic, and gave not only the time but the phases, it has been thoroughly investigated by Profs. Newcomb and Carpmael, assisted by Mr. C. A. Schott, of the U.S. Coast Survey. The final result of this re-examination is to change Prof. Carpmael's computation

[1] For European readers it seems necessary to refer briefly to the American "standard time" system, which will assist them in estimating the character of these time records. Throughout the Atlantic States all clocks designed for accurate time-keeping are set daily to the time of the 75th meridian west of Greenwich. In the Mississippi Valley they are similarly set to the time of the 90th meridian; in the Rocky Mountains to that of the 105th, and on the Pacific coast to the 120th meridian. They are called respectively, Eastern, Central, Mountain, and Pacific time, and the differences are exact hours. At some convenient hour every day the wires of every railroad and telegraph company in the country are put into circuit with the clock of some astronomical observatory (or with some standard clock controlled by an astronomical clock), and time signals are sent to every railway station and telegraph office. The station agents, or telegraph operators, of these companies are held responsible that these signals are received, and that their clocks are regulated by them daily. A failure to do so is a breach of discipline. The greatest purveyor of accurate standard time is the Western Union Telegraph Company, which furnishes it at a small charge to some railways, to telephone exchanges, to town and city offices, to hotels, to private corporations; in short, to anybody who wants it. For the Eastern and Southern States it takes its time by a special wire from the National Observatory at Washington. The system is essentially perfect, whereby clocks can be set once each day to exact standard time in every railway station and telegraph office in the country. And at every such station and office it is the duty of somebody to see that it is carried out. How accurately this is done is another matter. It depends upon the discipline of the companies and the habits of individuals, in which there are no doubt varying degrees of precision. The clocks supplied are always good ones, and ought not to have daily errors of over four or five seconds. But the best clock ever made will not keep good time unless properly managed. The demand for extremely accurate time throughout the greater part of the United States is enormous, and this acts as a constraint upon the companies and their *employés* to carry out the system with precision. This same demand has led to the organization of private companies in large towns and cities who receive time from the Western Union Telegraph Company and purvey it to private houses, hotels, merchants, workshops, &c.

[2] The distances have been measured somewhat hastily with a scale upon the War Department map of the United States, taking the greater epicentrum seventeen miles north-west of Charleston as the origin.

to 9h. 56m. 18s. for the beginning of the tremors, with a probable error of fully one minute. This large probable error is due to the very small scale upon which the magnetograph records time intervals (one-tenth of a millimetre corresponding to twenty seconds), and to want of sharpness in the photographed traces. This time gives 2·66 miles per second, or 4250 metres, with a probable error of one or two tenths of the amount.

The clock in the Western Union Telegraph Office at Pittsburgh (523 miles) was stopped at 9h. 54m.

From Cincinnati and suburban towns (500 miles) come many reports. In this city local mean time is largely used, owing to the fact that it is nearly midway between the 75th and 90th meridians, where the only inconvenience of standard time is at a maximum. The correction to the 75th meridian is + 37m. 40s. The Western Union Telegraph Office gives 9h. 54m. The *Times-Star* newspaper gives, from the clock in its own office, 9h. 16m. "exactly" (9h. 53m. 40s. standard); at the *Commercial Gazette* office, 9h. 17m. 45s. local, 9h. 55m. 25s. standard (probably noted after the shocks were over). At the fire tower, after the principal shock, 9h. 16m. 17s. was noted; clock error, twenty-three seconds slow, giving 9h. 54m. 20s. standard. Two other observers, noting by watches, give 9h. 16m.; and one notes an advanced stage of the shocks at 9h. 17m., but give no means of estimating their errors. At Covington, Ky., across the Ohio River, I. J. Evans, watchmaker and jeweller, reports his regulator clock stopped at 9h. 17m. 20s., Cincinnati local mean time. Phase of shock unknown.

From Crawfordsville, Ind. (622 miles), E. C. Simpson, C.E., reports through Prof. J. M. Coulter, of Wabash College: "Suddenly felt my chair move, jumped up and said, 'We are having an earthquake'; at once pulling out my watch I found it was 8h. 54m. p.m. standard time (Central)." Prof. Coulter adds that the watch was exactly with railroad time as shown at the railroad station, and also by the town clock.

From Dyersburg, Tenn. (569 miles), Louis Hughes writes:—"My time-piece was an English patent lever watch of Chas. Taylor and Son, London, which from business necessity I keep closely with railroad time at the station, which receives the time at 10 o'clock every morning. The railroad uses Central time. My first thought was that the shaking was caused by the children in the next room; but in the next moment, recognizing the peculiar sensation, I dropped the newspaper and observed the time, which was probably four to six seconds after 8h. 54m., and from that approximated it in even minutes." Speed 3·25 miles, or 5230 metres.

At Memphis, Tenn. (590 miles), the Signal Service Observer reports a considerable number of stopped clocks, one at 9h. 54m. and the others at 9h. 55m. For some unaccountable reason the seconds were not noted. The phase is unknown.

The foregoing comprise those time reports which seem to justify the presumption that the errors do not exceed one minute. There are others, which are obviously rude approximations, giving exact hours, quarter-hours, or tens of minutes. There are also some which look at first like good observations, but which surely involve some large unexplained error.

As the discussion of the time data is now progressing, no further comment will be offered here beyond the remark that there can be no doubt that the speed of propagation exceeded 3 miles, or 5000 metres, per second. The only questions are how much this speed was exceeded and whether the speed along any given line was constant. As regards the latter question, the data are not yet precise enough to justify an opinion. This matter will be inquired into.

The high rate of propagation will probably prove unexpected to European seismologists. We propose, however, to follow it up with the suggestion that it is about the normal speed with which such waves ought to be expected to travel, and that all determinations of the rate of propagation in any former great earthquakes which are much less than 5000 metres per second (for normal waves at least) are probably erroneous in proportion as they fall short of the Charleston earthquake. Finding as the time reports accumulated that a speed in excess of 5000 metres was indicated, and this presumption having become a conviction, we were led to inquire whether there was not some speed deducible from the theory of wave-motion in an elastic solid to which all great earthquakes ought to approximate.

In a homogeneous and perfectly elastic solid, the rate of propagation is, according to theory, dependent upon two properties of the medium: elasticity and density. There are two coefficients of elasticity in solid bodies, one of which measures their resistance to changes of volume; the other, to changes of form. Absolute experimental determinations of the values of these coefficients have never been made. If, however, we knew the ratios of these coefficients in one substance to the homologous coefficients in any other substance, and if we also knew the rate of propagation in either of them, the rate in the other would be at once deducible. The rate in steel bars has been the subject of much experimentation, and is given by Wertheim, whose researches have been as careful as any, at 16,800 feet per second. But as the waves in a steel bar are essentially waves of distortion, he multiplies this result by $\sqrt{\frac{3}{2}}$ or $\frac{5}{4}$ for the normal wave, giving a speed of 21,000 feet per second. The elastic modulus of steel for engineering purposes is usually taken to be 29,000,000. The corresponding modulus for such rocks as granite and basalt in a very compact state is about 8,000,000. If we may assume that these moduli are proportional to the two elasticities of the two substances respectively, we can compute the rate of propagation in rock. This assumption may or may not be true; but we assume it to be so. Let V_s be the rate of propagation in steel, and V_r the rate of propagation in rock, and let e_s and e_r be their true compressional elasticities, and let D_s and D_r be their respective densities. Our assumption is that $29 : 8 :: e_s : e_r$ from which we may form the equation—

$$\frac{V_s}{V_r} = \sqrt{\frac{e_s}{D_s} \times \frac{D_r}{e_r}}.$$

Taking the density of steel at 7·84, and of deeply-buried rocks in their most compact state at 2·85—

$$\frac{V_s}{V_r} = \sqrt{\frac{29}{7{\cdot}84} \times \frac{2{\cdot}85}{8}} = 1{\cdot}15 \text{ nearly.}$$

Taking the rate of compressional waves in steel to be 6400 metres per second, gives 5570 metres for similar waves in very compact and dense rock. The corresponding rate for waves of distortion would be 4450 metres. These results are so near to those deduced for the Charleston earthquake that they seem to be worthy of consideration.

The experimental measurements of the rate of impulses obtained by Milne and Fouqué seem to us inapplicable. The elasticity of the surface soil, we think, is no more to be compared with that of the profound rocks which transmit the great waves of an earthquake than the elasticity of a heap of iron filings is to be compared with that of an indefinitely extended mass of solid steel. The difference is *toto cœlo*. But the rate of propagation is a question of elasticity and density chiefly. The effect of temperature we have not considered. Perhaps the most striking experiment ever made with an artificial earthquake was at the Flood Rock explosion at Hell Gate, near New York, where General Abbott found a speed of propagation approaching very closely to that of the Charleston earthquake.

The question which is undoubtedly of deepest interest in this connexion is whether the Charleston earthquake throws any new light upon the origin of such events. While we are not prepared to say that absolutely nothing will be added to our information on this question, we are forced to admit that we expect very little new light. Hitherto our efforts have been devoted to bringing together the facts and to arranging and comparing them, and we have as yet given but little consideration to this final question. It will, however, shortly engage our attention, and in anticipation of this we prefer to remain silent for the present, fearing that, if we commit ourselves here to any preference for a particular view, we may find ourselves encumbered with a bias arising from the intensely human propensity to defend, through thick and thin, utterances which have once been formally given.

ON A POINT OF BIOLOGICAL INTEREST IN THE FLOWERS OF "PLEUROTHALLIS ORNATUS," RCHB. F.

IN December of last year (1886), in the Orchid-house at Kew, a specimen of *Pleurothallis ornatus*[1] flowered. Not only is this the first time that it has done so at Kew, but I am informed by Mr. Watson, of the Royal Gardens, who drew my attention to it, that hitherto *P. ornatus* has not been known to flower in captivity.

The flowers of this plant present a most interesting adaptation, whereby to attract insects, of which I propose in this note to give a short account.

The genus *Pleurothallis* is characterized (generally speaking) by the inconspicuousness of its flowers, which, as a rule, are of a reddish-brown colour. The flowers are either solitary and axillary, or in few-flowered racemes. The outer perianth-whorl (sepals), though never exceeding a few millimetres in length, is several times longer than the inner (petals). The sepals are sub-equal, and the lateral ones slightly connate at the base. The two lateral petals are small and wing-like on either side of the column. The short, superiorly-grooved labellum is always shorter than the petals, and articulates with the column by a narrow flexible neck. Such an arrangement, in consequence of which the labellum is more or less vibratile, and after a touch will oscillate several times, is found in several allied genera, *e.g. Restrepia*, and especially *Bolbophyllum*. The genus *Pleurothallis* is tropical American, and epiphytic.

Pleurothallis ornatus is especially distinguished from other members of the genus in the fact of its sepals possessing an extremely conspicuous fringe of white cirrhi. In no other species of the genus, of which I have been able to find figures or specimens, is anything of the kind seen.[2] The hair-like structures which form this fringe in *P. ornatus* average about 2 millimetres in length; and when it is remembered that the extreme diameter of an expanded flower does not exceed 10 millimetres some idea of the conspicuous part played by the fringe is obtained. Figs. 1 and 2 are respectively front and lateral views of a flower, magnified about five diameters. Each hair it will be seen narrows very much at its proximal end, and is in this way rendered versatile. From the fact of the hairs being air-containing they are excessively light, and moved by every breath of air. The motion of course is an entirely *passive* one—they are simply swayed to and fro on the hinge formed by this tapering.

In Fig. 3 is represented a microscopic view of one of the cirrhi detached. It consists simply of a prolongation of one of the epidermal cells at the edge of the sepal—and its lumen is continuous with that of the epidermal cell from which it originates (cf. Fig. 4). In form, the hair resembles that of a flattened club. Its width, throughout most of its extent, averages 0·2 millimetres. But it is flattened in the plane at right angles to this, so that its thickness is only about 0·025 millimetres. Externally the hair has a granular aspect, arising from numerous slight rugosities of its delicate cuticle (cf. Fig. 3). At its proximal end it narrows as it runs into the epidermal cell from which it arose.

In the expanded flower the hairs are air-containing, the protoplasm being entirely collapsed and dried up.

The versatile hairs are inserted along the margin of the sepals at intervals of less than 1 millimetre. Towards the attached part of the sepals they become much shorter.

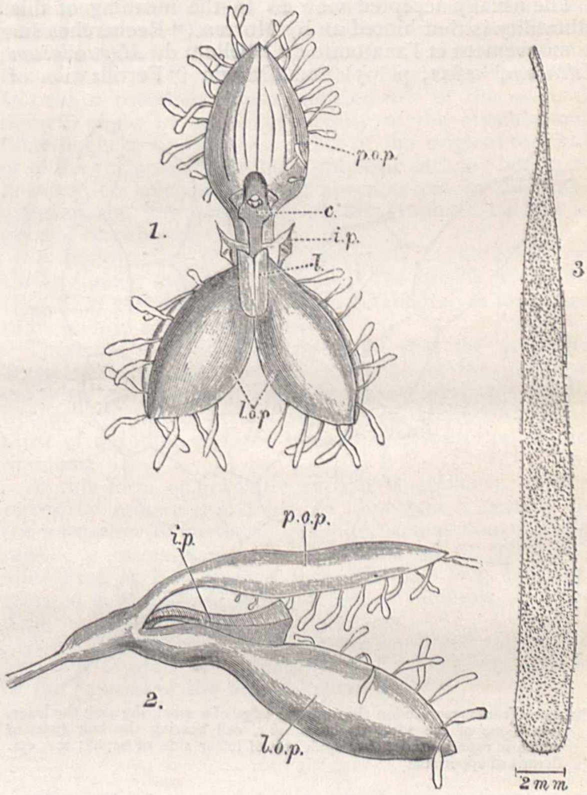

FIG. 1.—View of the flower from in front, × 5 diameters. *c*, column: *i.p*, petals; *l*, labellum: *l.o.p*, lateral sepals; *p.o.p*, posterior sepal.
FIG. 2.—Lateral view of same flower, × 5 diameters. References as in Fig. 1.
FIG. 3.—A single isolated vibratile hair, much magnified.

The precise mode of insertion is seen in Fig. 4, which represents a transverse section of the edge of a sepal. The hair is formed from one of a group of small cells (*h.c*) at the extreme edge of the sepal. In the figure are seen its relations to the parenchyma, and to the upper and lower epidermis (*u.e* and *l.e*) of the sepal.

I have been unable to examine buds of the plant, consequently no account can be given of the development of these hairs.

As regards its biological meaning, there can, I conceive, be little doubt but that the fringe serves to attract insects which fertilize the otherwise inconspicuous flowers. The white lustrous appearance of the cirrhi is a consequence of their air-content; and it is as important a factor as their versatility, in successfully rendering the small brown flowers conspicuous to insects. As I have

[1] Described by Prof. H. G. Reichenbach in Wittmack's *Gartenzeitung*, 1882, p. 105. To him I am indebted for this reference.

[2] Except perhaps in *Pleurothallis ciliata*, which is described and figured by Knowles and Westcott in "The Floral Album," vol. i. p. 40. Here, however, it is the *petals* which have a ciliated border. No description is given of the hairs, though the authors mention having examined them microscopically. The figure is a bad one, and barely shows the existence of a fringe.

said above, the motion is provoked by the least possible breath of air.

I do not remember a mechanism entirely like this elsewhere among either Orchids or other Phanerogams. Many Orchids are provided with long fringes, but these are due to excessive dissection of the sepals (as in Cirrhopetalum), or to hairs—often multicellular—which, however, are non-versatile. Mr. Rolfe, of the Kew Herbarium, reminds me of the case of *Bolbophyllum lemniscatum.* I need not here further mention the extraordinary appendages of the sepals: they are figured in the *Botanical Magazine*, Pl. 5967.

The labellum in *P. ornatus* is quite small: in Fig. 1 it is shown at *l*, but in the lateral view (Fig. 2) it is hidden by the two petals (*i.p*). Like the labellum in so many allied Orchids, it moves readily on its narrowed neck if touched. The oscillations are performed especially in a vertical plane.

The usually accepted view as to the meaning of this vibratility is that hinted at by Morren ("Recherches sur le mouvement et l'anatomie du labellum du *Megaclinium falcatum*," 1841, p. 95) and Darwin ("Fertilization of

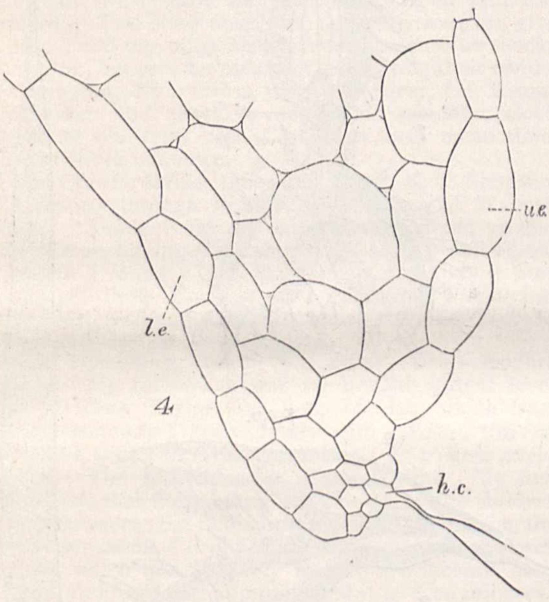

FIG. 4.—Transverse section through the edge of a sepal, showing the insertion of one of the vibratile hairs. *h.c*, cell bearing the hair (part of which is represented); *l.e*, epidermis of lower side of sepal: *u.e*, epidermis of upper side.

Orchids," p. 171); *i.e.* that by the continued motion of the labellum caused by the wind, insects are led from motives of curiosity to visit the flower. This explanation will hardly hold for such a genus as *Pleurothallis*, where the labellum is extremely small, and its motion would be hardly obvious from outside the flower. Here the labellum acts rather as a spring-board. The insect entering the flower will lean upon and displace the labellum, which, from the extreme elasticity of its neck, will oscillate up and down in precisely the same manner as a spring-board would. By this is insured the insect's head being thrust against the stigma or pollen-masses, and the act of pollinization promoted. Sometimes I have found that if the labellum be displaced by gently pressing downwards it will be retained for a few seconds in the displaced position on removing the force. Soon, however, the elastic reaction overcomes the resistance of the sepals (by which it is temporarily jammed), and the labellum flies up again, considerably overstripping its normal position of rest. After one or more small oscillations, it comes to rest. Such a simple experiment as this shows well enough how such an arrangement can aid cross-fertilization.[1] I believe this is the chief part played by the vibratile labellum in *Bolbophyllum*, in which genus the elasticity is especially manifest. This in no way excludes the attractive function suggested by Darwin. This latter could only hold for cases where the labellum is easily visible outside the flower, and for such cases as *B. barbigerum*, *B. tremulum*, &c., where it is richly plumed. On the other hand, there is no reason why the "spring-board" function should not operate in every case of vibratile labellum; hence I regard this as its primary significance, whilst the attractive one is secondary only. This is a question which I hope soon to follow up.

F. W. OLIVER.

Jodrell Laboratory, Kew.

CUBIC CRYSTALS OF GRAPHITIC CARBON.

IN the analysis of a meteoric iron found in 1884 in the sub-district of Youndegin, Western Australia, and of which two of the four fragments have been generously presented to the British Museum by the Rev. Charles G. Nicolay, Curator of the Geological Museum, Fremantle, I have obtained some crystals, a description of which may be of interest to the students of carbon.

The crystals were obtained as an insoluble residue on treatment of 8·3200 grammes of the iron with aqua regia: they are bright, opaque, grayish-black, have a metallic lustre, and present forms belonging to the cubic system. As their characters were not recognized as belonging to any known mineral, it seemed unlikely that the nature of the crystals could be completely determined, seeing that the total weight obtained was only 3 milligrammes; further, two fragments of the iron, weighing 2 and 7 grammes respectively, had not yielded a single crystal, and there was thus a possibility of their being so localized in the iron as to render impracticable an increase of the quantity of material available for experiment.

The crystals were about a hundred in number, the average thickness of the larger ones being 1/100 of an inch. Many of them are sharply defined cubes; some have their edges truncated by the faces of the dodecahedron; in others the edges are replaced by rounded faces of a tetrakishexahedron.

Their hardness is greater than that of rock salt and less than that of calcite: the streak is black and shining. Of four crystals, two sank to the bottom and two remained near the surface of a solution having a specific gravity of 2·12. The crystals are unaffected by acids: heated in a combustion-tube in a current of oxygen, hydrogen, or chlorine, they are unattacked, even when the glass begins to melt. Heated in a platinum capsule with the table-blowpipe, they slowly disappear without flame. Heated with potassium nitrate in a crucible over a Bunsen burner, they are unaltered; but disappear very slowly, without deflagration, when heated with the table-blowpipe.

In density, colour, and streak, and in its chemical behaviour, the residual mineral thus bears a close resemblance to native graphite, but it is considerably harder, and it presents itself in well-defined crystals which belong, like those of the other crystallized form of carbon, the diamond, to the cubic system: terrestrial graphite, when crystallized, is found only as tabular crystals so indistinctly formed that doubt has long existed as to whether they should be referred to the hexagonal or monosymmetric system.

In a paper entitled "Graphite pseudomorphous after Iron Pyrites," Haidinger, in 1846, described some graphitic crystals which were doubtless similar to those furnished by the Youndegin iron: his observation, however,

[1] Regarding the nature of the pollinia, and their mode of removal in *Pleurothallis*, *vide* Darwin, *loc. cit.* p. 166.

has been forgotten, and is without record in modern meteoric literature. The crystals—of the size, number, and completeness of which Haidinger makes no mention—were obtained by him from a nodule of graphite which had dropped out of the Arva meteoric iron, and chiefly from a study of their form he inferred that they were pseudomorphous after iron pyrites. Even yet no iron pyrites, crystallized or massive, has been found in a meteorite, the meteoric sulphide of iron being, not the bisulphide, but the protosulphide: further, Gustav Rose, after examination of the crystals, expressed the opinion that the replacement of the edges of the cubes was suggestive rather of holosymmetry than of hemisymmetry, an interpretation which would exclude iron pyrites as a possible antecedent mineral.

The Youndegin graphitic crystals support the view entertained by Rose: the existence of the dodecahedron face, of which there is goniometrical proof, is of itself quite sufficient to show that the crystalline form is distinct from that of iron pyrites.

The iron pyrites theory being discarded, and the fact being recognized that no mineral constituent of meteorites has yet been found which crystallizes in forms similar to those of the graphitic crystals, there naturally arises a feeling of doubt as to the correctness of the view according to which they are of pseudomorphic origin, and thus a question as to whether they may not possibly be a third allotropic condition of crystallized carbon presenting the general characters of graphite, but a crystalline form frequent in the diamond.

Bischof denies the possibility of explaining the pseudomorphism of terrestrial minerals by any other process than the slow action of water, of which there is no evidence in meteorites; and though it would be unsafe to argue that only in this way could meteoric pseudomorphs be produced, there is sufficient difficulty in their explanation to demand strong evidence before the pseudomorphism of the graphitic crystals is granted, more especially when we have regard to the fact that no other graphitic pseudomorph has yet been established either in meteoric or in terrestrial minerals.

Examination of the Youndegin crystals under the microscope shows that some of them are hollow, and appear to be built up of successive cubical shells: on several of the crystals there are globular growths covering a large part of a cube-face, and occasionally the globule is broken, and is seen to be merely a thin, now empty, shell, of which the bottom is the face of the cube. The crystals are easily frangible, and no cleavages were observed: they appear to be quite homogeneous in their material.

Although some of these characters suggest a pseudomorphic origin of the crystalline form, it cannot be said that they prove it. Both of the recognized crystalline forms of carbon, graphite and diamond, have long been standing difficulties for the crystallographer. As already pointed out, the crystals of graphite are rarely more than mere tables, of which there is a controversy as to the crystalline system; those of the diamond are often so different in their geometrical characters from the crystals of every other known substance, that it cannot be satisfactorily determined whether they are to be referred to a holosymmetric or to a hemisymmetric type.

Hollow and skeleton crystals are often the result of a hurried crystallization, as is so well seen in the artificial crystals of bismuth and of common salt. The diamond, too, when in cubes, has faces more uneven than those of the Youndegin crystals, and shows usually the same replacement of its edges by rounded faces of tetrakishexahedra.

It thus might be argued with some force that the Youndegin crystals have been the result of a hurried crystallization of carbon, and that, while striving to reach a dignity which has been assigned to cubes of diamond, they have been overtaken by misfortune and come out in cubes of the less honoured mineral, graphite. The obtuse, almost flat, square pyramid seen on some of the cube-faces, the hollow globular growths, the occasional parallelism of the grouping of the cubes are distinct, however, from what is met with in the diamond.

And after consideration of all the observed characters of these crystals it will be seen that the explanation of the occurrence of the crystals in the interior of a mass of iron by means of pseudomorphism is untenable. Though the easy frangibility, the absence of evidence of cleavage, the hollowness, and the occasionally crust-like structure, are more or less characteristic of pseudomorphic crystals, they are not incompatible with an independent crystallization: on the other hand, while the superior hardness distinguishes the crystals from those of native terrestrial graphite, the separateness, completeness, and general excellence of the crystals, the delicacy of various acicular projections, and more especially of the obtuse, almost flat, square pyramid seen on some of the cube-faces, are sufficient to prove that the crystalline form never had a previous tenant. The delicacy of the acicular projections is such that the crystals must have been formed *in situ*. In case of pseudomorphism the elements of the original mineral ought to be in the vicinity of the crystals, and there ought to be an excess either of the original mineral or of the replacing amorphous graphitic carbon: both are, however, conspicuous by their absence, and in this fragment of the iron the whole of the graphitic carbon is present as cubic crystals.

On examination of a large graphitic nodule from the Cocke County meteoric iron, now in the British Museum, crystals of graphitic carbon, cubo-octahedral in form, are to be seen in some of the crevices.

There can be absolutely no doubt that the graphitic crystals are the result of crystallization of the meteoric graphite, and that they represent a third allotropic condition of crystallized carbon, the general characters being those of graphite, and the crystalline system that of the diamond.

As this form of graphitic carbon is unknown among terrestrial minerals, and has so important a bearing on the formation of meteoric graphite, it may conveniently receive a special name; I suggest the term "cliftonite," after Prof. R. B. Clifton, F.R.S., who has long been interested in the physical characters of minerals, and has done much to encourage their study.

A full description of the meteoric iron itself and of the graphitic crystals will appear in the forthcoming number of the Journal of the Mineralogical Society.

L. FLETCHER.

NOTES.

WE are glad to learn that at the Naval Review (some lessons suggested by which we may refer to in a future number) 120 official invitations were sent out to men of science, while many were hospitably entertained by the Peninsular and Oriental, the Orient, the British India, and the Cable-Laying Companies. Some time next century we may hope that the existence of science, of a Royal Society, and of eminent scientific men employed in the public departments, may dawn upon the then Lord Chamberlain. The Jubilee dinner of the Electric Telegraph, which is going on as we go to press, is a brilliant affair, to which we shall refer at length next week.

WE print to-day the text of the Technical Education Bill. It was absolutely necessary that some such measure should be introduced, and we may hope that as it has no relation to party politics it will be passed without much difficulty. One change in the Bill ought certainly to be made. According to the fourth clause, there is to be no payment out of the local rate in respect of a scholar unless or until he has passed the sixth standard. This may be a very proper provision so far as boys are concerned;

but it must not be applied to the case of adults, many of whom should be encouraged to take advantage of the new system of technical instruction. A man of thirty would be extremely unwilling to go in for an examination in reading, writing, and arithmetic, but there is no reason why there should not be payment out of the local rate on his behalf, if he is disposed to enter upon a regular course of technical education. The more adults who can be induced to attend technical schools, the better for the working classes and for the country.

WE have received a circular bearing the signatures of W. E. Ayrton, Michael Carteighe, Alfred E. Fletcher, G. Carey Foster, Michael Foster, J. H. Gladstone, H. Forster Morley, William Odling, Sydney Ringer, H. E. Roscoe, W. J. Russell, and P. J. Worsley, who have either been pupils of Dr. A. W. Williamson during the thirty-eight years that he has been Professor of Chemistry in University College, London, or have been otherwise intimately associated with him. In this circular it is suggested that Prof. Williamson's resignation of his Chair affords a fitting opportunity for recording, in some permanent manner, the high appreciation of his influence as a scientific teacher, and the feeling of personal regard for him as a man, which are so generally entertained by those who know his work and character. It is accordingly proposed to ask him to sit for a portrait to be presented to University College, and subscriptions are invited for this purpose. As it is expected that this proposal will be widely responded to, one guinea is suggested as the ordinary amount of a subscription. Dr. W. J. Russell, F.R.S., 34 Upper Hamilton Terrace, N.W., has agreed to act as honorary treasurer of the fund to be collected, and Michael Carteighe, Esq., 36 Nottingham Place, W., and Dr. H. Forster Morley, University Hall, Gordon Square, W.C., as honorary secretaries.

THE Council of King's College, London, has elected Mr. J. W. Groves—Demonstrator of Practical Biology—to the Chair of Botany, rendered vacant by the resignation of Prof. Robert Bentley.

MR. W. L. SCLATER, B.A., of Keble College, Oxford, has been appointed by the Trustees of the Indian Museum, Calcutta, to be Deputy Superintendent of their Museum in succession to Mr. Wood Mason, who has become Superintendent upon the resignation of Dr. Anderson. Mr. Sclater, who was a pupil of Prof. Moseley, took a first class in the final Examination for Natural Science in 1885, and has since been working under Prof. Ray Lankester and Mr. Sedgwick, and for the last three years has prepared the report on mammals for the "Zoological Record." Last winter Mr. Sclater passed several months in British Guiana, under the hospitable roof of Mr. E. F. im Thurn, and made collections in several branches of natural history, which have been described in the Zoological Society's Proceedings.

THE summer meetings of the Institution of Naval Architects were opened on Tuesday in the hall of the Literary and Philosophical Society, Newcastle-on-Tyne. Lord Armstrong began the regular business of the conference by reading a paper by himself and Mr. J. Vavasseur on the application of hydraulic pressure to gunnery. A paper was also read by Mr. F. C. Marshall on recent developments in marine engineering. After the meeting the members were conveyed in brakes to the Elswick Works, where they were shown over the ordnance and ship-building departments, and were entertained to luncheon by Lord Armstrong.

AN Electrical Exhibition will be given in New York in the autumn by the New York Electrical Society. The Exhibition will be open from September 28 to December 3. It will include, says *Science*, "all that relates to the science and application of electricity in its broadest sense." As no electrical exhibition has ever been held in New York, it is expected that this one will attract a large number of visitors.

WE learn from *Science* that the American Committee of the International Congress of Geologists will present a report at the approaching meeting of the American Association concerning the positions to be taken by the representatives of American geologists at the next session of the Congress in London (1888), upon the more important questions of nomenclature, classification, and colouring, which will there be discussed. The Committee requests that a day may be set apart by Section E for the consideration of these questions, and it proposes that all American geologists (whether members of the American Association or not) shall be invited to attend this session and participate in the work.

WITH respect to the recent small but exceedingly fierce and destructive cyclone, which literally effaced a station on the coast of the Bay of Bengal, called False Point (NATURE, pp. 110 and 136), a correspondent writes to us from Calcutta :—"The storm was an exceedingly interesting one, and some of its features are quite different from those previously recorded. It is very noticeable in the fact that at the centre of the storm a lower pressure was recorded than during any storm that I have read of, for pressure fell to nearly 27 inches at sea-level. The rapidity with which the pressure fell was also extraordinary."

PROF. PEDLER, Principal of the Presidency College, Calcutta, who is in charge of the Bengal Meteorological Department, gave notice of the existence of this terrible storm in the middle of the Bay of Bengal five or six days before it broke over the land. He was also able to give twenty-four hours' notice of the precise part of the coast which the storm would (and did) cross. He hoisted warning signals in the river at Calcutta to prevent ships from leaving. Unhappily one steamer went out in spite of the signals, and foundered, with about 900 people on board, every one of whom was drowned. In obedience to the signals, six or seven other vessels remained in safety. Among these vessels were two steamers going to the same port as the one which foundered, and having about as many people on board. A large number of persons, therefore, owed their lives directly to meteorological science. It would be hard to conceive a more striking illustration of the practical value of meteorology.

WE have received the concluding part of the Quarterly Weather Report of the Meteorological Office for the year 1878. This volume is the third of the new series begun in 1876, and contains charts showing mean meteorological conditions for each month, a general summary of the weather for each quarter, and the usual tables giving the results derived from the records of the seven observatories then co-operating with the Office, together with continuous curves of the self-recording instruments. In an appendix is a paper by General R. Strachey, R.E., F.R.S., Chairman of the Meteorological Council, which will be very available for agriculturists. By the use of the tables the amount of the excess or defect of the daily temperature above or below any fixed minimum, below which active vegetation does not begin, may be easily obtained during the year from the ordinary temperature observations usually made; this could be effected previously only by a laborious calculation. The values of such "accumulated temperature," published in the Weekly Weather Report of the Meteorological Office, are calculated by these tables. The Monthly Weather Report, which began in 1884, and which is published nearly up to date, now takes the place of the Quarterly Reports.

THE *Meteorologische Zeitschrift* for July contains the concluding portion of Dr. Köppen's article on the classification of clouds (NATURE, June 30, p. 208). We are glad to see that in this second portion full justice is done to the recent researches of the Hon. R. Abercromby, and a lengthy report is given of the results of a conference between that gentleman and M. Hildebrandsson at Upsala at the end of 1886. This report points out that the study of the forms of clouds may be undertaken with different objects in view. If the object be weather-prediction, a detailed terminology is necessary, and for this purpose M. Hildebrandsson thinks Mr. W. C. Ley's classification of the higher clouds is unsurpassed. One of the principal objects is the determination of the directions of the wind in the higher regions of the atmosphere, and for this it is not necessary to distinguish so many forms; but we must be sure (1) that these forms are, generally speaking, everywhere the same, and (2) we must determine the mean heights of the various forms by direct measurements. With the view of settling the first point, Mr. Abercromby has made two voyages round the globe. The second question has been partially solved by the researches of MM. Ekholm and Hagström at Upsala (NATURE, June 30, p. 206). It is, however, necessary that such measurements should be made at various other places, and the same gentlemen intend to make further experiments elsewhere during this summer. Dr. Köppen concludes his article by some remarks on the history of the development of clouds, and recommends a series of observations in balloons similar to the celebrated ascents made many years ago by Mr. Glaisher. The same number of the *Zeitschrift* contains interesting articles on the results of meteorological observations during solar eclipses, by Mr. Winslow Upton, and on the method of counting the number of rainy days in various countries, and its influence on the resulting period of rain-frequency, by Dr. E. Brückner, of Hamburg. The amount of rainfall which is taken as representing a rainy day differs considerably in different countries. The author recommends the general adoption of 0·005 inch, without reference to whether it be caused by rain, snow, dew, &c. The amount has not yet been definitely fixed by the Meteorological Congresses, but that adopted by this country is 0·01 inch (or 0·005 inch where the rainfall is measured to thousandths of an inch). The International Polar Committee have adopted 0·1 millimetre (=0·004 inch) as representing a rainy day in all their publications, while for Prussia twice that amount is taken as the minimum quantity.

TIME-SIGNALLING on the German coasts began (we learn from a recent paper by Prof. Foerster) twelve years ago, and there are at present seven time-balls in action; viz. at Bremerhaven, Cuxhaven, Swinemünde, Neufahrwasser, Wilhelmshaven, Kiel, and Hamburg. In this respect, our country stands first. We began some thirty years ago, and have at present fourteen time-balls on our coasts, also five other arrangements for the same end. In our colonies and dependencies there are twenty-six time-balls. France possesses four time-balls (and two other arrangements); Sweden and Norway, Austria-Hungary, Holland with Belgium, and the United States, have five each; Denmark has two; Spain and Portugal one each. Italy has none as yet.

THE list of examples illustrating the law of isomorphism has just received a strong reinforcement at the hands of M. Charles Fabre, who describes in the last number of the *Comptes rendus* the result of his attempt to prepare a series of selenium alums isomorphous with the corresponding double sulphates. Following up the work of Wohlvil, Wöhler, and Pettersson, Fabre has succeeded in preparing double selenates of the general formula $Al_2(SeO_4)_3 . M_2SeO_4 . 24H_2O$, in which M represents respectively potassium, sodium, cæsium, rubidium, thallium, ammonium, ethylamine, di- and tri-ethylamine, and propylamine. Each of these alums crystallizes in the cubic system, generally in colourless octahedra; and some of them, notably the double selenate of aluminium and thallium, form exceptionally beautiful crystals. Further, the French chemist finds, as might be expected, that chromium forms a similar series of isomorphous double selenates, most of which build up splendid octahedra, black by reflected and violet by transmitted light. These alums are comparatively easy to obtain crystallized if the temperature be kept low, but at slightly elevated temperatures the small amount of chemical attraction by which the two constituent selenates are constrained to combine together in molecular proportions is overcome, and the alum can never be formed.

THE last numbers of the Journal of the China Branch of the Royal Asiatic Society (vol. xxi. Nos. 1 and 2) contain an interesting "symposium" on the question whether the Chinese should be taught Western science through the medium of their own or a European language. If the latter, no doubt the language would be English. The stumbling-block in the way of teaching science to the Chinese is the difficulty, not to say impossibility, of finding Chinese equivalents for the terms of our science. The Japanese have made the attempt at translation, but do not appear to be quite satisfied with the result. The missionaries who take part in the discussion appear to be of opinion that the Chinese language is the best medium, while on the other side it is contended that as long as it is taught by foreigners it had better be taught in a foreign language, "and probably by foreigners who have not had their faculties paralyzed by the task of mastering the Chinese language." Most of the laymen appear to be of this opinion. The question, after all, appears to be one of terminology; for if this difficulty can be overcome there is, we presume, no dispute that men, whether Orientals or Europeans, can best acquire knowledge through the medium of their native tongue. In the terminology the question appears, in Japan at least—and the same is doubtless true of China—to be whether the terms of Western science should be translated approximately or transliterated approximately. Should there be, for example, an attempt to reproduce by transliteration the words *hydrogen*, *nitrogen*, *logarithm*, &c., or an attempt to translate their meanings into concise terms which will take their places in Chinese and Japanese science? In either case the student will have to learn a new terminology, exactly as students in the West do. This is a point for Oriental scholars to decide, but it certainly does seem at first sight that transliteration is preferable to translation, for in the latter there is room for dispute and differences of opinion and practice, while the former has severe simplicity to recommend it.

SEVERE earthquakes were noticed on July 11 in the Hungarian districts of Arad, Temesvar, and Torontal.

ON July 17 shocks of earthquake were felt at Catania, Lecce, Ischia, Livorno, and Parma. Oscillations were felt in Rhodes, Crete, and Chios, and at Smyrna. Several houses were damaged at Canea, and in Rhodes a part of the fortress-wall and some chimneys were destroyed.

M. BURCH says, in *Cosmos*, that in America he saw six wild geese, when flying in a storm, killed by lightning.

THE French Academy of Sciences has received the Giffard legacy of 50,000 francs, and has resolved to employ the interest in grants to learned men in pecuniary difficulties.

PROF. LUNGE, of Zurich, has re-written and added to the treatise on "Coal-Tar Distillation" which he brought out in 1882. The new edition, with many new working drawings, will be ready very soon, and Messrs. Gurney and Jackson, Mr. Van Voorst's successors, are to publish it.

IN the *Moniteur Belge* of the 3rd inst., a Royal decree was published nominating the Vice-Presidents, Chief Secretary, and staff of the Scientific and Industrial Competition which is to be held in Brussels next year. M. Charles Mourlon is the Chief Secretary.

MR. HILCKEN, Librarian of the Bethnal Green Free Library, writes to us that the Library is greatly in need of one or two microscopes. "We have received," he says, "a present of interesting 'objects,' but they are useless without microscopes. Many of our readers would gladly avail themselves of the use of such instruments."

DR. R. H. GUNNING, of Rio de Janeiro and Edinburgh, has made the following munificent gifts in connexion with Her Majesty's Jubilee:—To the Council of the Royal Society of Edinburgh, a triennial prize of £105, to be named "The Victoria Jubilee Prize for the Advancement of Science." To the Council of the Society of Antiquaries of Scotland, £40 yearly, or £120 every three years, as they may prefer, to be named "The Victoria Jubilee Gift," the object of the founder being to assist experts to travel, with the view of "examining other collections, and keeping the Edinburgh Museum as completely furnished with information and examples as possible." To the Senatus of the University of Edinburgh, £200 per annum, to provide eleven post-graduation triennial prizes of £50 each. These are to be named the Monro, Sir Charles Bell, Edward Forbes, Hutton Balfour, Joseph Black, Christison, Lister, Gregory, John Thomson, Simpson, and Alison Prizes, and are to be administered by the Senatus, the incumbent of the Chair in connexion with which the prize is to be awarded having a wide choice in the subjects of examination. To the Royal College of Physicians of Edinburgh, £100 triennially, for a prize to bear the title "Dr. Gunning's Cullen Prize for the greatest benefit done to Practical Medicine." To the Royal College of Surgeons of Edinburgh, £120 triennially, for a prize to be called "The Liston Victoria Jubilee Prize," which shall be open to all Fellows and Licentiates of the College, and shall be awarded for the greatest benefit done to practical surgery. To the Edinburgh Association for the University Education of Women, £40 annually for a bursary to be called "The Victoria Jubilee Bursary." In addition to the above, Dr. Gunning has intimated, through Lord Maclaren, a gift of £100 for the Ben Nevis Observatory. Dr. Gunning, who was long resident in Brazil, is a Dignitary of the Brazilian Empire, a Fellow of the Royal Society of Edinburgh, and a Fellow of the Society of Antiquaries of Scotland.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♂) from India, presented by Mr. Francis Yare; a Cape Zorilla (*Ictonyx zorilla*) from Cape Colony, presented by Mr. J. A. Willet; a Spotted Ichneumon (*Herpestes nepalensis*) from Nepal, presented by Mr. T. C. Bacon; two Spotted Cavys (*Cœlogenys paca*) from South America, presented by Mr. William F. Kirton; an Arizona Squirrel (*Sciurus arizinensis*) from New Mexico, U.S.A., presented by Dr. R. W. Shufeldt; a Common Cuckoo (*Cuculus canorus*), British, presented by Mr. W. M. Alexander; a Lesser Kestrel (*Tinnunculus cenchris*), South European, presented by Mrs. M. Travers; two Corn Crakes (*Crex pratensis*), British, presented by Mr. S. C. Hincks; two Cardinal Grosbeaks (*Cardinalis virginianus*) from North America, presented by Mr. Samuel Nicholson; two Hybrid Herring Gulls (between *Larus argentatus* and *Larus dominicanus*), presented by Lord Lilford; two Viperine Snakes (*Tropidonotus viperinus*) from North Africa, a Bordeaux Snake (*Coronella girondica*), South European, presented by the Rev. T. W. Haines; a Grey Ichneumon (*Herpestes griseus*) from India, an Aldrovandi's Skink (*Plestiodon auratus*) from North Africa, deposited; a Crested Porcupine (*Hystrix cristata*), born in the Gardens; two Slender Ducks (*Anas gibberifrons*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE TOTAL SOLAR ECLIPSE OF 1886.—Mr. W. H. Pickering, who observed the total solar eclipse of August 1886 at Grenada, W.I., communicates to *Science*, vol. x. No. 230, a brief account of his results, in order that it may be published in time to be of service to the observers of the approaching eclipse on August 18. It was found that, by using rapid gelatine plates, an exposure of one or two seconds was sufficient to show the details of the inner corona satisfactorily with an ordinary telescope-lens. With a portrait-lens, the ratio of whose aperture to its focus was as one to five, the same exposure showed the outer corona satisfactorily as far as a distance of 15′ to 30′ from the limb of the moon. Beyond that the light was very decidedly fainter, and was shown best by exposures of from eight to forty seconds. The corona showed the usual short rays proceeding from the sun's poles, and from the south-western quadrant a very conspicuous ray, appearing like a hollow cone, projected to a distance of about 20′. A number of prominences were seen near the equator, on both sides of the moon; but the most conspicuous one was situated in the north-western quadrant. It extended to the height of about 100,000 miles, and had apparently a somewhat spiral structure. The spectra of the various prominences were shown very clearly by the prismatic camera. In the equatorial ones the hydrogen and H and K lines were prominent, superposed on a background of continuous spectrum; but in the large prominence the hydrogen lines were absent, although the H and K lines were strongly marked. The position of the maximum density in the continuous spectrum of the prominences was found to be quite different from that of the corona; in the former it is not far from G, whilst in the latter it lies between G and F. A large number of persons observed the shadow-bands, which appeared before and after totality. The general result of their observations indicated that the bands were about 5 inches wide and 8 inches apart, that they were coloured like the spectrum, and that they moved with a velocity comparable with that of an express train; at all events much faster than a man could run. Before totality the bands lay N. 12° W. and S. 12° E., and travelled west; after totality they lay N. 60° E. and S. 60° W., and travelled north-west.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 *JULY* 31—*AUGUST* 6.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on July 31

Sun rises, 4h. 24m.; souths, 12h. 6m. 9·1s.; sets, 19h. 48m.; decl. on meridian, 18° 18′ N.: Sidereal Time at Sunset, 16h. 24m.

Moon (Full on August 3) rises, 17h. 15m.; souths, 21h. 36m.; sets, 1h. 56m.*; decl. on meridian, 19° 37′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Decl. on meridian. ° ′
Mercury ...	4 26	11 46	19 6	14 35 N.
Venus	8 41	14 53	21 5	1 42 N.
Mars	2 2	10 20	18 38	23 35 N.
Jupiter... ...	11 56	17 10	22 24	9 45 S.
Saturn... ...	3 26	11 24	19 22	20 47 N.

* Indicates that the setting is that of the following morning.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′			h. m.	
U Cephei	0 52·3	81 16 N.	Aug.	1,	21 30	*m*
			,,	6,	21 9	*m*
Algol	3 0·8	40 31 N.	,,	1,	22 54	*m*
V Boötis	14 25·2	39 23 N.	,,	5,		*M*
δ Libræ	14 54·9	8 4 S.	,,	5,	22 24	*m*
V Coronæ	15 45·5	39 55 N.	,,	4,		*M*
R Ursæ Minoris ...	16 31·5	72 30 N.	,,	5,		*m*
U Ophiuchi	17 10·8	1 20 N.	July	31,	4 2	*m*
		and at intervals of			20 8	
W Sagittarii ...	17 57·8	29 35 S.	Aug.	2,	1 0	*m*
T Herculis	18 4·8	31 0 N.	,,	2,		*M*
η Aquilæ	19 46·7	0 43 N.	,,	2,	2 0	*M*
				6,	21 0	*m*
S Sagittæ	19 50·9	16 20 N.	,,	5,	21 0	*m*
δ Cephei	22 25·0	57 50 N.	July	31,	4 0	*M*
			Aug.	3,	22 0	*m*

M signifies maximum; *m* minimum.

Occultations of Stars by the Moon (visible at Greenwich).

August.	Star.	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image.
			h. m.	h. m.	° °
1 ...	21 Sagittarii	... 5 ...	0 23 ...	1 29 ...	99 323
6 ...	70 Aquarii	... 6 ...	1 14 ...	1 38 ...	35 6

August 3.—Partial eclipse of the Moon. First contact with shadow 19h. 36m.; middle of eclipse 20h. 49m.; last contact with shadow 22h. 2m. Magnitude of eclipse = 0·419 of moon's diameter. The moon will rise at Greenwich at 19h. 35m.

GEOGRAPHICAL NOTES.

THE rumour as to the death of Mr. Stanley is universally discredited in geographical circles, and among those directly interested in the Emin Pasha Expedition. The rumour seems quite inconsistent with the news as to Mr. Stanley's having left the Aruwimi River on June 3 for Wadelai. Had he been shot, as reported, it must have been after this date, and during the land journey, whereas one version of the rumour gives out that he was killed on the Congo. He may meet with Emin Pasha sooner than he expected. Emin, it seems, is at present exploring on the south of the Albert Nyanza, endeavouring to find the connexions of the great affluent he discovered on the south side of the lake, and ascertain whether it may proceed from the Mwuta Nzige. So that he and Mr. Stanley may meet half way. Letters from Mr. Stanley are expected in this country early in August.

THE Report of Dr. Hans Schinz on his exploration of the German colony known as Luderitzland (South-West Africa) has just been published. Dr. Schinz made two journeys: the first, in 1884, from Angra Pequena to Am-Hub on the Xamob, a sub-affluent of the Orange; and the second, in 1885, across Namaqua-land and Damara-land, and the little-known region which separates Damara-land from the Cunene River. The Report contains much valuable information, especially on the flora and the people of the region visited. The region is quite as sterile and hopeless as it has been painted by previous visitors. It is only on the north of Etosha (18° S. lat.) that the flora and fauna become anything like abundant—bauhinia, palms, cassia, baobab. The population becomes more dense as we approach the Cunene. But three-fourths, if not four-fifths, of the new German colony is unworkable and uninhabitable.

IN the new number of *Timehri* the valuable serial published in British Guiana, will be found a condensed translation of Père de la Borde's "History of the Origin, Customs, Religion, Wars, and Towns of the Caribs of Antilles," the first of a series of reprints of the literature of West India and Guiana red men, which it is proposed to publish from time to time in the journal. A large part of the number is devoted to Mr. Im Thurn's notes on the plants observed during the Roraima expedition.

THE last Annual Report of the Russian Geographical Society for 1886, which has just reached us, contains a good deal of useful information. An account of several interesting journeys is given. The publications of the Society were numerous and valuable. Seven fascicules of the Memoirs appeared during the year, containing the work on the geology of Lake Baikal, by M. Tchersky; a hydrological inquiry into the Upper and Middle Amu-daria, by the late M. Zuboff; on the landslips at Odessa, by M. Jarintseff; on the exposure of thermometers, by M. Savelieff; on a journey to North-West Persia and the Transcaspian region, by M. Nikolsky; on the province of Olonets, by M. Polyakoff; and on the Votyaks, by M. Sokolovsky. The Society published, moreover, a volume of the "Works of the Siberian Expedition," containing Fr. Schmidt's "Miocene Flora of Sakhalin," and three volumes of observations of the Polar stations on the Lena and on Novaya Zemlya. It is good news that the addenda to the capital "Geographical Dictionary of Russia," by P. Semenoff, are being rapidly prepared for the press. The great gold medal of the Society has been awarded to M. Potanin for his twenty years' geographical work; and that of Count Lütke to M. Tchersky for his remarkable geological explorations around Lake Baikal and in East Siberia altogether. Other gold medals have been awarded to MM. Nalivkin for their work "On the Position of Woman amidst the Settled Population of Ferganah," published last year at Kazan; to M. Yastreboff for a work on Turkish Servians; to M. Makaroff for his researches into the double currents in straits; to MM. Skassi and Bolsheff for cartographical work; and to M. Eigner for his work at the Lena Polar station. Many silver medals have been awarded for works of less importance. The Committee of the Russian Geographical Society for Pendulum Observations and the Meteorological Committee have done most useful work.

THE TECHNICAL EDUCATION BILL.

I.

THE following is the text of the Bill to facilitate the provision of technical instruction:—

Be it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows:

1. This Act may be cited as the Technical Instruction Act, 1887.

2. Any local authority as defined by this Act may pass a resolution that it is expedient to provide for supplementing by technical instruction the elementary education supplied in its district, and for that purpose to put in force the provisions of this Act.

3. (1) A local authority shall, before proceeding to carry into effect a resolution under this Act, cause the resolution to be published in the prescribed manner, and within the prescribed time, not being less than two months after the publication, fifty persons entitled to vote at the election of members of the local authority, or one-third of the total number of those persons, may, by a written requisition, require a poll of those persons to be taken as to carrying the resolution into effect, and thereupon the poll shall be taken in the prescribed manner, and in accordance with the prescribed regulations.

Provided that—

(*a*) the poll shall, so far as circumstances admit, be conducted in like manner in which the poll at a contested municipal election is directed by the Ballot Act, 1872, to be conducted; and, subject to any exceptions or modifications contained in any order of the Department of Science and Art made in pursuance of this Act, the Ballot Act, 1872, shall apply accordingly; and

(*b*) all persons entitled to vote at the election of members of the local authority shall be entitled to vote at the taking of the poll; and

(*c*) each of those persons shall be entitled to one vote only.

(2) If the resolution is negatived at the poll it shall not be carried into effect, and shall not be again proposed until the expiration of not less than twelve months after the taking of the poll.

(3) This section shall not apply to the metropolis as defined in the Elementary Education Act, 1870.

4. (1) For the purpose of supplementing by technical instruction the elementary education supplied in its district, a local authority may in pursuance of a resolution under this Act—

(*a*) Provide technical schools for its district; or

(*b*) Combine with any other local authority for the purpose of providing technical schools common to the districts of both authorities; or

(*c*) Contribute towards the maintenance, or provision and maintenance, of any technical school; or

(*d*) Make such arrangements as to the local authority seem expedient for supplementing by technical instruction the instruction given in any public elementary school in its district.

(2) The expenses incurred by a local authority for the purposes of this Act shall be defrayed out of the local rate.

(3) Provided that no payment shall be made under this Act out of the local rate in respect of a scholar unless or until he has obtained a certificate from the Education Department that he has passed the examination in reading, writing, and arithmetic prescribed by the standard set forth in the schedule to this Act (being the Sixth Standard fixed by the minutes of the Education Department in force at the passing of this Act) or an examination equivalent thereto.

(4) Two or more local authorities may, with the sanction of the Department of Science and Art, enter into any agreement which may be necessary for carrying into effect any resolution under this Act; and any such agreement may provide for the appointment of a joint body of managers, for the proportion of the contributions to be paid by the respective authorities, and

for any other matters which, in the opinion of the Department of Science and Art, are necessary for carrying out the agreement.

5. (1) Every school provided under this Act shall be conducted in accordance with the conditions specified in the minutes of the Department of Science and Art in force for the time being, and required to be fulfilled by such a school in order to obtain a grant from that Department.

(2) Those conditions shall, amongst other things, provide that a grant shall not be made by the Department of Science and Art in respect of a scholar admitted to the school unless or until he has obtained such a certificate from the Education Department as is herein-before mentioned.

(3) A minute of the Department of Science and Art not in force at the *passing of this Act* shall not be deemed to be in force for the purposes of this Act until it has lain for not less than one month on the table of both Houses of Parliament.

6. (1) Every local authority providing a school under this Act shall maintain and keep efficient the school so provided.

(2) For the purposes of providing and maintaining any such school a local authority shall have the same powers as a school board has for providing sufficient school accommodation for its district, but for the purposes of this Act the provisions of the Elementary Education Acts with respect to the exercise of those powers shall have effect as if the Department of Science and Art were substituted therein for the Education Department.

(3) Where a local authority has provided or maintains any such school, it may discontinue the school or change the site thereof, if it satisfies the Department of Science and Art that the school to be discontinued is unnecessary or that the change of site is expedient.

7. (1) The managers of any technical school in the district of a local authority may make an arrangement with the local authority for transferring their school to that authority, and the local authority may assent to any such arrangement.

(2) The provisions of section twenty-three of the Elementary Education Act, 1870, with respect to arrangements for the transfers of schools in pursuance of that section, shall apply in the case of arrangements for the transfers of schools in pursuance of this section, with this modification, that for the purposes of this section references to the school board shall be construed as references to the local authority, and references to the Education Department as references to the Department of Science and Art.

8. In this Act—

The expression "technical instruction" means instruction in the branches of science and art with respect to which grants are for the time being made by the Department of Science and Art, or in any other subject which may for the time being be sanctioned by that Department; and the expression "technical school" means a school or department of a school which is giving technical instruction to the satisfaction of the Department of Science and Art.

The expression "local authority" means a school board and the council of a borough for which there is no school board.

The expression "local rate" means—

(*a*) in a district for which there is a school board, the school fund;

(*b*) in a borough for which there is not a school board, the borough fund or borough rate.

The expression "the Education Department" means the Lords of the Committee of Her Majesty's Privy Council on Education.

The expression "prescribed" means prescribed by the Department of Science and Art.

9. In the application of this Act to Ireland the expression "borough" means a borough subject to the Act of the session of the third and fourth years of the reign of Her present Majesty, chapter one hundred and eight, intituled "An Act for the regulation of municipal corporations in Ireland," and the Acts amending the same.

Schedule.

Standard VI.

Reading.—To read a passage from one of Shakspeare's historical plays, or from some other standard author, or from a history of England.

Writing.—A short theme or letter on an easy subject, spelling, handwriting, and composition to be considered. An exercise in dictation may, at the discretion of the inspector, be substituted for composition.

Arithmetic.—Fractions, vulgar and decimal, simple proportion, and simple interest.

II.

We reprint from the *Times* of July 21 the following article on the Bill:—

The measure introduced late on Tuesday night by Sir William Hart Dyke, the Vice-President of the Council, may prove to be of far greater practical importance than many a measure that may for the moment loom larger in the public eye. It is a Government Bill for organizing throughout England and Wales at least the beginnings of a system of technical education. The Scotch Office is meanwhile preparing an analogous Bill for Scotland, which it is hoped will proceed *pari passu* with the English Bill through the House; and the Government intends, if possible, to carry both measures this session. It is quite time. There has been plenty of talk about technical education; and we want action in the matter. The need is admitted on all hands. It is a crying need, as much recognized in such authoritative statements as the Report of the late Commission as in the reports of examiners appointed by the Technical Institute at South Kensington. The former admits the great superiority of foreign nations over ourselves in this matter, and shows how both France and Germany make much more serious and successful attempts than we to train their workmen in the theory as well as in the practice of their trades. One result is the increased severity of foreign competition, from which British industry is suffering in all directions. What we lately stated, on the authority of the Committee of the London Chamber of Commerce, with regard to the competition of German with English clerks in London and the north may be applied, with little change, to the foreign workmen. They are not above learning their trade. They know that their bread depends on their excelling, and they strive to excel, with their Governments behind them, showing them, by carefully organized instruction, what is the best way. As yet, in England, we have done little more, by way of meeting this activity of our competitors, than to build a fine Institute at South Kensington. Not that that Institute is not doing good. Its very existence is a protest against the inveterate English belief in rule of thumb. It has as yet only touched the fringe of the questions before it; but, while it has done something positive by such means as teaching teachers, it has also done not a little to test the actual state of technical knowledge in many trades. Two months ago we called attention to the reports of its examiners, and pointed out how unfavourable on the whole they were. In the bleaching, dyeing, cotton-spinning, paper-making, carriage-building, and other industries, very few candidates showed any theoretical knowledge to speak of; on the one hand they were ignorant of the rudiments of chemistry, on the other of the rudiments of drawing. In a word, they failed to link the primary education which they might be supposed to have received with the business of their handicrafts.

The Government Bill proposes to do much to render this state of things less common. So far as can be judged from the Vice-President's speech, the Bill being not yet printed, it is a Bill for enabling local authorities—generally School Boards—acting in concert with the Science and Art Department, to provide technical instruction for pupils who have left the elementary schools, and in certain cases for those who have not yet left them. What the mover calls the operative clause enables local authorities to provide technical schools, and at the same time to combine with other local authorities by way of saving expense. The power of rating is given, but at the same time the ratepayers are to have a veto on "any proposal under the Bill." The combination clause, which permits the joint action to which we have referred, is that on which Sir William Hart Dyke relies to convince the public that his Bill will be cheaply and easily worked. Another, with the same object, is the clause which enables the local authority to make any arrangements which it may deem expedient for supplementing the technical instruction at present given in the schools. As to the agricultural districts, and the teaching of agricultural subjects, the Vice-President admits that his Bill will not do very much, and, indeed, it would seem that the provision of that instruction, as was urged earlier in the evening, is beyond the power of the Science and Art Department. The question of London, and the London vote when debatable questions arise, is one which the Government have foreseen, but on which they can only vouchsafe some rather mysterious information. It would be "very wrong," says the Vice-President of the Council, to bring into force the "enormous voting power" of London on the question of forbidding some scheme of the local authority; and consequently he has put himself into communication with the London School Board, or rather with Sir Richard Temple, its Vice-Chairman, to devise a way out of the difficulty. With the result he seems particularly pleased, but, as the proposal of Sir Richard Temple is not made public, it is lawful to reserve our opinion. Then there is the question of the directing authority. It is not to be the Education Office; it is to be the Science and Art Department. Whether this will create any possible conflict of authorities it is difficult to say; but as those two bodies have the same head—the President and the Vice-President of the Council—it may be hoped that the conflicts will not be common or easy.

It is not to be supposed that such a Bill as this, which creates a new rating authority, and therefore threatens the pockets of the ratepayers, will pass into law without a good deal of criticism, or that it will be universally popular. Our correspondent, Mr. Daniel Watney, this morning gives utterance to a protest of which the language is strong, though the arguments are unconvincing. He admits that the old apprenticeship system has broken down, and that some substitute must be found; but anything like a general system of technical instruction, directed by the local authorities and the Science and Art Department, is condemned out of hand. Mr. Watney seems to think that the new proposal would give too much power to Professors, for whom he entertains the contempt of the "practical man." The practical man is commonly little more than an imperfect theorist; and just now, in England, his success in maintaining the commercial supremacy of the country is not such as to invest him with commanding authority. For our part we do not see where the Professors are to come in under Sir William Hart Dyke's Bill; but if they did come in, perhaps it might not be a bad thing for the improvement of our theoretical, and therefore our practical, knowledge. As to the immediate prospects of the Bill, it would seem from its reception on Tuesday night that the House is favourable to it. Mr. Mundella made two objections: one to the delegation of all power of initiation to the localities, and one to the exclusion of all pupils below the sixth standard. The objections stand on different grounds. The former is one of principle, the latter one of detail. It is not likely that the Government will venture, so late in the Session, and at a time when other difficulties have to be met and faced, to propose a sweeping measure for imposing technical instruction by the act of a central Department. The ratepayer must be humoured if his assent is to be won. As to the second objection, we think Mr. Mundella is probably right. The choice lies between retaining all children at school till they have passed the fifth standard, and admitting fifth-standard children to whatever technical classes may be available. It would be unjust to deprive them altogether, after they have left school, of the opportunity of learning whatever can be learnt about their trades.

SCIENTIFIC SERIALS.

Bulletin de la Société des Naturalistes de Moscou, 1887, No. 1.—The *Scaphirhynchus*, being an elaborate comparative anatomical description (in German) of the genus and its species, by N. Iwanzow (with two plates).—On the great comet (43) of 1886, by Th. Bredichin (with a plate).—Enumeration of the vascular plants of the Caucasus, by M. Smirnoff (in French). In this third paper the author discusses the relative moistness of the air in the Caucasus; he gives most valuable tables from twenty-three Caucasian stations, and shows the dependency of moisture upon the prevailing winds; he then gives tables as to the amount and frequency of rain in different parts of Caucasia, and discusses this climatic factor in comparison with the distribution of rains upon the Mediterranean region generally. This most valuable paper is to be continued.—On calorimetric methods for determining minimal quantities of iron in mineral waters, by E. Kislakovsky.—Comparative discussion of the data collected in Russia as to the epochs of the blooming of plants which are freely growing or cultivated between the 44th and 60th degrees of latitude, by A. Dœngingk, being a most valuable paper (in German), containing a list of the times of blooming of 270 different species at Pyatigorsk, Kishineff, Sarepta, Orel, Moscow, and St. Petersburg. This is followed by a note on the blooming of 225 plants at Pyatigorsk and Elizabethpol in the Caucasus, as also on trees and bushes, endemic and exotic, in the Caucasus, showing the origin of the exotic plants.—On the parasitical pteromalines of the Hessian fly, by Prof. Lindeman. Five parasites, all new species, are described (in German) and figured.—Entomological notes, by the same, on the *Haltica vittula* of Russia, the *Scotylus amygdali* of Transcaucasia, and the *Cleigastra flavipes* from Moscow.—On the tooth-plates of the *Gulnariæ*, by Dr. W. Dybowski (in German).—On remains of the *Ursus spelæus* in Transcaucasia, by N. Anutschin (in German).—On the species of *Taraxacum* and *Glycyrhiza*, and *Alhagi camelorum*, by A. Becker.

No. 2.—Comparative anatomical inquiry into the structure of the cord of fishes and its cuticular envelopes, by W. Lvoff (with three plates). A most elaborate inquiry into, preceded by an historical sketch of the literature of, the subject (summed up in German).—A study on the palæontological history of the Ungulatæ in America and Europe, by Mary Pavlow (in French). After having summed up the ideas developed on this subject by MM. Cope, Wortman, and Schlosser, the author studies the group of *Condylathra*, and shows that its separate members may have been predecessors of some orders of Mammalia; that it is a mixed group containing species which have the characters of Ungulatæ as well as of Unguiculatæ; and that it may be considered as standing at the head of the genetic tree of the Ungulatæ and Carnivores. Madame Pavlow shows, moreover, that the *Condylathra* have also representatives in Europe.—Notes on the remains of man and *Ursus spelæus* in Transcaucasia, by N. Anutschin.—The Hessian fly (*Cecidomyia destructor*) in Russia, by Prof. Lindeman (in German), being an elaborate paper on the history of its spreading, its habits and devastations, and its development (to be continued).

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, July 6.—Dr. D. Sharp, President, in the chair.—Mr. McLachlan remarked that at the meeting of the Society in October 1886 he exhibited a quantity of the so-called "jumping seeds" from Mexico, containing larvæ of *Carpocapsa saltitans*, Westw. The seeds had long ceased to "jump," which proved that the larvæ were either dead, had become quiescent, or had pupated; about a fortnight ago he opened one of the seeds, and found therein a living pupa. On the 4th inst. a moth (exhibited) was produced.—The President, on behalf of the Rev. H. S. Gorham, exhibited the following Coleoptera, lately taken in the New Forest: *Anoplodera sexguttata*, Fab., wholly black variety; *Grammoptera analis*, Fab.; *Colydium elongatum*, Fab.; and a specimen of *Tachinus elongatus*, Gyll., with brownish-red elytra.—Mr. S. Stevens exhibited a specimen of *Orsodacna humeralis*, Latr. (*lineola*, Panz., var.), taken by him at Norwood; he also exhibited a specimen of the same beetle taken by him fifty years ago in Coombe Wood; during the interval he had never seen it alive.—Mr. G. T. Porritt exhibited, on behalf of Mr. N. F. Dobrée, of Beverley, a series of about thirty specimens of a *Tæniocampa* he had received from Hampshire, which had previously been referred to as a red form of *T. gracilis*. Mr. Dobrée was inclined to think they were not that species, but *T. stabilis*.—Mr. A. C. Horner exhibited the following species of Coleoptera from the neighbourhood of Tonbridge:—*Compsochilus palpalis*, Esp. (5); *Acrognathus mandibularis*, Gyll. (4); *Homalota atrata*, Mann., *H. vilis*, Er., and *H. difficilis*, Bris.; *Calodera rubens*, Er.; and *Oxytelus fulvipes*, Er. He also exhibited a *Rhizophagus* from Sherwood Forest, which appeared to belong to a new species; and several specimens of *Holopedina polypori*, Först., also from Sherwood Forest, where he had found it in company with, and probably parasitic on, *Cis vestitus*.—Mr. Elisha exhibited two larvæ of *Zelleria hepariella*, Stn. Mr. Stainton remarked that as the greater part of the larvæ of *Zelleria* were attached to the Oleaceæ, it seemed strange that certain species had recently been found on Saxifrage.—Mr. Slater read a paper on the presence of tannin in certain insects, and its influence on their colours. He mentioned the facts that tannin was certainly present in the tissues of the leaf- wood- and bark-eating species, but not in the tissues of the carnivorous beetles, and that black colour on the elytra of certain beetles appeared to be produced by the action of iron on tannin. A discussion ensued, in which Prof. Meldola, Mr. Poulton, Dr. Sharp, and others took part.

PARIS.

Academy of Sciences, July 18.—M. Janssen in the chair. —On the transition between the aromatic and fatty series, by MM. Berthelot and Recoura. By the synthetic process this transition is effected very clearly in the polymeric transformation cf acetylene into benzene, and in the allied pyrogenous reactions. Some light has also been thrown on the more obscure problem of the transition in living organisms by Prunier's experiments with quercite, and Maquenne's with inosite. These studies are here subjected to further investigation by the measurement of the heats of formation of the various principles, themselves deduced from the heats of combustion. In all cases the passage of a body belonging to the fatty series to one of the aromatic series by deshydratation is shown to be accompanied by a considerable liberation of heat; that is to say, by a loss of energy corresponding to the excess of stability acquired by the fundamental hydrocarbonated nucleus.—Comparative locomotion: action of the pelvic member in man, the elephant, and the horse, by MM. Marey and Pagès. Their recent researches on the locomotion of the horse and elephant enable the authors to establish certain analogies and differences presented by the posterior member of these quadrupeds compared with the movement of the lower member in man. The parallelism, which is illustrated by several diagrams, bears both on the slow and rapid motion (walking and running) of the three types here under consideration. Contrary to the general opinion, there appears to exist in the step or pace of the quadrupeds a period of double rest more prolonged in the hind than in the fore-quarters. It is also shown that the trot in the horse corresponds unquestionably with the running action of man, but that elephants have no such action, just as man lacks the gallop of the horse, which in this respect thus stands at the head of the series. But, when urged to quicken their speed, the elephants broke into an action somewhat approaching that assumed by man when passing from a walk to a run. In general, both in slow and rapid motion, the action of the pelvic member remains essentially the same in all three types. The difference between them lies in the action on the concurrent limbs, which is slight between man and the elephant, much greater between these two and the horse.—On the habits of Phylloxera, and on the present state of the French vineyards, by M. P. Boiteau. During the year 1886 the author continued his experiments on the reproduction of Phylloxera, which he has cultivated for six consecutive years. In 1885 he had reached the nineteenth generation by the parthenogenetic process, all necessary precautions being taken to prevent fertilized insects from coming in contact with those derived directly from the winter egg. At present he has reached a second generation for 1887, or a total of 24 or 25 altogether, all these agamous generations being very healthy, lively, and prolific. The condition of the vines, which suffered so much last year, is described as highly satisfactory, with every prospect of a good vintage in most of the wine-growing districts. —Comparison of the energies radiated by platina and silver in fusion, by M. J. Violle. By the process here described the total radiation of platina is found to be 54 times that of silver in fusion. Yet this relation, great as it is, is far less than that of the luminous intensities, which is superior to 1000.—Solidification of liquids by pressure, by M. E. H. Amagat. Theoretically, J. Thomson's formula implies that at a given temperature solidification becomes possible under sufficient pressure, provided the density be greater in the solid than in the fluid state. But no instance has hitherto been known of any liquid properly so called being solidified by pressure alone. Now, however, the author, after numerous experiments, has succeeded in solidifying the bichloride of carbon (C_2Cl_4), obtaining some crystals which are here figured, and which appear evidently to belong to the cubic system. This substance is solidified at the temperatures of $-19^\circ \cdot 5$, 0°, 10°, and $19^\circ \cdot 5$ C. under the respective pressures of 210, 620, 900, and 1160 atmospheres. This and other results would seem to imply that every fluid has a critical point of solidification; that is, a temperature above which solidification will take place under no pressure: just as there appears to be a temperature below which the body remains solid under the slightest pressures.—On the calorific conductibility of bismuth in a magnetic field, by M. A. Righi. The considerable increase of electric resistance, and the intense rotation of the equipotential lines (Hall's phenomenon) which occur when bismuth is introduced into the magnetic field, naturally led to the inference that a decrease of calorific conductibility and a rotation of the isothermal lines should take place under the same conditions. The author has now completed a series of extensive experiments, which completely confirm this supposition, and the summary results of which have been published in the *Resoconti dell' Accademia Reale dei Lincei* for June 12; that is, eight days before the analogous communication recently sent by M. Leduc to the *Comptes rendus*.—On the *Chlorœma dujardini* and *Siphonostoma diplochaitos*, by M. Joyeux-Laffuie. In reply to M. Kunstler, it is pointed out that there is no ground for supposing that these two organisms are identical, the former being from 15 mm. to 20 mm., the latter 8 cm. long.—On the earthquake of June 9, 1887, in Central Asia, by M. Venukoff. A detailed account is given of the disastrous effects of this disturbance, especially in Vernoï, a town of 17,000 inhabitants, where 1700 out of 2500 buildings of brick and stone were levelled with the ground, while 800 wooden houses remained almost uninjured. As many as 200 persons perished in Vernoï, and over 800 in the surrounding district, chiefly in the Ala-tau Mountains. The first great shock of June 9 has been followed by several others, which still continue, obliging the inhabitants to take shelter under tents on the open plains.—On a hailstone inclosing a stony nucleus, by M. G. Tissandier. This specimen fell during a violent thunder and hailstorm in the Tarbes district on June 20. The nucleus consisted of some gypsum, which had clearly been worked, and no doubt sucked up by a water-spout to a thunder-cloud, where it became incrusted with ice.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Course of Practical Instruction in Botany, part ii.: Bower and Vine (Macmillan).—The Teaching of Geography: A. Geikie (Macmillan).—Sunlight, Second Edition, 1887 (Trübner).—Morality and Utility: G. P. Best (Trübner). —The Scenery of Scotland, Second Edition: A. Geikie (Macmillan).—The Forms of Nasal Obstruction: G. Macdonald (A. P. Watt).—Report of the Royal Commission for the Colonial and Indian Commission, 1887 (Clowes).—Smithsonian Report, 1885, part i. (Washington).

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