THURSDAY, MARCH 18, 1880

DISSOCIATION OF CHLORINE, BROMINE AND IODINE

IN NATURE, vol. xx. p. 357, I gave an account of Prof. V. and Herr C. Meyer's remarkable observations on the density of chlorine at high temperatures, which showed that the chlorine evolved from platinous chloride at temperatures of 1,200° and above had a density only two-thirds of that corresponding to the molecular formula Cl_2. I also mentioned that the Meyers had stated that iodine exhibited a similar behaviour.

These observations, tending as they did to show that chlorine was not the simple substance it had hitherto been supposed to be, naturally excited great interest among chemists, and further information has been most anxiously looked for; it must be admitted, however, that they were received with considerable scepticism, more especially because the statement relating to iodine was in direct contradiction with a most careful series of experiments on the comparative behaviour of air and this substance made by Deville and Troost, who, after assuring themselves that iodine vapour underwent a normal expansion, made use of iodine as a pyrometer in many determinations in the course of their celebrated investigation of the density of a variety of inorganic bodies at furnace temperatures.

This scepticism was considerably strengthened by the appearance, in a recent number of the *Comptes Rendus*, of a paper by a well-known American chemist, Prof. Crafts, describing a quasi-repetition of the Meyers' experiment with chlorine. The method adopted by Crafts was a slight modification of that introduced by V. Meyer. Two graduated and calibrated U-tubes, maintained at constant temperature by a bath of cold water, were connected with V. Meyer's apparatus in such a manner that a known volume of gas could be transferred from the one to the heated bulb of the density apparatus through a very fine tube, the volume of gas displaced by it being collected and measured in the second U-tube. In two experiments made in this manner at the highest temperature of the furnace, the density apparatus being filled with air, 10 c.c. of chlorine displaced 10·37 c.c. and 10·24 c.c. of air; the apparatus being filled with chlorine, 10 c.c. of air were found to displace 9·98 and 10 c.c. of this gas. These experiments were made with a porcelain apparatus; using a platinum apparatus, 10 c.c. of chlorine were found to displace 10·43 c.c. and 10·50 c.c. of air. If the expansion observed by the Meyers had taken place, the quantities of air and of chlorine collected should have been 15 c.c. and 6·6 c.c. respectively, so that operating with free chlorine, Crafts failed to verify the observation of the German chemists.

With iodine, however, he obtained results confirmatory of their statement, the observed density being 6·01 and 5·93, instead or 8·79, the theoretical number corresponding to the formula I_2. Bromine was found to be intermediate in its behaviour, the numbers obtained being 4·39 and 4·48, instead of 5·57, indicating a reduction in density of one-fifth in place of the reduction of one-third observed in the case of iodine. Hydrogen chloride and carbon dioxide gave normal results, showing that there was no fault inherent in the method; Crafts, however, noticed that the glaze of the Bayeux porcelain vessels used was much attacked by the coal-gas flame, and that at the high temperatures employed they were slightly porous to hydrogen and water gas, but not to other gases, although not to an extent to vitiate the experiments, only ·001—·002 gramme of water passing through in the course of an hour.

The announcement of these results has led Meyer to give an account of experiments he has made in conjunction with Herr Züblin since the publication of the paper by C. Meyer and himself, but prior to the publication of the paper of Crafts. Meyer and Züblin confirm the accuracy of Crafts's observations. Using chlorine gas prepared in the ordinary way, and carefully purified and dried by passing it through water and sulphuric acid and over phosphoric anhydride, they found in three experiments at a yellow heat, 2·57, 2·63, 2·64; in mean 2·61, instead of 2·45, which is the density corresponding to the formula Cl_2.

We have then the astonishing result that whereas ready prepared free chlorine is stable at high temperatures, nascent chlorine, *i.e.*, chlorine at the moment of liberation from the compound platinous chloride, is unstable, and undergoes dissociation: for there can now be little doubt that such is the nature of the phenomenon involved in the reduction of its density observed by the Meyers, the argument that this may be due to a great difference in the rate of expansion of chlorine as compared with gases such as oxygen and nitrogen at high temperatures being disposed of by the fact that free chlorine does exhibit a normal behaviour in this respect.

Meyer also publishes the results of a long series of experiments on the density of iodine. In all of these, purified solid iodine was employed and not an iodine compound. The first series of observations, made in a porcelain vessel, are summarised in the following table:—

Temperature.	Observed density.	Theoretical density.
253°	8·89 8·83	8·78 = I_2
About 450	8·84 8·85	
,, 586	8·73 8·71 8·71	
,, 842	6·68 6·80 6·80	
,, 1,027	5·75 5·74	
,, 1,570	5·67 5·60 5·71 5·81	5·83 = $\frac{2}{3}$ I_2

On comparing these results with those for chlorine from platinous chloride, it will be observed that the dissociation of iodine is complete at a considerably lower temperature (about 1,000°) than that of chlorine (at about 1,200°).

These results being so at variance with those obtained by Deville and Troost at a temperature of 1,040°, Meyer subsequently made further experiments with entirely new apparatus and fresh iodine, but without observing any departure from them. A determination at about 1,052° in a porcelain apparatus gave 5·88; and the density of mercury at the same temperature being simultaneously determined to control this result, the number 6·98 was obtained in place of the theoretical number, 6·91. Two experiments with iodine in a platinum vessel at about 1,567° gave 5·71 and 5·81 as the density.

The only explanation which can at present be advanced to account for the difference between the observations of Deville and Troost on the one hand, and Meyer and Crafts on the other, is that in the experiments of the former the iodine was gradually converted into vapour, whereas the method adopted by the latter involves the almost instantaneous volatilisation of the iodine; in the case of some organic compounds a difference of this kind in the mode of heating is known to exercise a considerable and in many respects similar influence on the result, so that this explanation is not unsupported by analogy.

Great difficulty was experienced in determining the density of free bromine in consequence of the explosive rapidity with which it is converted into gas when introduced into the intensely-heated bulb of the density apparatus. The results obtained are not accordant, but all lie between the number corresponding to the molecular formula Br_2 and that required on the assumption that dissociation takes place to the same extent as in the case of iodine. Using platinic bromide, $PtBr_4$, however, instead of free bromine, Meyer and Züblin find that a reduction in density takes place precisely of the character of that observed for chlorine from platinous chloride and for iodine. Thus at a temperature of about 1,570° the observed density in two experiments was 3·78 and 3·64, 3·64 being exactly two-thirds of the density corresponding to the molecular formula Br_2.

As yet Meyer has told us nothing of the nature of the dissociation products of the three halogens; their determination and separation will probably be attended with great experimental difficulties, but the problem could not well be placed in abler hands, and we trust that ere long we may be able to congratulate him on the accomplishment of this the crowning triumph of his labours.

HENRY E. ARMSTRONG

GLAISHER'S FACTOR TABLES

Factor Table for the Fourth Million. By James Glaisher, F.R.S. (London: Taylor and Francis, 1880.)

THERE is no general method of ascertaining whether one number is divisible, without remainder, by another specified number (less than its half) except by actual trial, or by the knowledge, otherwise acquired, of all the divisors of the first number. If then the second is not among these, it is also known that it is not a divisor of the first number. The knowledge of whether a specified number has any divisors at all, and if so what they are, is only to be obtained in general by trying it with all possible divisors less than its square root. The process can be shortened, but only to a limited extent, and, speaking generally, it would require hundreds of division sums, to ascertain by trial that 3,979,769 had 1979 for a divisor, and was consequently the product of 1979 and 2011.

It is, however, frequently important to mathematicians to know how to split up any given number into its divisors or factors, and this without the enormous labour which *may* be involved in actually trying for its divisors, especially as there is no general mathematical principle which enables us to dispense with the trial, or even to shorten it so as to bring it within practicable limits. The alternative is to tabulate numbers up to a given limit, and to indicate, for each, whether it has divisors, and what they are. It is not necessary, or usual, to include in such tables *every* number without exception; for an inspection of the last figure of any number tells us whether it is divisible by *two* or by *five*; and the old rule of "casting out the nines" tells us whether it is divisible by *three*. These considerations greatly reduce the number which it is necessary to tabulate; for, among the first 300 numbers, 150 are even, that is to say, divisible by 2; and of the remaining 150, 50 are divisible by 3; while of the 100 left after that, 20 are divisible by 5. The exclusion of the numbers divisible by 2, 3, or 5 thus reduces the number of tabular entries required, from 300 to 80, and this proportion holds all through the table, as well as for the first 300 numbers. It will be observed that the last two figures of these 80 numbers remain the same for every batch of 300. This facilitates the tabulation, and advantage has been taken of this facility in printing the Tables.

The first extensive tables of this kind were those published by the Austrian General, Baron von Vega, at the close of the last century. These extended from 1 to 108,000, and thus give all the divisors of the numbers not divisible by 2, 3, and 5 within those limits. The next table was that of Chernac, a Polish Professor of Mathematics at Deventer, in Over-yssel, which was published in 1811. It contained all the divisors of all numbers, not divisible by 2, 3, and 5 up to 1,012,000. It forms a very thick quarto volume of over 1,000 pages.

The next extension was made by Burckhardt (1814-17), who published a series of three volumes, giving, not *all* the divisors, but the least prime divisor, of all numbers (except those divisible by 2, 3, and 5) up to 3,036,000. This is not quite so convenient, as a matter of immediate reference, as giving all the divisors; but it answers every necessary purpose. For example, when we know that 3,999,589 has 11 for its least divisor, we can find by actual division that the quotient is 363,599. We "look out" this number in the earlier part of the table, being sure of finding it there, seeing that 11 was the *least* divisor of its multiple; we find its least divisor to be 31. Performing the division by 31, we obtain the quotient 11,729. We "look out" this again in the earlier part of the table, and we find that 37 is the least divisor. Performing this division, we obtain 317 as the quotient. Since this is less than 37×37, we know that it can have no divisors except unity and itself, or that it is prime. If, instead of the least prime divisor, all the divisors had been given, we should at once have found from the table

$$3{,}999{,}589 = 11 \times 31 \times 37 \times 317.$$

There is an obvious advantage in the more complete table. Unfortunately it is balanced by the practical inconvenience of size, and "a great book is a great evil." What this practically comes to may be judged of from the remark that Chernac's table, which gives all the prime factors from 1 to 1,019,000, takes 1020 quarto pages; while Burckhardt's, which gives only the least prime divisor, contains the numbers from 1 to 3,036,000 in 336 quarto pages. It is true that Burckhardt's table is more closely printed than Chernac's, with somewhat smaller type, and a slightly larger form; but, making all allowances, the

condensation obtained by giving the least prime divisor, instead of all the divisors, cannot be put at less than three to one. It must be observed also, that the processes of division, which have to be performed when the least divisors only are given, are definite divisions with a known divisor, and do not involve the tentative process of finding what the divisor is; it is just this tentative process which it is the object of all such tables to avoid.

Burckhardt's tables extend, as has already been stated, to 3,036,000. They consequently tabulate no divisor exceeding 1741, which is the prime number next below the square root of 3,036,000, which lies between 1742 and 1743.

The celebrated German computer, Zacharias Dase, began the task of extending this table to nine or ten millions. There was then a prospect of the fourth, fifth, and sixth millions being printed from a manuscript by Crelle, so that Dase, instead of taking the fourth million, began with the seventh. His task was interrupted by his death, but was resumed by his friend Dr. Rosenberg. The seventh, eighth, and ninth millions were published by a Society called the Dase-Verein, and printed in Hamburg, and the tenth million exists in manuscript. These publications, however, were of little practical value to science, so long as the gap between 3,036,000 (Burckhardt's final limit), and 7,000,000 (Dase's initial limit) remained a blank, and it was found that Crelle's manuscript, which had fallen into the possession of the Berlin Academy, was not sufficiently reliable, in respect of accuracy, to supply this gap.

This blank Mr. Glaisher has undertaken to fill up, and the first instalment, the fourth million, is now before us. With the assistance, towards the expenses of computation and printing, of grants from the British Association, and of the Government grants administered by the Royal Society, but without any requital of his own toil, except such as all good workers find in the satisfactory completion of their labour, he has secured for England a share in the performance of this work. The fourth million, added to Burckhardt's three millions, makes perfect work as far as it goes. The fifth million is now going through the press, and the manuscript of the sixth million is nearly complete. When these are printed, the work of Dase and Rosenberg will couple on, and we shall have, in a shape available for immediate reference, a complete knowledge of the divisors of all numbers up to nine millions. To test a number nearly equal to nine millions might involve our trying, as divisors, all the prime numbers from 7 to 2,999 inclusive.

It would be premature to discuss the question of accuracy of performance until much more trial has been made of the work than has been possible in the few days which have elapsed since its appearance. Very good guarantees, however, are afforded by the systematic method in which the process of calculation has been performed, as well as by the great experience which Mr. Glaisher has had in accurate computation, and again by the numerical tests of comparing the number of primes actually counted, within given limits, with the approximate numbers indicated by theory.

It is well known that the frequency of the occurrence of prime numbers in the neighbourhood of any large number, x, is expressed by the reciprocal of the hyperbolic logarithm of x. Soldners' integral, $\int_0^x \frac{dx}{\log x}$, should therefore express, with a high degree of approximation when x is large, the number of primes below a certain number. One difficulty of the application of this is, that the function integrated becomes infinite between the limits. Nevertheless a highly approximate formula for the number of primes below a high number x is given by the expression (due to Legendre)—

$$\frac{x}{\log x - 1{\cdot}08366}.$$

A serious practical difficulty in attributing exactness to any such formula, or in determining its constants to any high approximation, lies in the irregular distribution of the prime numbers. It not unfrequently happens that two consecutive odd numbers are primes; that is so with 3,999,311 and 3,999,313. On the other hand there is no prime number at all between 3,826,019 and 3,826,157, which differ by 138. This variation of frequency effectually throws out any minute comparison between actual counting, and analytical expressions for the number of primes, founded on the assumption of regular continuity. A discussion of this part of the subject is given in Mr. Glaisher's introduction.

For a full development of this and of the cognate theorems, and of their limits, we must refer to the extremely valuable preface which Mr. Glaisher has prefixed to his work. To that also we must refer for an account of the ingenious methods used in abridging the enormous labour of computation, and at the same time of seizing the advantages of the most systematic arrangement possible, in order to secure accurate work in the first instance, and then the detection of error, if accidentally committed. The amount of accuracy which it is possible to obtain may be inferred from the fact, that after many years' use, only two errors have yet been pointed out in Burckhardt's extensive table, and that Chernac is nearly as good. We have no reason to doubt that this high standard of accuracy has been maintained by Mr. Glaisher.

Our review would hardly be complete without some remarks on the utility of this work. We have already pointed out the utter impossibility, as a practical question to practical men, of ascertaining whether a given number has divisors, and what they are, without the help of such tables. One of the most obvious applications is to the calculation of high logarithms. The larger logarithmic tables, to a great number of figures, only extend from 1 to 20,000 in the case of common logarithms, and from 1 to 10,000 in the case of Napierian logarithms. When, therefore, such a logarithm is required for an incommensurable number (as is commonly the case), it becomes necessary to split it, either absolutely or approximately, into factors. Now this series of tables, when complete, will give us at sight the breaking up of the first seven figures of any number, and by a little adjustment, turning upon the formula $a^2 - (b \pm c)^2$, suggested by Burckhardt, to a far higher extent. For instance, Burckhardt himself gives as an approximate value of π, $256 \cdot 19 \cdot 173 \cdot 229 \cdot 509 \cdot 3203$, which (neglecting cyphers) is good for the first ten figures; and in the same way it has been found that

$$\log_e 10 = 64 \cdot 5 \cdot 13 \cdot 13 \cdot 103 \cdot 109 \cdot 541 \cdot 701 + 24844$$

up to the fourteenth decimal place.

Again, the tables virtually furnish lists of primes to their full extent. We need not remind mathematical readers how often it is important to know, concerning certain results of calculation, whether a number is prime or not, this being the necessary preliminary to further inferences from the processes which give rise to it. As an easy example of the consequence of knowing how a number splits up into prime factors, we may mention the elementary theorem, that any recurring decimal whose period consists of five figures *must* have one or more of the numbers 3, 41, or 271, as factors of its divisor. This is simply a consequence of the numerical identity—

$$99999 = 3 \cdot 3 \cdot 41 \cdot 271.$$

Now, as to relative utility: We are inclined to think that the utility of such tables is measured by the index of the power of 10, to which they extend—that this rule represents the advantage of Vega's table, up to 108,000, over Barlow's, up to 10,000; of Chernac's, up to 1,012,000, over Vega's; and of this set of tables, when completed up to ten millions, over Chernac's. We think this estimate holds for theoretical questions relating to the enumeration and distribution of primes, and cognate questions relating to the theory of numbers, as well as for the practical command they give us over the numbers themselves. Nevertheless, it would not be right to underestimate the important point that this work *does* give us a command over numerical magnitude such as we did not possess before. In that view he would be a bold man who should say that the money cost of the production and printing of these tables was a bad investment for science, especially when the directing labour was gratuitously given. What that directing labour involves can be understood by those alone who have worked upon millions. None others know what an awful factor a million is, when applied to the multiplication of the simplest process. We shall heartily congratulate Mr. Glaisher on the termination of his labours, and we no less heartily congratulate our mathematical friends upon their good fortune in having found such a man to undertake such a task.

We conclude by reminding our mathematical readers that all the processes by which these tables have been formed are but skilful adaptations of the well-known CRIBRUM ERATOSTHENIS, of which the analytical expression was first given by Euler (*introductio in analysin infinitorum*) in his remark that the harmonic series—

$$1 + \tfrac{1}{2} + \tfrac{1}{3} + \tfrac{1}{4} + \tfrac{1}{5} + \tfrac{1}{6} + \ldots \text{ to infinity}$$

is the reciprocal of the continued product—

$$(1 - \tfrac{1}{2})(1 - \tfrac{1}{3})(1 - \tfrac{1}{5})(1 - \tfrac{1}{7}) \ldots,$$

in which the primes only enter.

C. W. M.

WHO ARE THE IRISH?

Who are the Irish? By James Bonwick, F.R.G.S. (London: David Bogue, 1880.)

THIS little work is issued as the first of a series on "Our Nationalities," to be followed by three others on the Scotch, Welsh, and English. It does not appear from the prospectus whether the rest of the series is to be entrusted to Mr. Bonwick; but if they are it is to be hoped that he will qualify himself for the task by a preliminary study of at least the first principles of ethnology. The present volume, with all its good intentions and praiseworthy industry, must be regarded as a hopeless failure, owing entirely to the neglect of this necessary precaution. For many years ethnology, anthropology, and philology were subjects which any one seemed competent to deal with, who had got hold of a few lists of words in some obscure African or Polynesian dialects (the obscurer the better), or who had desecrated a sufficient number of ancient barrows, or posed to admiring circles under the shadow of some Druid's altar in Cornwall or Brittany. But those halcyon days of the amateur ethnologist are no more, though the writer, unfortunately, seems scarcely alive to the fact. Almost every page of his little tractate betrays solecisms and crudities, such as one naturally looks for in the writings of the Pinkertons, Vallanceys, Vans Kennedys, Bethams, and other obsolete writers of the old Keltic school, but which have become anachronisms since Keltic studies have been placed on a solid basis by the labours of Pritchard, Pictet, Zeuss, Ebel, Lottner, Diefenbach, Whitley Stokes, and Dr. W. K. Sullivan.

A great many authorities are quoted, some, it may be, at first hand, but most of them vicariously, some good, some of no account, some utterly worthless. But all are treated with equal deference, and nowhere is there betrayed the least sense of discrimination as to their respective merits. Thus at p. 27 we have "Betham makes them Teutons, and Wilde, Celts," as if the opinion of a keltomaniac like Sir William Betham could matter a straw one way or the other, and as if in the writer's view it commanded as much weight as that of the distinguished member of the Royal Irish Academy, with whom he is here strangely associated. This vice pervades the entire work, and of itself alone reveals the utter incapacity of the author to deal with such a theme as that of the affinities of the Irish race. Hence it is not perhaps surprising to find ethnical terms treated quite as wildly as ethnological authorities. At p. 19 occurs the following passage, which is quite a curiosity in its way:—"The Basques are believed to be of Turanian origin, while the Celts are Aryans, like most of the Europeans, as well as Persians, Hindoos, &c. Some Turkish and Finnish tribes, with ancient races in Greece, Italy, and Assyria, have been deemed Turanian with Tartar (*sic*) sympathies. The Etruscans of Tuscany were leaning to the Iberian." For wild incoherence and confusion this will surely hold its own with anything to be found in the lucubrations of the most popular exponents of Keltic ethnology in the present or past generation. Frequent use is naturally made of the convenient but dangerous term "Turanian," but its meaning is nowhere defined. Careful writers, if they use it at all, at least restrict it to the Finno-Tataric or Ural-Altaic family. But it is here apparently separated from that connection, so far at least as regards the Tatars, while the Tatars themselves are spoken of as something distinct from the "Turkish" (read Tûrki) tribes, with whom they are nevertheless identical. Why or when "the Etruscans of Tuscany were leaning to the Iberian" we are not informed, nor are we told by whom "the Basques are believed to be of Turanian origin." Meantime it may be well to remind the author

that, though linguistically standing quite apart, the Basques belong ethnically to the same great Mediterranean or Caucasian stock as do the Aryans themselves, and that they can therefore have nothing in common with the "Turanians." He should also try to realise the fact that Aryan is much more a linguistic than an ethnical term; hence that though there may have been non-Aryan speaking peoples in the British Isles, they need not necessarily have belonged to a different ethnical type from the Aryan-speaking tribes, who afterwards arrived in successive waves of migration, and practically absorbed the previous elements. In a word, apart from the question of quaternary man typified on the Continent by the fossil remains discovered at Canstadt, Cromagnon, Furfooz, Nagy-Sap, and elsewhere, there is nothing to show that in the present geological epoch these islands have been occupied by any races typically distinct from the Mediterranean, least of all that "the primitive Irish were . . . of a kindred more like Finns, Lapps, and Siberians" (p. 9). The Finns have been proved to be comparatively recent arrivals in Eastern Europe, and certainly never have reached the west. Who the "Siberians" are it is impossible to say, for the term is unknown to anthropology as a distinct racial appellation, being in fact a purely political or geographical expression.

A good deal is said about "the dark stock" prevailing in the west and south-west of Ireland. But one of the chief sources of that element is entirely overlooked, probably because too recent and too obvious to arrest the attention of the palæolithic and neolithic ethnologists. The source in question is the Spanish, due to the close commercial and even social intimacy maintained by Spain with the west coast of Ireland down to quite recent times. There were important Spanish trading stations at Dingle, Valentia, Cahirciveen, Bantry, Timoleague, Galway, and elsewhere. Many of the old houses in these places are built in the Spanish style, and it may not be generally known that Valentia Island was actually held by the Spaniards until expelled during the vigorous administration of Cromwell. Many of the peasantry in Kerry and Galway bear an unmistakable Spanish expression, and this factor ought certainly to be taken into account in dealing with the complicated problem of Irish ethnology.

Verbal resemblances are appealed to or at least quoted in the most reckless manner. One instance must suffice: "The *Lettmanni*, or Leathmannice, are said to have given name to the Avene Liff or Liffey; some trace the tribe to *Livonia* of the Baltic" (p. 20). Why to "Livonia of the Baltic" any more than to Livadia of Greece, or Livno of Herzegovina, or Livorno of Italy, or Livuma of East Africa, or Livny of Russia, or Lippai of Styria, or Liffa of the Moluccas? It is the old story of a river in Macedon and a river at Monmouth, so that "the situation, look you, is both alike," and Fluellen's ethnology quite as good as that of many here appealed to as authorities.

On the subject of the Round Towers the writer has some sensible remarks, and we are glad to see that he has had the courage to reject the Christian theory of their origin. Referring to those overthrown by the earthquake of 448 A.D., he well remarks that "it was very unlikely they had been erected as belfries, since the churches of the period were *all* of wood, and continued to be of wood for six hundred years after. The oldest stone churches are extremely rude and of imperfect masonry. It is strange, therefore, that the belfries, supposed to have been raised in the twelfth or thirteenth century, when churches were either of wood or clay, or of miserable stone-work, should have a finish and delicacy of work rivalling anything of modern times. . . . . If Christian, how is it that only two out of one hundred and twenty-five should bear the least symbol of a Christian character, and while those evidently show such marks to be novel alterations?"

The writer's style and grammar are peculiar. On the very first page we have "lots of discussions;" "we might, it is true, track backward on the track of newcomers;" "we could thus pass by English, Scotch . . . . without ever *getting across* the original men." Farther on, "The cup-marks are being still reverenced," p. 10; "inroading peoples," p. 17. "They brought with them *there* fifty maidens," p. 21. "They reappear on Irish *sods*," p. 23. "The Danes made Dublin, Wexford, Cork, and Waterford the commercial ports they are, whose people are now lighter than the others," p. 59. "Silver was once abundantly ornamenting it, besides precious stones," p. 80. Elsewhere the uncial style of penmanship is spoken of as a "corrupt Latin;" the famous "Book of Kells" is referred to as "the Book of Kelly;" the abolition of clan war-shouts is said to have removed "one cause for shillelahing;" the tendency of the English to become assimilated to the natives is described as "the habit of English to turn Irishy (*sic*) there;" hence the king hesitates "about the expediency of allowing decent Englishmen *mixing up* with Irish," p. 120. There is a good deal of this flippant tone, which cannot fail to give as much offence to the sensitive Irish as the extraordinary grammar certainly will to the sensitive English reader.

A. H. KEANE

OUR BOOK SHELF

Zoology for Students and General Readers. By A. S. Packard, Jun., M.D., Professor of Zoology and Geology in Brown University. With numerous Illustrations. (New York: Henry Holt and Co. London: Trübner and Co., 1879.)

THIS neatly printed and well illustrated volume forms one of the American Science Series, the principal object of which is to supply the lack, in some subjects very great, of authoritative books whose principles are, so far as practicable, illustrated by familiar American facts, while they should at the same time at least not contradict the very latest generalisations of science. Prof. Packard's "Zoology" is one of the first published of the series; it is designed to be used quite as much in the laboratory or with specimens in hand as in the class-room. It is an expansion of a course of lectures for college students, though prepared to meet the wants of the general reader. Most of the anatomical descriptions and drawings have been made expressly for this book, and special portions have had the benefit of being supervised by Professors Hyatt, Gill, Cope, and Dr. E. Coues; the illustrations are to a large extent original, though some of them have appeared before in the pages of the *American Naturalist*, or in Dr. Coues's "Key to the Birds of North America."

The classification adopted is described as a provisional one; in it the animal kingdom is divided into eight branches—Protozoa, Porifera, Cœlenterata, Echinodermata, Vermes (flat and round worms, Polyzoa, Brachiopods, Annelids, Tunicates), Mollusca, Arthropoda, and Vertebrata. It is hinted that the Tunicates might even form a ninth branch, to stand next below the Vertebrates. The evident aim and object of the writer has been to write in the smallest possible compass a clear and intelligent account of the animal kingdom, one that would give a fair idea to the reader of what is already known about it, and that would at the same time suggest where new work might be done and how to do it. In this effort it is our opinion that the author has in a very great measure succeeded; but the subject is so large a one that with all the help he has received he still sometimes falls short of his aim. Some of the shortcomings are strange; thus Fig. 33 is a copy of Lovén's *Hyalonema boreale*, a species having nothing to do with the vitreous sponges and yet referred to as typical. On p. 85 we read, "In Tubipora the polyps are compound and secrete solid, calcareous, bright red tubes arranged side by side"; and yet in the next paragraph but one it is stated that Heliopora differs from Tubipora "in that the hard tissue of its corallium shows no sign of being composed of fused spicules." To call attention to all such instances as have caught our eye as we looked carefully over this book would serve no useful purpose. We could easily on the other hand call attention to many new facts here recorded, not to be found perhaps in any other manual, and we feel sure that this handbook deserves a successful career. It is brought out in a style in every way worthy of its publishers.

Principles of Agriculture. Questions, Answers, Notes, &c. By S. Tomlinson, Stud. Inst. C.E. (Bradford: T. Brear, 1880.)

THE object of this book is, we presume, the instruction of students about to be examined in subject xxiv. of the Science and Art Department. It mainly consists of such answers as Mr. S. Tomlinson would have given to the questions asked in the examination papers set by Mr. H. Tanner in the years 1876-9. It is difficult to characterise this incoherent pamphlet as it deserves. It is not merely inadequate; it is something worse than feeble; in fact it abounds in the errors, direct and implied, which a mere beginner in the study of agricultural chemistry would be most likely to make. We quote such statements as the following in support of our adverse criticism. "Some guanos contain phosphates," p. 20. Where is the guano free from them? "The general composition of cows' milk is:—Water 858, casein 68, butter 38, sugar 30, salts 6;" p. 22. It is needless to remark that the figure representing butter in this analysis is the only one which approaches the truth. "Fibrin in wheat; albumen in corn," p. 30. What is the distinction implied here between wheat and corn? "The use of soils depends upon their place amongst other rocks," p. 39. Even if soils were species of the genus rock, their agricultural value could not be fairly stated to depend upon their geological horizon. On page 46 phosphorus is given as an element essential to the constitution of albumen and fibrin. But we will say no more, having already probably said too much. A. H. C.

The Cotton-Worm. By Chas. V. Riley, M.A., Ph.D. *Bulletin* No. 3 of the United States Entomological Commission. 8vo, pp. 1-144. (Washington: Government Printing Office, 1880.)

WE think this monograph exceeds in value all others of Prof. Riley's well-known writings on North American injurious insects. The cotton-worm is the larva of a moth of the family *Noctuidæ*, and belongs to that section of it in which the caterpillars form what is termed a "half-loop" in walking, owing to one pair of pro-legs being absent. It is calculated that in a year of severe visitation it occasions damage to the amount of 30,000,000 dollars, or 15½ per cent. annual average loss since the war. No wonder it has become a subject of governmental solicitude. The first forty-seven pages are occupied by an exhaustive natural history of the pest, illustrated by numerous very excellent original woodcuts, and a few (not original) that are indifferent, and also by a fine plate, admirably executed in colours, by what is termed the lithocaustic process. This portion consists not only of a complete history of the moth itself, but also of every imaginable kind of parasite and external enemy, so that it is of the greatest service to the scientific, as well as to the economic entomologist. The formidable nature of the subject may be readily imagined, when it is stated that in the hot districts the number of broods is almost continuous, and that in summer the whole life-cycle may be completed in less than three weeks. As to whether the perfect insect hibernates or not, there appears to be considerable difference of opinion, but Prof. Riley believes it does so in the southern districts, but not otherwise. This biological portion is succeeded by an extended examination of the remedies proved or tried, and an illustrated description of the various implements and appliances used to distribute these remedies, reminding one of the illustrated catalogues of some of our large agricultural implement makers, only in these one looks in vain for any parallel to the "brushers," "distributors," "atomisers," "sprinklers," &c., that here figure. Considerations of the advantages of light and saccharine matters for attracting the moths are not lost sight of, neither is the new idea of infecting the larvæ by means of the yeast fungus, although this is reported upon somewhat disparagingly. Our author, while admitting the efficacy, in greater or lesser degrees, of other insecticides, appears to fall back upon "Paris green" as the most effective, as he has done in former cases, when treating upon the Colorado beetle, &c.

Not the least interesting and amusing part of the book is the appendix of answers by correspondents to a circular of questions addressed to them. These answers display that same amount of great knowledge and gross ignorance combined as one finds amongst agriculturists at home on similar subjects. Biologists inclined to favour the theory of abiogenesis will find enthusiastic advocates amongst cotton-planters, even in connection with an animal so high in the scale as a moth; one planter expresses his decided opinion that "the atmosphere created the germ right there;" others strongly deny that any pairing of the sexes takes place; another bold theorist states as his belief that "it is a peculiar parasite of the cotton-plant, and as such, that the cryptic germ of the insect is to be found with the germ of the plant itself, and, like all parasites, only requires favourable circumstances to develop it." Some, again, assert that the moths are brought from the south by strong breezes; others, that the larvæ are not especially attached to the cotton-plant, but feed upon anything on which the eggs were deposited, only then they differ from those on the cotton. Even supposing all Prof. Riley's time and trouble in investigating the matter to be thrown away—and there is no reason to imagine it will be—so far as arresting the damage, or lessening it, is concerned, he will have done good service in explaining to the planters the true state of things regarding the natural history of the insect; but we must not suppose all will believe him.

The moth is *Aletia argillacea* of systematists, *Aletia* being a genus closely allied to *Anomis*, Hübner. It has also been described as *Anomis bipunctina* by Guenée (if we mistake not), originally from a figure in Abbot's beautiful work, though our author makes no mention of this.

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 ensure the appearance even of communications containing interesting and novel facts.*]

C. F. Gauss

In August of last year the editor of NATURE forwarded to me a letter he had received from Mr. Robert Gauss, of the firm of McDearman and Gauss, attorneys at law, St. Charles, Missouri, U.S.A. The object of this letter was to obtain, if possible, a copy of the *Proceedings* of the Royal Society (vol. vii.), referred to in my centenary notice of Gauss (NATURE, vol. xv. p. 533). I have not succeeded in obtaining this volume, and I learn from Mr. Walter White that there is no copy available from the Royal Society. In the course of a subsequent correspondence I have learnt several family particulars which, as I have Mr. Gauss's permission, I should like to give to supplement my former notice referred to above. I am the more disposed to do so as the notice of Gauss in the *Encycl. Brit.* (vol. x.) gives but scanty details, and, I observe, gives the erroneous date of April 23 (for April 30) as his birthday (vol. xv. p. 533), and further, all reference to Gauss's married life was omitted in my notice. Gauss, it is well known, was twice married. By his first wife he had two sons, Joseph and Louis, and one daughter, Minna; Joseph died in Europe four or five years ago, Louis died in infancy, and Minna, wife of Prof. Ewald, of Göttingen, died about ten years before her father. The second wife was Minna Waldeck (there is a letter from her mother to Olbers, in Dr. Bruhns's "Briefe zwischen A. v. Humboldt und Gauss," No. vi.); by her Gauss had also two sons and a daughter. This daughter, Theresa, died in Europe. The second son, William, settled in Missouri, and died August 23, 1879, at St. Louis. My informant says he died rich, and his sons are very well circumstanced in business: one son is a Presbyterian minister. Eugene Gauss, the eldest son by the second marriage, is the only living child of C. F. Gauss, and is in his sixty-seventh year (almost entirely blind with cataract in his eyes); he is Mr. R. Gauss's father; he left Europe about 1831, and has not since left his adopted country. The family propose to publish a translation of the several memoirs of Gauss in book form, and are very desirous of procuring copies of his letters to scientific men, more especially such as would be illustrative of his character and thoughts on general subjects. I have an extract before me of a letter from the daughter Theresa (date December 6, 1850), in which she says: "I cannot tell you much out of our quiet, simple life; one day and one year resembles very much the other, although they are peaceful days and years, for father, even now in his advanced years, retains his health unimpaired, and an always cheerful and happy frame of mind;" and then follows an account of the celebration in July, 1849, of his "semi-centennial doctors'-jubilee." Brunswick and Göttingen heaped honours upon him, and the "King sent him autograph congratulations and bestowed on him the degree of a higher order; of letters and addresses there was no end" . . . "then father delivered an address in the University hall, which was filled to overflowing with spectators and auditors, and which was so decorated with flowers as to look like a fairy palace. Even the houses in the streets through which he passed were decorated, and the city swarmed with well-dressed people as on a holiday. When at last, at seven o'clock, he returned home from the dinner, he was indeed very much exhausted, and it was well that the torch-light procession, which the students had thought of getting up in his honour, was, at his wish, omitted." It was a matter of regret to the old man that not one of his sons was able to be present.

A subsequent letter (November 16, 1855) describes the closing scene: "Gradually his life ebbed away, while his sufferings ('from an organic heart trouble') increased. He bore it all though with constant cheerfulness, and with a uniform patience and submission. He did not altogether lose hope, and he retained his consciousness until the last. His physician Bauer remained with him during the day previous to, and during the night of, his death. At 1 o'clock in the morning he took hold of his pulse, and said: 'It is moving quietly and full as in his best days, death may linger a long time yet.' Ten minutes later all was over! He died sitting up in his chair; and it was thus that his son Joseph found him enjoying, apparently, a quiet peaceful sleep." It is granted to few mathematicians to be so honoured in life.

R. TUCKER

Trans-Atlantic Longitudes

In an admirable article by M. Perier on telegraphic differences of longitude, published in the *Bulletin de la Société de Géographie* for September, 1879, he refers to the cables across the Atlantic, and their use for the above-mentioned purpose.

As a matter of historical interest, I beg to forward you the following memoranda of the work of this class executed by this country.

By officers of this Survey:—

In 1866: Between Cambridge, Mass., and Greenwich, *viâ* Newfoundland and Ireland.

In 1870: Between Cambridge, Mass., and Brest, France.

In 1872: Between Cambridge, Mass., and Greenwich, *viâ* St. Pierre, Brest, and Paris.

The results of these observations are shown in our paper, written by Prof. J. E. Hilgard, on these longitudes, a copy of which is forwarded herewith.

By officers of the U.S. Navy:—

In 1874 and 1875: Key West to Havana, Havana to Santiago de Cuba, Santiago to Kingston, Jamaica, and Kingston to Panama.

In 1875 and 1876: Kingston to St. Thomas, to Port Spain, to Barbadoes.

In 1878 and 1879: Greenwich to Lisbon, to Funchal, to Porto Grande, to Pernambuco, to Bahia, to Rio de Janeiro, to Monte Video, to Buenos Ayres.

The cable between Para and Port Spain having been broken, the complete grand circuit cannot at present be effected.

C. P. PATTERSON

U.S. Coast and Geodetic Survey Office, Washington, March 1

The "Zoological Record"

In acknowledging with thanks the kindly notice of the last volume of this publication given in NATURE, vol. xxi. p. 392, I trust I am not out of order in referring to one or two sentences in it that require explanation. If the reviewer knew the difficulty of getting competent recorders at the slight remuneration we can offer, he would also appreciate the impossibility of enforcing uniformity in treatment of the separate subjects: the work is almost done as a favour, and each writer has his own idea as to the method most likely to be useful, and would probably desire all the others to conform to his standard.

The scheme of separate pagination referred to as a convenience to the printer is, on the contrary, a source of considerable additional trouble mechanically both to the printers and myself: it was adopted in deference to the expressed wishes of some working zoologists, who naturally desired to have as soon as possible the portions of the work devoted to their special branches, and who indeed very probably care for no other part of the publication. The query affecting myself as editor as to the accent always given on the *a* of *infrà*, scarcely needs the answer that *infra* without the accent is a preposition requiring the accusative, and with the accent, as used here, is an adverb (see any large Latin dictionary, such as the old Ainsworth). It is also perhaps unnecessary to refer to the remark as to reproduction of the Greek "κ" by the English *c*, beyond observing that generic words, such as *Kallispongia*, Wright, are supposed to be in Latin, not English; discretion is scarcely allowable when uniformity is desirable.

The identification of the author, H. W. Mackintosh, has evidently escaped Dr. Lütken, who has been puzzled by the form "Mr. Mackintosh" used in *Quart. Jour. Micr. Sci.*, xvii. p. 104.

In "Cœl. 13," *Cylicozoa* is not a misprint for *Calycozoa*, as is readily seen by referring to Taschenberg's paper itself.

Mr. Ross's paper on the muscles of a specimen of the Cheetah which he dissected, was possibly considered by the recorder as purely medical, with no attempt at deduction (the number of *Proceedings* of the Royal Irish Academy containing it did not arrive to my hands in London until October, 1878, long after the mammalian part was written).

The omission of a second reference to *Ceratella labyrinthica*

shall be supplied in the next volume; those who take the trouble to note such *omissa* are the truest friends we have.

1, Savile Row, W. E. C. RYE

[The writer of the review claims to know something of the difficulties the editor of the *Zoological Record* refers to, with which "haud ignar*us* mali" he sympathises, and still he clings to the idea that it might be expedient for the editor to keep his young team in hand, but in thus suggesting a uniformity in practice, nothing was further from his thoughts than an unfriendly criticism. As to the accentuation of the *à* in *infra*, he quite agrees with the editor that he would find the fact he mentions in an "old Ainsworth," but no modern writer now ever thinks of using an accent on Latin words under any circumstances, and hence the query. As to *Kalispongia*, Wright, being spelt with a *K* and not a *C*, though the subject is a tempting one for comment, yet a controversy on it would hardly be suited for the columns of NATURE, but surely the editor will draw a distinction between an attempt to preserve a uniformity in the style of the several records, and an insistance on authors being uniform in their spelling of generic names.]

A Museum Conference

MR. PATON'S suggestion about a museum conference is an admirable one, although I think that it should not be confined to officials only. The time has come when an Association for the Promotion and Systematic Arrangement of Museums must be formed. I trust, therefore, that those competent to do it will take the matter up and produce some practical result.

J. ROMILLY ALLEN

The Tay Bridge Storm

IN his interesting letter on the above subject (NATURE, vol. xxi. p. 443) Sir Ralph Abercromby remarks that "there is a good deal of evidence to show that where the velocity of the [cyclone] centre is very great, the strength of the wind for any given gradients is increased, or at all events becomes more squally and gusty;" and again (p. 444) that the Tay Bridge storm "was exceptionally squally and gusty, doubtless owing to the unusually rapid rate of its motion." I am far from wishing to be understood to impugn the accuracy of these remarks, but I would say that the law which is indicated in them has, if I mistake not, escaped general observation, and I believe that meteorologists will be grateful to Sir R. Abercromby, than whom no one can be found better able to do so, if he will point out the evidence on which it rests.

It is, I think, generally admitted that in traversing the continents both of Europe and of North America storms have on some occasions a greater velocity of propagation than has been recorded in the British Isles; and it seems possible that an increment in the quality of "gustiness" may be produced in an air current by its passage over a very extensive surface whose friction coefficient is large. But this scarcely seems to throw light upon the relation, mentioned by Sir R. Abercromby, between the gustiness of the wind for a given gradient over a particular and very limited area, and the velocity of propagation of the wind-system across that area.

The relation between the strength of the wind and the steepness of barometrical gradient is somewhat complex, and has not even yet received complete study. The relation between the strength of the wind and the velocity of propagation, or rate of progress of a storm, is a more intricate and obscure subject, and I believe that any facts which tend to elucidate it will be of considerable value, especially if this second relation can be shown to be independent of the first.

W. CLEMENT LEY

March 12

Strange Arithmetic

IN the March number of the *Contemporary Review* is an article by Dr. C. B. Radcliffe, entitled "A Sequel to the Pedigree of Man," in which some most startling theories are propounded. As an appendix to this article, he gives several tables intended to prove that the mean time of high spring-tide throughout the world is about six o'clock (morning and evening). For this purpose he gives the time at a considerable number of stations, and the very large discrepancies led me to inquire how he arrived at his results. This he does by adding the times together, and dividing by the number of places! It is surely clear that any miscellaneous selection of times treated in this manner *must* give a result somewhere near six.

His first table shows a result of 6h. 9m., but if you take his figures, and number the hours from morning to evening, instead of noon to midnight (that is, call six twelve, and twelve six), the result is 6h. 27m., or on our hypothesis 27 minutes past noon! The proper way of treating the figures would be to show at how many places the tide is high during each hour, and the annexed table shows that it is utterly impossible to fix any mean time. If all Dr. Radcliffe's theories rest on such hollow proofs as this, they are certainly worthy of little attention.

Hour.	Table I.	Table II.
1[1]	3	0
2	3	3
3	4	2
4	9	2
5	1	3
6	4	3
7	7	1
8	5	1
9	0	7
10	2	2
11	2	6
12	2	2
No. of places	42	32

Chester, March 6 E. S.

Fertilisation of the Grape Vine

THE season is favourable for an examination of the floral development of the vine, and I recommend an inspection of the flower of that plant to all who are curious. For my own part I shall be glad if any one who has remarked more than is obvious will tell us something about it, for the flower is certainly remarkable. On examination it is seen that each little knob, which at first sight seems to be the young grape, is, in fact, a little green *cap*, which, when lifted off, discloses a group of stamens closely surrounding the pistil. To all appearance this cap—which is all that represents the flower (in the common acceptation of the word)—must effectually prevent anything like cross-fertilisation. Apparently it becomes detached below and is thrown off as soon as the stamens, which continue to support it, lose their vitality, and not before. It is, indeed, not easy to conceive any other so simple an arrangement, by which, whatever of fertilisation is necessary, can be ensured being done at home. It seems as if by this arrangement every flower *must* fertilise, though there were not another within miles, and *cannot* be fertilised by any other but itself, though it be one among thousands.

Collingwood, March 14 J. HERSCHEL

EXPLORATION IN BORNEO

HERR CARL BOCK has successfully accomplished his journey across Borneo—from Koetei to Bandjermassing—arriving at the latter place on the last day of 1879. The journey was commenced on November 21, from Tangeroeng, the residence of the Sultan of Koetei, who promised to accompany Herr Bock, but did all in his power to dissuade him from going. From hence the route was up the Mahakkan River, to the village of Moara-Kaman, where the mosquitoes were so troublesome that a retreat was almost determined on. On the 24th the largest Malay village in the interior was reached—Kotta Bangoen, containing more than a thousand inhabitants. The whole of the lower part of the Mahakkan is occupied by the Malays, the Dyaks dwelling only on the smaller tributaries, or towards the source of the main river. In this neighbourhood there is abundance of rattang gutta, or edible birds' nests, and bees' wax, to obtain which the Malays go in parties of twenty or thirty into the forests for fear of the Dyaks. Owing to the great drought of last year in this district, the whole forest is leafless, a very unaccustomed sight in the tropics, and as a result the birds had all deserted it, or at least none were to be seen. At this village, as well as at

[1] That is, 1.0 to 1.59 (morning or evening).

Tangaroeng and Moara Kaman, Herr Bock has found traces of a former Hindoo race, and a Dyak had lately dug up a beautifully formed bronze Hindoo goddess. From this point Herr Bock diverged from the Mahakkan, in order to visit the lake district and observe the Dyak inhabitants. He has made a number of sketches of these savages, many of whom are cannibals. The most dreaded tribe are the Tring Dyaks, whose chief, by name Sibau Mobang, Herr Bock summoned to meet him in the name of the Sultan. This man is most villanous in looks, and told our traveller that he frequently cut off the heads of either sex for the sake of eating the brain, which was sweet, as were also the palms of the hands, but the shoulder was bitter; and he presented him with his shield, covered all over with tufts of human hair. At the last village in the Malay part of his dominions, Moara Pahou, the Sultan summoned a large number of the Dyaks to accompany him and accumulated a body of some 600 in all, of whom 75 accompanied Herr Bock one or two days' journey in advance. The Dyak tribes are constantly at war with each other in order to obtain heads, and the Malays look down on them as savages, and by this means the terror of their name is increased. The upper part of the Moara Pahou branch of the Mahakkan is broken by rapids, over which the praus had to be dragged by rattang ropes. The last village on this river, Moara Anar, was reached on December 20, and then the march through the forest over the water-shed commenced. One of the advanced party was here killed, but no further loss was sustained. A Dyak road has been made through the forest with narrow bamboo bridges over the numerous small streams; these, however, were at the time mostly under water, owing to the recent floods. The journey on foot occupied four days of twelve hours, during two of which Herr Bock had to feed on the wild fruits, his provisions having been left behind. Perfect silence here reigns, broken only by the occasional note of a bird, though none are to be seen. No attempt at molestation appears to have been made by the more savage tribes of the Dyaks, although at one village the chief pressed his visitors to partake of rice and fruit, which they had been forewarned was poisoned, and therefore declined. The end of this march brought our traveller to the river Benangau, a tributary of the Tewé, down which he passed till he arrived on Dutch territory, where the Dyaks are altogether comparatively civilised, and very different to those of Koetei.

Very little that is new in zoology appears to have been obtained in this journey, which lay across a rather barren district; but Herr Bock has had splendid opportunities for making ethnological observations and these have been turned to good account. Many attempts were made to find the family which were said to have tails—but though several Dyaks were spoken to who had seen them, their whereabouts was not discovered.

The journey was undertaken at the desire of the Dutch government, who will doubtless take care that its successful accomplishment is duly honoured.

THE AUDIPHONE

THE instrument which is now being introduced into this country under the name of the audiphone, is the invention of Mr. R. G. Rhodes of Chicago. It is intended, as its name attempts to indicate, to provide the deaf with the means of hearing, and is for some persons undoubtedly a more efficient aid than the hearing-trumpet. The figures appended show the original form of the instrument, and the modification of it suggested by Prof. Colladon of Geneva. The American audiphone consists of a thin elastic plate or sheet of hard ebonite rubber, furnished with a handle, and about the size and shape of an ordinary palm-leaf fan. The strings attached to the upper edge serve to bend it into a curving form, and a small clamp fixes the string at the handle. When thus strained into shape, the instrument is pressed against the upper front teeth by the deaf operator, the convex side being turned outwards. The sounds received upon the thin sheet cause it to vibrate, and the vibrations are thus conveyed through the teeth and bones of the skull to the auditory nerves. Its use is therefore confined to the

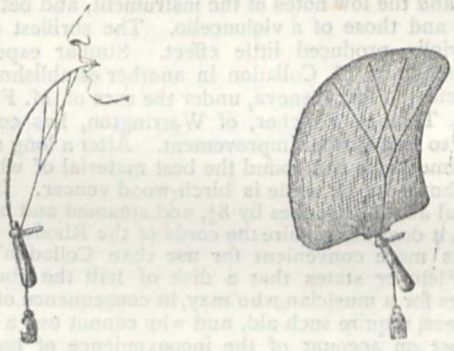


FIG. 1.—Rhodes's Audiphone.

partially deaf, or at least to those in whom the auditory sense is not entirely absent, or the nerve atrophied.

The ebonite of which the audiphone is made being costly, Prof. Colladon has suggested a cheap and efficient substitute in the form of a strip of elastic cardboard of the peculiar kind known to the trade as satin-board or shalloon-board, and which may be described as a fine kind of yellow mill-board with a very smooth, glazed surface.

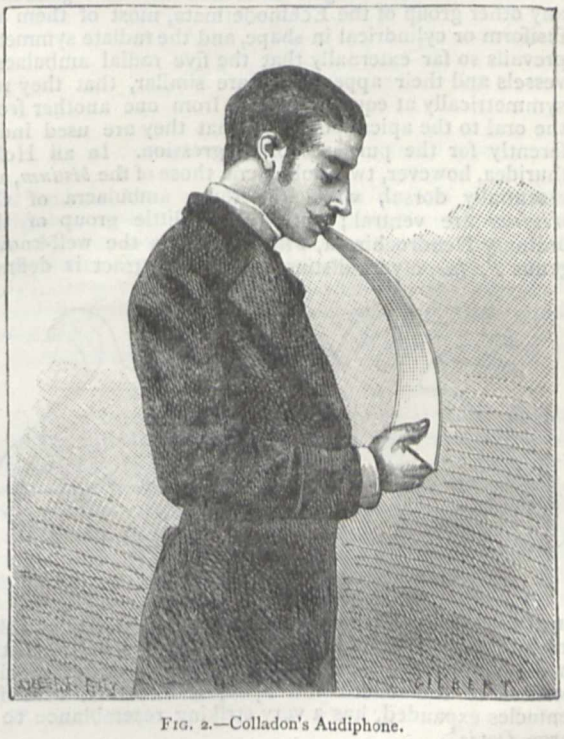


FIG. 2.—Colladon's Audiphone.

A sheet of this material, about eighteen inches long by ten broad, and varnished at the edge where it is placed in contact with the teeth, yields results quite equal, if not superior, to those afforded by the ebonite article of fifty times the cost. Prof. Colladon has made a number of experiments in conjunction with M. Louis Sager, upon the hearing of deaf-mutes. Not all who tried the instrument

could succeed in hearing with it, but all with whom the experiment was successful preferred the card audiphone to that of ebonite.

A number of deaf mutes under the care of M. Sager, were blindfolded and provided with audiphones; the distances from a grand piano, at which they began to hear the sounds, indicated their different degrees of deafness. They could distinguish at once between the high and the low notes of the instrument, and between its tones and those of a violoncello. The shrillest tones of the violin produced little effect. Similar experiments were made by M. Colladon in another establishment for deaf-mutes, near Geneva, under the care of M. Forestier.

Mr. Thomas Fletcher, of Warrington, has communicated to us a further improvement. After a long series of experiments he has found the best material of which the audiphone can be made is birch-wood veneer. If cut to an oval about 12 inches by 8½, and steamed and bent to a curve, it does not require the cords of the Rhodes' pattern, and is more convenient for use than Colladon's form. Mr. Fletcher states that a disk of half the above size suffices for a musician who may, in consequence of partial deafness, require such aid, and who cannot use a hearing trumpet on account of the inconvenience of holding it while playing his instrument. The disk of veneer is so light that it may be held between the teeth without effort and almost without consciousness of its presence. If stained black it is less visible.

THE ELASMOPODA (HJALMAR THÉEL) A NEW ORDER OF HOLOTHURIDEA

ALTHOUGH the Holothuridea show a greater tendency to a bilateral arrangement of their internal organs than any other group of the Echinodermata, most of them are fusiform or cylindrical in shape, and the radiate symmetry prevails so far externally that the five radial ambulacral vessels and their appendages are similar, that they run symmetrically at equal distances from one another from the oral to the apical pole, and that they are used indifferently for the purposes of progression. In all Holothuridea, however, two ambulacra, those of the *bivium*, are essentially dorsal, while the three ambulacra of the *trivium* are ventral; and in one little group of the ordinary Dendrochirota, which includes the well-known genus *Psolus*, a very distinct ambulatory tract is defined

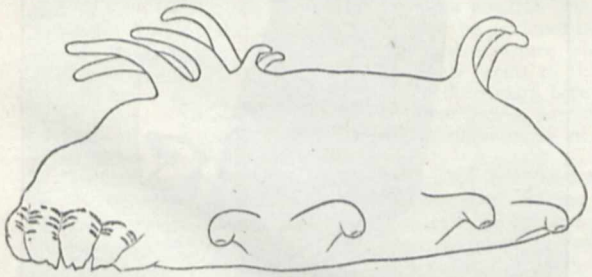


FIG. 1.—*Elpidia glacialis*, Théel. Side view.

on the ventral surface of the body, and the pedicels of the rest of the ambulacral system are either absent or greatly modified. From the form of the ambulatory disk and the position of the mouth and apex, a *Cuvieria*, with its tentacles expanded, has a very striking resemblance to a large *Doris*.

In the year 1875 Dr. Hjalmar Théel, attached as naturalist to Nordenskjöld's expedition to the Yenisei, dredged in the western portion of the Kara Sea at a depth of 150 fathoms, fourteen specimens of a small Holothurian, which he was at first inclined to take for a nudibranchiate mollusc. *Elpidia glacialis*, Théel, is about 20 mm. long and 8 mm. broad. The anterior portion is abruptly contracted, so as to give the appearance of a head, and the mouth, surrounded by a ring of ten tentacles, simple with the exception of two terminal papillæ, is turned downwards. A transverse section of the body is semicircular, the dorsal surface being strongly arched, while the ventral (trivial) surface is flat, and forms an ambulatory disk. The skin, which has the usual structure of the skin in the Holothuridea, is strengthened by a thick layer of felted calcareous spicules of different forms, with delicate branches which project through the skin, roughening it slightly. Very sparsely scattered, just below the epidermis, there are a few large wheels much like those of *Myriotrochus*, and a large number of very minute wheels are found in the outer layers of the skin. *Elpidia* has eight very prominent partially retractile pedicels or water-feet, placed in two opposite rows of four, on the lateral ambulacra of the trivium, along the edges of the ventral disk. Radial vessels are developed in two ambulacra only, the vessels of the ambulacra of the bivium and the central ambulacrum of the trivium being entirely suppressed. The nervous system is radially symmetrical, five cords running back symmetrically from the oral nerve ring along the five ambulacral lines. Otocysts of peculiar structure are placed at intervals along the course of the nerves.

On the back there are two rows of paired foot-like appendages much in the position of the bivial ambulacra; the appendages of the anterior group bend forwards, and those of the posterior backwards. From the absence of the bivial water-vessels these appendages are not in connection with the water-vascular system; they receive twigs, however, from the radial nerves.

Elpidia is unisexual; the small genital opening is placed in the dorsal middle-lines about mid-way between the crown of tentacles and the anterior group of dorsal appendages; the so-called "respiratory tree" and the Cuvierian glands are absent.

Elpidia is very remarkable both in external form and in internal structure, and differs widely both from the typical Pedata and from the Apoda, in many respects taking an intermediate place between these groups.

Since the appearance of Dr. Théel's paper Messrs. Koren and Danielssen have described in the *Nyt Magazin for Naturvidenskaberne*, two new genera procured by the Norwegian North-Sea Expedition, whose close relation to *Elpidia* is manifest. The characters of these genera will be given in their place in the systematic list.

On looking over the Holothuridea of the *Challenger* Expedition, I at once recognised the resemblance of a large number of the deep-sea species to the form which Dr. Théel had worked out with much care and skill, and acting under the advice of my friend, Prof. Lovén, I asked Dr. Théel to be good enough to undertake the description of the *Challenger* material belonging to the class, Prof. Lovén kindly offering his advice and assistance. Dr. Théel was over last summer and examined the collection. He recognised over 200 species, half of which are new to science, and of these the greater number from the deep-sea are related to *Elpidia*. The group enlarged to such an extent, and presenting so many marked peculiarities quite revolutionised the *facies* of the Holothuridea, and asserted itself as an order of value equal at all events to that of the PEDATA and APODA. For this order Dr. Théel proposes the name ELASMOPODA.

Dr. Théel selected all the forms belonging to the new order in the *Challenger* collection, and carried them with him to Sweden, and a few weeks ago he published, with the permission of the Treasury, in the *K. Sv. Vet.-Akad. Handl.*, Band 5, No. 19, the first part of a preliminary report on the Holothuridea of the *Challenger* Expedition, in which seven new genera and seventeen new species of Elasmopoda are defined.

The following are the genera established by Dr. Théel, and I add the definitions of the two others described by

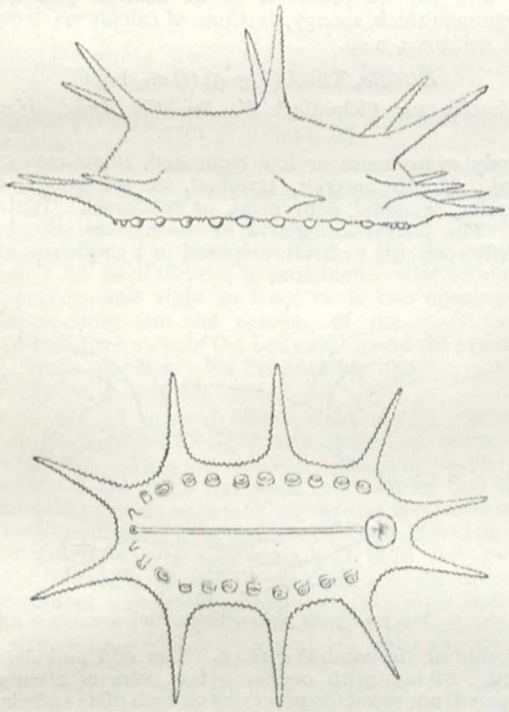
Koren and Danielssen to complete the sketch of the order according to our present knowledge.

Order : ELASMOPODA (ἐλαύνω, to move).

Body distinctly bilateral. Ambulacra well defined. The lateral ambulacra of the trivium bearing large, slightly retractile pedicels, disposed either in a single row, or sometimes in two rows, along each side of the ventral surface, and sometimes with another series of larger highly elongated not retractile processes placed externally and above the pedicels; pedicels of the two lateral ambulacra symmetrically arranged, being more or less distinctly opposed across the ventral surface. The odd ambulacrum naked or very seldom with a few rudimental pedicels. Bivium provided with very long not retractile processes, often disposed in one or more rows along each of its ambulacra and more or less distinctly opposed across the dorsal surface, or with only a few rudimental ones in its anterior part, or with a single very large one, resembling a broad, branched or unbranched lobe, and near to it some small papillæ. No respiratory trees. Integument naked, spiculous, or plated.

Deima, n.g., Figs. 2, 3 (δεῖμα, a fright).

Back highly convex; ventral surface flat. Mouth anterior, ventral; anus posterior, ventral. Tentacles small, perfectly retractile, about twenty (?). The lateral ambulacra of the trivium with large pedicels, slightly retractile at their ends alone, disposed in a single row all along each side of the ventral surface, and with another series of highly elongated, conical, rigid, not retractile



FIGS. 2, 3.—*Deima fastorum*, Théel. Lateral and ventral views.

processes, placed externally and above the pedicels all along each side of the body and directed straight outwards. The odd ambulacrum naked. Bivium with processes, resembling those of the trivium, disposed in a single row all along each of its ambulacra. Processes forming transverse rows, more or less distinct. Integument with crowded, irregularly rounded, perforated plates.

D. validum, n.sp. *D. fastorum*.

Oneirophanta, n.g., Fig. 4 (ὀνειρόφαντα, a vision).

Back highly convex; ventral surface flat. Mouth anterior, subventral; anus posterior, ventral. Tentacles twenty, large and retractile at their ends alone. The lateral ambulacra of the trivium with large pedicels, slightly retractile at their ends, disposed in a double row all along each side of the ventral surface, and with another series of highly elongated, conical, more or less flexible, not retractile processes, placed externally and above the pedicels all along each side of the body. The

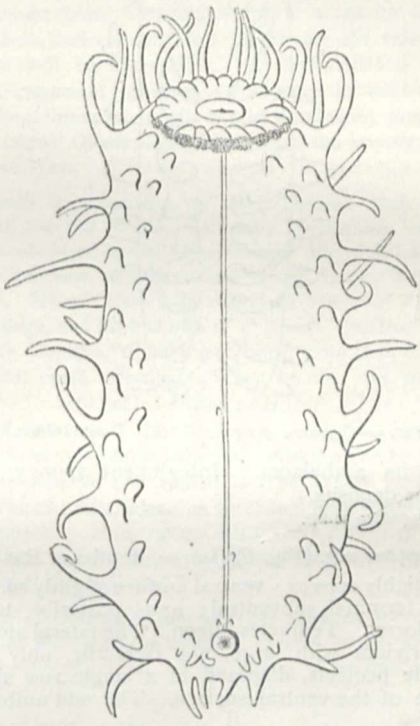


FIG. 4.—*Oneirophanta mutabilis*, Théel. Ventral surface.

odd ambulacrum, with a few more or less rudimental pedicels. Bivium with processes, resembling those of the trivium, disposed in a single row all along each of its ambulacra. Processes not forming transverse rows or very indistinct ones. Integument with crowded, irregularly rounded, perforated plates, often provided with minute processes.

O. mutabilis, n.sp.

Orphnurgus, n.g. (ὄρφνη, darkness).

Back convex; ventral surface almost flat. Mouth anterior, terminal, subventral; anus posterior, terminal, slightly dorsal. Tentacles twenty. The lateral ambulacra of the trivium with very large, not retractile pedicels, disposed in a single row all along each side of the ventral surface, and with another series of slender, very flexible, for the most part apparently retractile processes, placed above the pedicels all along each side of the body. The odd ambulacrum naked. Bivium with a crowded series of numerous processes, resembling those of the trivium, apparently disposed in two rows all along each of its ambulacra. Integument with spicula of various forms, but destitute of wheels.

O. asper, n.sp.

Cryodora, n.g. Fig. 5 (κρύος, cold).

Back highly convex; ventral surface almost flat. Mouth anterior, subventral; anus posterior, terminal, subdorsal. Tentacles fifteen. The lateral ambulacra of the trivium with large, slightly retractile pedicels, disposed in a single row all along each side of the ventral surface. The odd ambulacrum naked. Bivium with slender, flexible, not

retractile processes, disposed in a single row all along each of its ambulacra. Integument spongy without calcareous deposits.

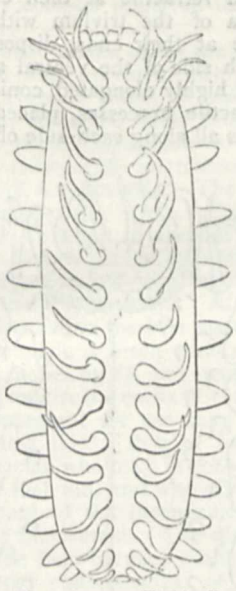


FIG. 5.—*Cryodora spongiosa*, Théel. Dorsal surface.

C. spongiosa, n.sp.

Lætmogone n.g. (Fig. 6) (λαῖτμα, depths of the sea).

Back highly convex; ventral surface slightly so. Mouth anterior, terminal, subventral; anus posterior, terminal, slightly dorsal. Tentacles fifteen. The lateral ambulacra of the trivium with large, not retractile, only a little contractile pedicels, disposed in a single row all along each side of the ventral surface. The odd ambulacrum

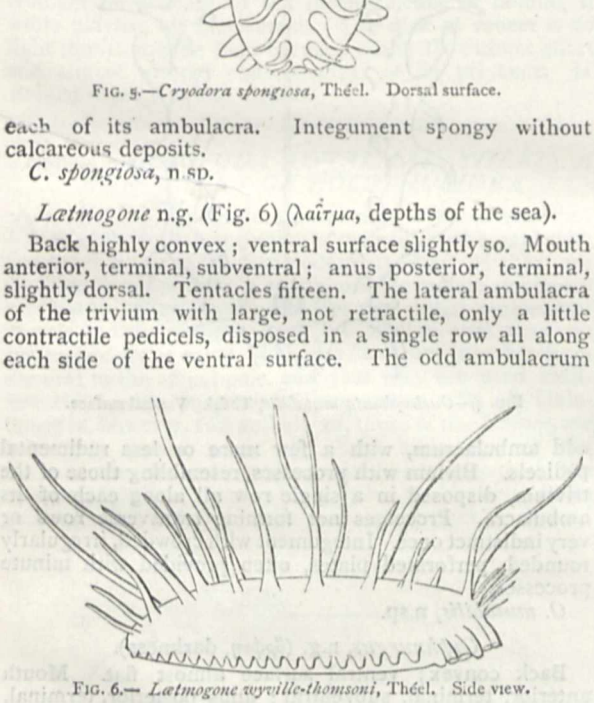


FIG. 6.—*Lætmogone wyville-thomsoni*, Théel. Side view.

naked. Bivium with highly elongated, flexible, cylindrical, not retractile processes, disposed in a single row all along each of its ambulacra. Integument with numerous wheel-shaped plates and other calcareous secretions.

L. wyville-thomsoni, n.sp.; *L. violacea*, n.sp.

Ilyodæmon (Fig. 7), n.g. (ἰλύς, ooze, δαίμων, spirit).

Back highly convex; ventral surface nearly flat. Mouth anterior, almost ventral; anus posterior, terminal, subdorsal. Tentacles fifteen. The lateral ambulacra of the trivium with large, not retractile pedicels, apparently disposed in a double row all along each side of the ventral surface. The odd ambulacrum naked. Bivium with a crowded series of very numerous, completely retractile, slender, rather long processes, disposed in three or four irregular close-set rows all along each of its ambulacra. Integument with numerous wheel-shaped plates and dichotomously branched bodies.

L. maculatus, n.sp.

Achlyonice n.g. (Fig. 8) (ἀχλύς, darkness).

Back highly convex; ventral surface flat or almost concave. Mouth anterior, ventral; anus posterior, dorsal. Tentacles twelve. The lateral ambulacra of the trivium with more or less retractile pedicels, disposed in

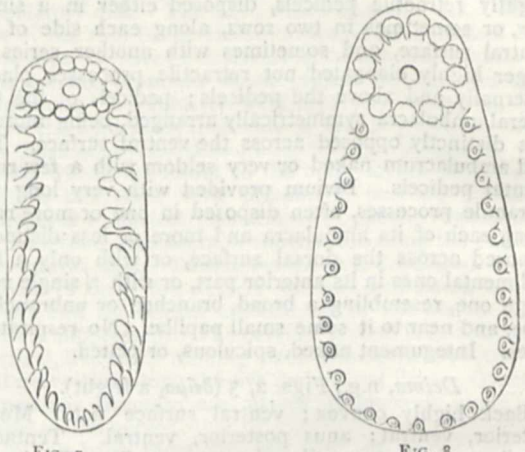


FIG. 7. FIG. 8.

FIG. 7.—*Ilyodæmon maculatus*, Théel. Ventral surface. FIG. 8.—*Achlyonice ecalcarea*, Théel. Ventral surface.

a single row all along each side of the ventral surface. The odd ambulacrum naked. Bivium with a few very soft and flexible processes in its anterior part alone. Integument thick, spongy, destitute of calcareous deposits.

A. ecalcarea, n.sp.

Elpidia, Théel (Fig. 9) (ἐλπίς, hope).

"Mémoire sur l'Elpidia," *K. Sv. Vet.-Akad. Handl.*, Bd. 14, No. 8, 1877.

Body ovate, more or less elongated, sometimes cylindrical. Mouth anterior, terminal, or subventral, anus posterior, terminal, subventral, or subdorsal. Tentacles ten. The lateral ambulacra of the trivium with large, slightly retractile pedicels, disposed in a single row along

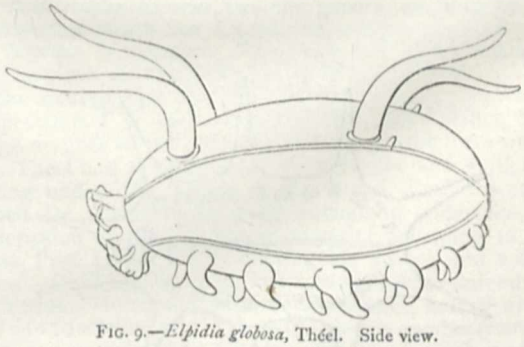


FIG. 9.—*Elpidia globosa*, Théel. Side view.

each side of the ventral surface. The odd ambulacrum naked. Bivium with one or a few pairs of often very elongated, not retractile processes on each of its ambulacra, or with only a few more or less rudimental ones in its anterior part. Integument with spicula of various shapes.

E. glacialis, Théel. *E. mollis*, n.sp.
E. verrucosa, n.sp. *E. nana*, n.sp.
E. murrayi, n.sp. *E. papillosa*, n.sp. *E. elongata*, n.sp.

Irpa, K. and D. (Fig. 10) (from the Norse mythology).

Body nearly cylindrical, bilateral. Mouth nearly central, anal opening terminal. Ten short, thick, digitate tentacles. Along the sides of the body nine pairs of long,

stiff, non-retractile pedicels, and six round the posterior end of the body. On the back two rows of papillæ, and

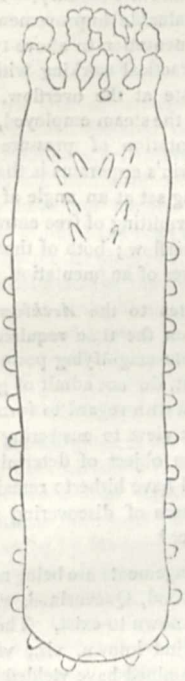


FIG. 10.

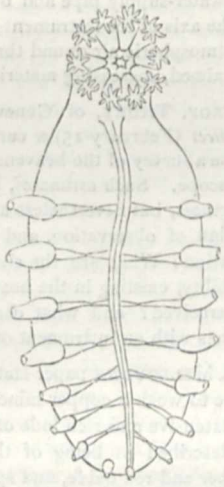


FIG. 11.

FIG. 10.—*Irpa abyssicola*, K. and D. Dorsal surface. FIG. 11.—*Kolga hyalina*, K. and D. Ventral surface.

two standing separate between them. Calcareous spicules in the skin.

L. abyssicola, K. and D.

Kolga, K. and D. (Fig. 11) (from the Norse mythology).

Body bilateral; oral disk furnished with ten tentacles, turned towards the ventral surface. On the anterior portion of the back there is a prominent collar furnished with papillæ, and right in front of it two openings, a genital opening and the opening of the sand canal. Pedicels on both sides of the body and round the posterior end. Sexes separate. No "respiratory tree."

K. hyalina, K. and D.

These are all abyssal forms, eight of the seventeen species having been dredged from depths of more than 2,000 fathoms. They are very extravagant in shape—the names which Dr. Théel has given them shows that their appearance suggests such stuff as dreams are made on—and they are of large size, some over a foot in length.

One group is very gelatinous, and of a rich purple colour; others are gelatinous, grey, and semi-transparent; while another series, and among these the most fantastic of the whole, are yellowish and have a test crustaceous with a thick layer of calcareous plates, often running out into strangely shaped processes. A peculiar little group from the Antarctic Sea are little more than a gelatinous membrane, covering an enormously distended intestine, filled with diatom ooze. From the number of species and individuals which came up in our scattered and infrequent hauls of the trawl, the *Elasmopoda* must form quite a prominent feature of the abyssal fauna.

C. WYVILLE THOMSON

NOTES

A HIGH and well-deserved compliment has been paid to the United States Signal Service, of whose services to meteorology our readers are so well aware. The German Government recently addressed through the German Minister at Washington, a letter requesting to be exactly informed as to the processes by which the Signal Service Bureau so promptly collects at the War Department the meteorological reports from all parts of the United States—an extent of territory greater than Europe—and so rapidly drafts and publishes them upon the printed daily weather map. These maps are issued three hours after the records are read at the distant stations. When it is remembered that the request comes from a government noted for its skilled chartographers, and standing first in Europe, the value of the compliment will be appreciated. It is understood that the German Government proposes an advance in meteorological work. The information sought has been minutely prepared by the Chief Signal Officer, Gen. Myer, with the approval of the Secretary of War.

THE death is announced of Mr. Thomas Bell, F.R.S., F.L.S., &c., of the Wakes, Selborne, Hampshire, on Saturday, at the advanced age of eighty-seven. Mr. Bell had a large practice as a dentist, and his name was well known in the scientific world. He was for a long period Professor of Zoology in King's College, and his histories of "British Quadrupeds" and of "British Reptiles," though published more than forty years ago, are still much esteemed. When he was over eighty-four years old he brought out his edition of Gilbert White's "Natural History of Selborne." Mr Bell was Corresponding Member of several foreign scientific societies. About eighteen years ago he gave up practice and retired to The Wakes at Selborne, Gilbert White's house, which he purchased from the great-nieces of the naturalist. Here he collected every memorial he could find of White, and the house and grounds were ever open to the admirers of "The Selborne."

THE Paris Academy of Sciences has received information of the death of M. Zinin, the eminent chemist, of St. Petersburg. He was the discoverer of the production of aniline colours by hydro-carburets.

THE University of Königsberg lost towards the close of last month one of the oldest members of its professorial staff, in the person of Dr. Ludwig Moser, Professor of Physics. Long before photography had become a practical art, Dr. Moser had acquired considerable reputation by his systematic and successful experiments in this department. He was in his seventy-fifth year.

THE following epigram on Dr. Siemens's recent paper has been sent us as by "a well-known scientific man." It is entit'ed Electric Chlorophyll:—

"Quis veterum vidit plantas sine sole virentes
Germinat en semen Siementis lumine claro."

THE Ancient Monuments' Bill has been read a second time in the House of Lords and been referred to a Select Committee.

HER MAJESTY has been graciously pleased to command that the Agricultural College, Cirencester, be styled the "Royal Agricultural College."

M. MASCART, the head of the French Central Bureau of Meteorology, has sent out a circular to his several rural correspondents, with forms for the purpose of collecting information on a number of natural phenomena relating to animal and plant life.

IT appears that the Berlin Municipal Corporation has granted to Dr. W. Siemens the concession of one electrical railway which will connect Wedding-Platz with Belle Alliance-Platz. The rails will be supported by iron columns, which will not be an obstruction for the circulation of carriages and passengers in the streets. There will be no intermediate station between the two termini.

ENGELMANN of Leipzig announces the appearance in April of a new botanical serial, *Botanische Jahrbücher für systematik Pflanzengeschichte und Pflanzengeographie*, edited by Prof. A. Engler of Kiel. The journal will appear at intervals of from three to six months, in numbers of from four to six sheets. The first part will contain papers by Oswald Heer, Alph. de Candolle, E. Warming, O. Beccari, and Prof. Engler.

THE first ordinary meeting of the Epping Forest and County of Essex Naturalists' Field Club was held at the head-quarters, 3, St. John's Terrace, Buckhurst Hill, Essex, on February 28, the president, Mr. Raphael Meldola, F.R.A.S., F.C.S., &c., presiding. Nearly seventy Members were present. The minutes of the Foundation Meeting having been read and confirmed, the President proceeded to deliver an inaugural address on the objects and work of the club. He said their Society, in general terms, might be said to have for its scope the study of nature in the field. Although not quite two months old, it already numbered more than 160 original Members. It was unnecessary, he thought, for them to plead any excuse for their *raison d'être*, it only remained for them to show those who had so readily extended the hand of encouragement, by the future work of the Members, that the sympathy had not been given in vain. They now looked forward, he might add, with confidence to receiving from their Members substantial support in the way of contributions to their publications, exhibitions of specimens at their meetings, and the discussion of problems in natural science in that amicable spirit which was most conducive to the real advancement of knowledge. In forming a Society such as the Epping Forest Club, their primary object was, of course, the furthering of science; the annual addition of something, however humble, to the general stock of human knowledge. Their chief object—the advancement of natural science—would be best effected by the publication of *original papers*, notes, and discussions; but they must likewise bear in mind that science will also be indirectly promoted by mutual intercourse and instruction, and, above all, by fostering and educating the scientific faculty in their younger members. He impressed upon the members that their most useful work would first be the observation and recording of the phenomena of that district which they had fixed upon as the field for their studies. With this alone they had a large and pleasant task in hand. In the course of time, and as their society continued to increase—as it surely would if it only fulfilled the promises of its early youth—they should hope to establish permanent collections in a museum, and any contributions of specimens to form the nucleus of such a public collection would at any time be welcome. Mr. Meldola suggested that a "Museum Fund" be started for that purpose. He pointed out the obvious advantages of having in one building their collections, library and meeting room, and suggested that it would be best for the members to endeavour to furnish the museum as far as possible from specimens collected by themselves in the county. The secretary then read a paper communicated to the club by Mr. R. M. Christy, of Chignal, near Chelmsford, on the occurrence of the great bustard (*Otis tarda*, L.), and the rough-legged buzzard (*Buteo lagopus*), near Chelmsford, during the winter of 1879. The meeting then resolved itself into a *conversazione*.

PROF. BORLINETTO, of the University of Padua, suggested some time ago the employment of cardboard covered with a film of collodion in the construction of the electrophorus. The instrument yielded excellent results, the sparks obtained from it being sensibly longer than those derived from an ordinary electrophorus of resin and shellac of the same size. Collodion is an extremely electrical substance, and becomes negatively electrified when rubbed with all other known substances. An electrical paper was also employed by Schönbein in the construction of an electrical machine.

THE report of a committee of the Franklin Institute, which recently spent five days in examining the action of Irwin's steam injector and ejector, appears in the journal for February. They consider Mr. Irwin has contributed a valuable improvement in injectors, increasing their power of augmentation to above twice that of the pressure of steam used for practical working without waste, and about four times with waste at the overflow. It seems to be a general law that the lower the steam employed, the higher could the proportional augmentation of pressure be carried. Among the peculiarities of Irwin's apparatus is that of the water-supply pipe and overflow being set at an angle of 45° to the axis of the instrument; also the permitting of free entrance of atmospheric air at and through the overflow; both of them, it is claimed, increasing materially the power of augmentation.

PROF. THURY, of Geneva, contributes to the *Archives des Sciences* (February 15) a curious paper on the time required to make a survey of the heavens with different magnifying powers of telescope. Such estimates, he points out, do not admit of great exactness, but nevertheless are of interest with regard to forming a plan of observation, and also with a view to answering the question: What are the chances that an object of determinate visibility, existing in the heavens, should have hitherto remained unperceived? and what chances are there of discovering new objects with an instrument of given power?

A MELBOURNE paper states that arrangements are being made there to work a copper mine near Dotswood, Queensland, where an extensive and rich lode of copper is known to exist. The ore is described as being of the richest kind known, viz., virgin copper and red oxide, and specimens examined have yielded 58·2 per cent. of copper and 5 dwt. of gold and 4 oz. of silver per ton of ore.

THE students of the Institution of Civil Engineers have been recently invited to take part in a series of supplemental meetings of members of their body to take place on the undermentioned dates, when the following papers will be read and discussed:—March 12—"Storage Reservoirs," by Walter Cradoc Davies, Stud. Inst. C.E. March 19—"The Manufacture of Bessemer Steel Rails," by Horace Allen, Stud. Inst. C.E.—April 2—"The Construction of Brick and Concrete Egg-shaped Sewers," by Ernest van Putten, Stud. Inst. C.E. April 9—"Small Motive Power," by H. S. Hele Shaw, Stud. Inst. C.E. April 16—"Railway Tyres and Tyre Fastenings," by Robert Read, Stud. Inst. C.E. The chair will be taken at seven o'clock on each evening, and successively by Mr. Giles, M.P., Mr. C. Wm. Siemens, F.R.S., Mr. R. Rawlinson, C.B., Dr. Pole, F.R.S., and Mr. Berkley, Members of Council.

A DEPLORABLE accident has taken place at the Grenoble Lycée. The professor of chemistry was lecturing on salts of mercury, and had by his side a glass full of a mercurial solution. In a moment of distraction he emptied it, believing he was drinking a glass of *eau sucrée*. The unfortunate lecturer died almost immediately.

MERCURY was seen at Paris on May 10 and 11 with the naked eye, owing to the transparency of the atmosphere and the great elongation of the planet. It had the brightness of a 1st class star, and was of a yellowish colour. The observation was made by MM. Henry brothers, at the Paris Observatory.

ETNA is again tranquil, its summit is once more covered with snow, and an ascent is contemplated, with a view to examine the alterations caused in the crater by the recent eruptions.

WE have received the first number of the *Bulletin* of the Algerian Scientific Association, the object of which is to popularise and develop scientific studies in Algeria, and to facilitate in every possible way the work of its members. This first

number contains some papers worthy of attention, among others, "A Critical Study of the Fevers of Algiers," by Dr. Angel Murraud; "Considerations on the Herbaceous Plants of the Summer Flora of Algiers," by M. J. A. Ballandito; and a lecture on "The General Phenomena of Reproduction among Vegetables," by M. F. Trabut.

THE post of *astronome titulaire* to the Paris Observatory having been declared vacant, the Minister of Public Instruction has decided upon following for the first time the prescriptions of an old decree of 1852, declaring that the Minister should only have the faculty to appoint one of the persons whose name should have been inscribed on either of two lists, written one by the Academy of Sciences and the other by the Astronomical Board of the Observatory. The list of the Board has been sent to the Minister with the name of M. Perrigault in the first line and Leveau in the second. The Section of Astronomy has submitted to the Academy a list containing Perrigault in the first line and Leveau and Perrotin in the second. The Academy will vote at its next sitting on these conclusions.

THE additions to the Zoological Society's Gardens during the past week include a Grivet Monkey (*Cercopithecus griseo-viridis*) from North-East Africa, presented by Mr. H. E. Laver; a Common Marmoset (*Hapale jacchus*) from South-East Brazil, presented by Madame Sparagnapane; a Persian Gazelle (*Gazella subgutturosa*) from Persia, presented by Mr. W. Dunt; a Golden Eagle (*Aquila chrysaëtos*), European, presented by the Viscount Hill; a Horrid Rattlesnake (*Crotalus horridus*) from Aracati, Brazil, presented by Mr. Karl J. Schmettan; a Red-fronted Lemur (*Lemur rufifrons*) from Madagascar, a Guilding's Amazon (*Chrysotis guildingi*) from St. Vincent, W.I., eight Golden Plovers (*Charadrius pluvialis*), European, purchased; four Wild Swine (*Sus scrofa*) born in the Gardens.

OUR ASTRONOMICAL COLUMN

MINOR PLANETS.—The circulars of the *Berliner astronomisches Jahrbuch* prove that Prof. Tietjen is using great exertion to keep pace in calculations with the rapid discoveries of small planets; the latest circular contains elements and an ephemeris of No. 212 detected at Pola on February 6. The actual number is now 214, the last having been discovered also by M. Palisa at Pola on March 1.

THE SOUTHERN COMET.—Approximate positions of the large comet first remarked in South Africa on February 1, deduced from observations at the Royal Observatory at the Cape on each evening from February 10-15 inclusive, were received from Mr. Gill by last mail. The right ascensions were given to minutes of time only, the corresponding north polar distances to minutes of arc, but the motion of the comet in R.A. being pretty rapid it has been possible to found elements upon the Cape places, which will afford an idea of the true orbit, and indeed which represent the observations on the six evenings as nearly as could be expected under the circumstances. The elements are as follow:—

Perihelion passage, 1880, January 26·4559 G.M.T.

Longitude of the perihelion	255 47·2
,, ascending node	332 25 0
Inclination	46 38·6
Logarithm of the perihelion distance	8·59917

Heliocentric motion—retrograde.

This orbit represents the observed places with the following differences:—

	R.A.	N.P.D.
	′	′
February 10	0·0 ...	0·0
11	− 4·7 ...	+0·4
12	+ 1·6 ...	+0·1
13	+ 2·4 ...	+1·4
14	+10·7 ...	+1·1
15	0·0 ...	0·0

Calculating for 8h. 30m. mean time at the Cape Observatory we have the subjoined positions, during the period that the comet, so far at least as regards its lengthy train, appears to have attracted so much attention in the other hemisphere:—

	R.A.	N.P.D.	Distance from the Sun.	Distance from the Earth.	Intensity of light.
	h. m.	° ′			
Jan. 30 ...	3 14 ...	113 40 ...	0·237 ...	0·768 ...	30·3
Feb. 1 ...	2 59 ...	116 55 ...	0·322 ...	0·709 ...	19·2
3 ...	2 29 ...	119 42 ...	0·399 ...	0·671 ...	14·0
5 ...	1 54 ...	121 51 ...	0·469 ...	0·649 ...	10·8
7 ...	1 12 ...	123 13 ...	0·535 ...	0·641 ...	8·5
9 ...	0 25 ...	123 44 ...	0·597 ...	0·647 ...	6·7

The above orbit will barely suffice to indicate the comet's actual positions within narrow limits; for March 19, at 8 P.M., the computed right ascension is 4h. 16m., and the north polar distance 104°, which places the comet above our horizon after sunset, but the intensity of light has diminished to 0·2, which, with the presence of the moon, seems to allow but little chance of observations.

With the elements we have given the comet would be north of the ecliptic less than two days, or from about January 25d. 20h. to 27d. 17h. Greenwich time. The orbit telegraphed from Brazil, apparently on the authority of a note of M. Liais's, differs very widely except in the perihelion distance.

GEOLOGICAL NOTES

GEOLOGICAL SURVEY OF SAXONY.—This well-appointed and well-led body of geologists continues to produce a series of excellent maps, which are issued as chromolithographed sheets, at the price of 2*s*. Each sheet is accompanied by an explanatory pamphlet, price 1*s*., in which the geological structure of the ground is made clear to the reader. The contents of the pamphlet are conspicuously printed on the back of the cover. Eight of these sheets and pamphlets have recently been issued, embracing the sections of Colditz, Leisnig, Döbeln, Penig, Waldheim, Burkhardtsdorf, Marienberg, and Elterlein. The area embraced by these publications includes large tracts of gneiss, schist, and other azoic rocks, which are described in great detail in the text. There can be no doubt that this thorough investigation of the Archæan rocks of Saxony will be of great service in future discussions regarding the age and genesis of the crystalline schists.

GEOLOGICAL SURVEY OF INDIA.—Mr. Medlicott, superintendent of this survey, has issued his Annual Report for 1879, from which we learn that in the Peninsular area there were five parties in the field during the past year, while in the extra-peninsular area there were two parties. The map accompanying the report shows that a large area of the Carnatic has been recently mapped and published, and that a wide tract is in progress between Hyderabad and the Bay of Bengal. The maps and reports of another large district in the lower part of the Indus Valley were last year published, as well as several detached areas in the Peshawur and Kashmir regions. The areas completed by some of the surveyors are of wide extent. Thus Mr. Feddes completed the survey of some 1,900 square miles in continuation of his previous season's work, besides making preliminary traverses of adjoining territory. This large piece of ground is almost wholly occupied by eruptive igneous rocks. Mr. Hacket, however, succeeded in adding more than 10,000 square miles to his previous survey of the Arvali region. This region is described as a wide waste of sand with only scattered outcrops of rock. Mr. Medlicott makes in his report an important statement as to the nature and conditions of publication in the office under his charge. He points out that were the issue of the work of his subordinates postponed until it could be thoroughly tested and brought up to the best standard of the time, it would often be indefinitely postponed. He states that such postponement, previous to his appointment, had been the rule, and he cites the case of the description of the Rájmahál hills as an example, this work having actually been delayed for fifteen years, though even at last it is in no important respect better than it would have been had it appeared at once. He considers that the chief duty of the Geological Survey is to the general public, which requires, first of all, an intelligible map and description of areas hitherto geologically unknown. He claims that the least finished work of the Survey fulfils that duty, however imperfectly, and that on the whole it is better, even at the risk of publishing crude material, to give the results forth to the world than to withhold them for an indefinite period until

they can be completed and perfected. This immediate publication likewise removes any cause for discontent on the part of the officers whose labours might be withheld from the public, while at the same time the consciousness that their work will at once be exposed to criticism must naturally act as a stimulus to care and accuracy. Mr. Medlicott adds: "I see no compromise but the one I adopted, and to which I adhere. The risk it obviously implies—the exposure of faulty work—falls upon our own heads. The minor evils it involves are no greater than those it removes, and the smart of public criticism is more wholesome than the heart-burning of official suppression." His efforts at conciliation and usefulness, however, have landed him in another dilemma. Of course he is compelled to make corrections of the publications of the Survey; but the wielding of his editorial pen seems to be now and then resented by some over whose lucubrations it has been displayed. And thus the injured writers, proud of their flowery periods or of their inaccurate geology, rush off to newspaper editors and pour forth their complaints in angry letters! Would it not sometimes be the most fitting punishment to publish the lucubrations just as they are put into the superintendent's hands? One or two glaring cases of this kind would possibly cure the evil, unless the burning sun of India makes a geologist's hide thicker than is usual in our colder clime.

American Geological Surveys.—Though the various independent geological surveys under different departments of the United States administration were abolished by Act of Congress in June of last year, certain provision was made for the publication of their results. Among the corps embraced in the demolition was that which, under Capt. George Wheeler of the Engineers, had done much good work. From a document just issued, and forming part of the Annual Report of the Chief of Engineers for 1879, we learn that Capt. Wheeler's geologists stuck to their ground almost up to the very day when their appropriations expired. They took the field on May 20 of last year in Colorado and New Mexico, and after a month of hard work the party was disbanded on June 24, six days before the end of the financial year. Prof. J. J. Stevenson of New York, who has been in charge of the Engineer geological explorations in that area, has published a preliminary report in anticipation of the final memoir. It shows that he has accomplished much interesting detail, particularly in regard to the succession of the coal-bearing Laramie series. We trust that he will be able to give satisfactory sections of the Sangre de Christo range, particularly with reference to the structure and age of its metamorphic rocks. He alludes to them in this preliminary report as "archæan." In Hayden's Report of the United States Geological and Geographical Survey of the Territories for 1875 (p. 208) Dr. Endlich concludes that these rocks are metamorphosed Silurian strata; and in the Report of the same Survey for the previous year he presents a similar conclusion with regard to the granite of the San Juan country. Detailed and accurate information on the true stratigraphical relations of the so-called "archæan" rocks of the Rocky Mountains and western ranges of North America are much needed. While referring to American official geological publications we would point out the absolute necessity of reference to the labours of previous explorers. We could pick out not a few otherwise excellent reports which are disgraced by an utter obliviousness of the existence of any earlier writings on the areas described. Without warning or explanation new names are given to formations which had already been named and described. If the original names and descriptions are defective or inaccurate let that be stated. But in common fairness to fellow-labourers, not to speak of duty to the reading public, let us know distinctly whether we are perusing an account of ground that has never been described before, or whether we are merely getting a new rendering of facts already familiar to us. When the history of geological exploration in Colorado comes to be written how many different and rival expeditions will have to be enumerated, and in how many cases will it be found that they have recognised each other's existence!

Imperfection of the "Geological Record."—Geologists and those who take interest in the literature of Evolution will find some curious papers by Th. Fuchs in recent numbers of the *Verhandlungen* of the Geologische Reichsanstalt of Vienna—apparently the first of a series in which he proposes to demolish Darwinism by accurately compiled statistics. He contends that the assertion of the imperfection of the "Geological Record" rests for the most part on gross exaggeration of the facts. He holds that instead of being, as Darwin and his followers maintain, full of gaps, the record of the older faunas and floras of the earth is extraordinarily perfect. He contends that Palæontology as it now stands is able, with a properly directed criticism, to afford a perfectly satisfactory basis on which to discuss with confidence the biological questions involved in Darwinism. He points out that in such a discussion it is needful to keep clearly in view a twofold series of animal remains. 1. Those which on account of their fragility, habitat, or habits can only be exceptionally preserved, such as medusæ, ascidians, insects, birds, small mammals, and tender plants. 2. Those with enduring hard parts, which, in consequence of their habitat and habits, are necessarily, in the regular progress of sedimentation, inclosed in new formations, such as corals, echinoderms, molluscs, &c. Admitting the exceptional preservation of the first series as fossils, he maintains that the entombment of those of the second series, so far from being exceptional, is now, and always has been, part of the daily and necessary *régime* in the formation of sedimentary accumulations, and that in this way the geological record of the past is remarkably complete. To prove or illustrate this contention, he gives a few examples of the kind of "statistical data" on which he relies. For example, in an up-raised bed of marine clay near Messina about 100 species of organisms were found, nearly all still living in the adjoining sea, but including a few that were not known in the existing fauna. Further search of the sea-bottom, however, detected these forms also. "In this case, therefore," says Herr Fuchs, "the fauna of Messina Harbour was more completely known from the fossil than from the living fauna." Again the Tyrrhenian Sea has yielded 337 species of conchiferous shells; of these 300 are found in the quaternary deposits of Leghorn; therefore the fauna of that sea could be with great completeness made out from fossil forms! In a subsequent number of the same journal Herr R. Hoernes has shown the fallacy of this reasoning; but Herr Fuchs has evidently laid in his store of ammunition, and does not mean to be disturbed until he has fired it all off. He continues his broadside in the number of the *Verhandlungen* just received, where he has a paper "On some Fundamental Phenomena in the Geological Development of the Organic World."

GEOGRAPHICAL NOTES

According to the last news received from M. Prjevalsky, he reached, on September 12, the boundary of Southern Tsaïdam, and thus entered the great highway which leads from China to Tibet. Detailed information as to his journey of last year from Kami to Sha-jeu, appears now in the *Izvestia* of the Russian Geographical Society. Khami is at the extremity of the sandy steppe described as the Mouschoun Gobi; it is a desert, nearly quite deprived of vegetation. For fifty miles are seen only immense spaces of clay covered with gravel; the temperature at the beginning of June reached as high as 38° Cels., and the soil had sometimes a temperature of 68° Cels. Journeying must be done in the night. No large animals, except the antelope and the wild camel, which comes from the deserts of Lob-nor, were seen. M. Prjevalsky crossed this desert in a south-eastern direction for 232 miles, and reached the oasis of Sha-jeu, a very fertile one, being the best tract of Central Asia, after Kulja. A high ridge of mountains covered with snow, the Altyn-tagh of Lob-nor, here joins the Nian-shan of Koko-nor. Thus the question as to the junction of these two systems of mountains is solved definitely. M. Prjevalsky stayed for a month in Sha-jeu, seeking for guides to Tsaïdam, and finally he found in the mountains three Mongols who agreed to serve as guides, so that he could reach Tsaïdam, going first south-west to Lake Serten and thence to Lake Koko-nor.

The last number of the Russian *Izvestia* contains an interesting paper, by M. Oshanin, on the upper parts of the Muk-su River, a tributary of Surkhab. These tracts were not previously visited, only one point in the valley of Muk-sou being known to Russian travellers, namely, the grave of Altyn-mazar, situated at the confluence of the Sel-su, Suk-su, and Kainda Rivers. Very high peaks inclose this deep valley, the bottom of which is no less than 8,000 feet above the sea-level. The Sandal peak, which is in the middle of the chain, reaches to no less a height than 25,000 feet, and two other peaks, Shelveli and Muz-jilga, are situated beside it. They are covered for two-thirds of their height with snow, and immense glaciers flow from their wide amphitheatres into the valley of Sel-su and of its tributaries. They form together a glacier which descends very low, its lower extremity, one and a half miles wide, being met with at a distance

of fifteen miles from Altyn-mazar. The length of this glacier is not less than twenty to twenty-five miles, and it is fed with several other glaciers of very large size. The oscillations in its length have a great importance, as sometimes it advances so far into the valley as completely to bar up the valley of the affluent of Sel-su, the Baland-kiik; this last thence forms a wide base which afterwards cuts through a passage in the ice and inundates the main valley, destroying the forests; now the glacier is once more in advance, and has nearly barred up the valley of the Baland-kiik. M. Oshanin proposes to give to this glacier—probably the second or third in size in Central Asia—the name of "Fedtchenko-glacier." As to the vegetation of its neighbourhood, it is very poor, the bottom of the valley being covered only with brushes of *Tamaris* and *Atraphaxis*, whilst the lateral valley of the Baland-kiik, although far higher than that of Sel-su, is covered with rich forests and grass. The season was too late for affording opportunities to collect insects, but M. Oshanin observed immense quantities of the *Microplax interrupta*, Fieb., in the neighbourhood of Altyn-mazar. This *Oxycerenina*, which is characteristic of the southern parts of the paleoarctic region in Europe, reaches in Central Asia such heights as in the Alps and Pyrenees are occupied with representatives of the Arctic zone. After having uselessly attempted to penetrate further into the high regions at the sources of the Baland-kiik, M. Oshanin was compelled to return, having thrown but a glance on this region of glaciers.

NORDENSKJÖLD has met with a warm reception at Lisbon. We have already spoken of the honour done him at Naples, and the honours which await him in France. Amsterdam has invited him, Copenhagen will intercept him on his way home, and in Sweden he will doubtless receive a worthy reception. What is our own Geographical Society to do? We hear of no preparations being made for the reception of one of the greatest and most modest of explorers. Wherever he has touched, Nordenskjöld has had honours showered upon him by the governments of the country; but we suppose it would be "bad form" in an English government to show anything like enthusiasm on behalf of science; though there is no saying, the Swedish explorer may, after all, become the fashion for a week.

AT the meeting of the Geographical Society on Monday next, Mr. E. Hutchinson, the Lay Secretary of the Church Missionary Society, will read a paper on the ascent of the Binué branch of the Niger, by the missionary steamer *Henry Venn*, in August of last year, supplementing his account of this exploration by remarks on the systems of Rivers Shari and Binué.

WE understand that the Free Church of Scotland have received from Mr. James Stewart, C.E., of Livingstonia, an account of his recent exploratory journey from the head of Lake Nyassa, to the south end of Lake Tanganyika, where he arrived on the afternoon of November 5. Great interest will attach to this report, as we believe that for two-thirds of the way Mr. Stewart's route was considerably to the westward of Mr. Thomson's, and that he met with much less difficult country, and which had, in fact, a very gradual rise and descent. This, no doubt, will account for the erroneous statement first received by telegram from Mozambique, that Mr. Thomson had found the country level between the two lakes.

THE principal original paper in the new number (85) of the *Zeitschrift* of the Berlin Geographical Society is the interesting journal of the late Dr. Erwin von Bary, kept during his journey from Tripoli to Ghät and Aïr. There is a fine new map of the Fagüm, by Dr. Schweinfurth, after the survey of Rousseau Bey, in 1871; Dr. Schweinfurth promises a paper discussing several points connected with the geography of the district. In No. 27 of the *Verhandlungen* Dr. Rohlfs furnishes an account of his recent journey to the Oasis of Kufra; a series of barometrical measurement of heights, of Col. Prjevalsky, in Central Asia, is given.

WITH the current number of *Les Missions Catholiques* is issued an interesting map of a portion of Eastern Equatorial Africa, which has been prepared by Père F. Charmetaut, who went to Africa to organise the first Algerian missionary expedition to the lake region. The features of the country between the coast and Lake Tanganyika are shown in considerable detail, and the routes followed by the Algerian missionaries to Ujiji and Lake Victoria are also laid down. Père Charmetaut bases his map to some extent on special information which he claimed to have obtained in Africa.

WE regret to hear that Père Ruellan, who was a member of the second Algerian missionary expedition to East Central Africa, died at Tabora, on November 24, of typhoid fever. Before leaving for Zanzibar last summer, Père Ruellan, with one of his colleagues, was sent to Paris to the Natural History Museum, and the Montsouris Observatory, in order to take lessons in practical geography, astronomy, natural history, &c. Père Ruellan promised to be an energetic geographer, for on the journey to Mpwapwa his first thought on arriving in camp was always to determine the position of the locality, and he looked forward to being able to render useful service to the science of ethnography in Eastern Africa.

DR. MATTEUCCI, the well-known Italian traveller, who recently left Rome on a journey of exploration in Africa, in company with Prince Borghese, has arrived in Cairo, where he has had the good fortune to meet Mgr. Guillaume Massaja. From Mgr. Massaja's long practical knowledge of Abyssinia and the Galla country, Dr. Matteucci would, no doubt, obtain from him much valuable information respecting those regions, which Italian travellers are beginning to affect as their own particular field of exploration.

FROM the *Colonies and India* we learn that a scientific survey of the district of the Chaudière River, in Canada, is about to be made in search of the deposits of gold which are said to have been found on both banks of the river. The country is chiefly forest land, and some of the timber-getters there have met with nuggets of gold. The River Chaudière rises some 120 miles south of Quebec, and empties into the St. Lawrence, nearly opposite that city.

THE January number of the *Boletin* of the Madrid Geographical Society is largely occupied with three *Memoirs*, accompanied by two excellent charts of the Passage Islands, in the West Indies, two of the *Memoirs* being devoted to the Island of Culebra.

ON THE BAROMETRIC SEE-SAW BETWEEN RUSSIA AND INDIA IN THE SUN-SPOT CYCLE

IN his Report on the Meteorology of India in 1877, Mr. Eliot drew attention to the fact that throughout that year the pressure of the atmosphere, as shown by the barometric registers of all parts of India, was more or less in excess of the average; at some places absolutely without intermission (on the means of the several months), at other places with slight and comparatively insignificant interruptions. He also pointed out that this condition was not restricted to India, but appeared to have prevailed also in the distant regions of New South Wales and Victoria, where, however, the oscillations were greater and its continuity more interrupted.

In point of fact this condition of excessive pressure lasted not less than two years in the Indian region, having set in between May and August, 1876, and continued to between May and August, 1878, after which for many months the pressure was as persistently and strikingly below the average as it had exceeded it during the period in question. It included two years of serious failure of the rains, first in the Peninsular and afterwards in the Gangetic provinces. Further examination has shown that the condition of excessive pressure prevailed over not only the Indo-Malayan region and Eastern Australia, but also the greater part if not the whole of Asia, probably the whole of Australia and the South Indian Ocean (at least as far as the Mauritius), but in the extra-tropical regions of both hemispheres it was subject to considerable variations, which were but faintly reproduced in the tropics. As the result of an inquiry into the characteristic features of this widely extended atmospheric condition, pursued back into past years, I have been led to some preliminary conclusions which seem to me of much interest, not only in themselves, but also as opening up a field of research which may be profitably extended to other quarters of the globe. It may be stated at the outset that as regards the Indo-Malayan region, and perhaps also South-Eastern Asia generally, the excessive pressure of 1876-78 was in part the maximum phase of a cyclical oscillation; but that as regards Northern Asia, and probably also Australia, it was anomalous and apparently non-periodic, and even in the Indo-Malayan region, it was probably to a considerable extent of this character also.

With respect to the cyclical oscillation, which appears to

conform to the sun-spot period, one or two facts have already been noticed in the pages of NATURE by Mr. F. Chambers (vol. xviii. p. 567), and Mr. Archibald [1] (vol. xx. p. 28); but those which I have now to bring forward will serve to give it greater precision, and a much more extended basis, and they serve also to throw some slight additional light on the nature of the agency by which the oscillation is effected, and which has, I think, been misapprehended by one if not both of the above writers. In the present communication I shall restrict myself to this subject, reserving the more abstruse question of the anomalous element for future discussion.

To begin with the most regular and uniform case of variation, that of an insular station situated almost on the equator. The barometric register of Singapore in lat. 2° (elevation 10 feet above sea-level) gives the following deviations from the several monthly averages since its commencement in 1869.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
Mean	29·892	29·894	29·877	29·840	29·836	29·851	29·858	29·863	29·875	29·868	29·865	29·873
1869	—	—	—	—	−·012	−·025	−·020	−·015	−·009	−·015	−·009	−·037
1870	−·093	−·060	−·055	−·043	−·038	−·035	−·035	−·084	−·031	−·022	−·015	−·012
1871	?	?	?	?	?	?	+·004	−·007	−·022	−·024	−·025	+·007
1872	−·003	−·024	−·004	−·021	0	−·035	−·020	−·025	−·021	−·024	−·056	−·043
1873	−·041	−·029	−·025	−·014	−·030	−·024	−·018	−·015	−·008	−·015	+·019	−·003
1874	+·062	+·030	−·010	+·024	+·007	−·003	−·008	+·016	+·004	+·014	+·040	+·043
1875	−·003	−·001	+·025	+·012	+·010	+·015	+·013	+·028	+·028	+·014	+·049	+·023
1876	+·003	+·005	+·011	0	+·033	+·030	+·032	+·023	+·025	+·040	−·014	+·037
1877	+·060	−·043	+·026	+·029	+·020	+·049	+·045	+·054	+·040	+·049	+·036	−·003
1878	+·015	+·033	+·036	+·016	+·002	+·005	−·014	+·014	−·011	−·028	−·037	−·050

I must observe that in 1869 and 1870 the register was taken from the readings of a different barometer from that used subsequently, and no comparison has ever been made between them. There may thus be some small uneliminated error in the figures for these two years, but since both Batavia to the south and Port Blair to the north show a barometric depression in 1870 not less persistent and (in the case of Port Blair) almost as intense, this error can hardly be of importance. The registers of these two latter stations show the following differences. For that of Batavia, I am indebted to the kindness of Dr. Bergsma, who has communicated to me a proof sheet of his forthcoming volume. The values are in millimetres. The Port Blair table is drawn up from the registers in the Calcutta Meteorological Office, reduced to the Calcutta standard and the present elevation of the barometer at 61·16 feet above half-tide level.

BATAVIA (millimetres).

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Means	758·75	758·65	758·68	758·23	758·26	758·78	759·01	759·11	759·20	758·81	758·67	758·42
1866	+0·83	−0·40	+0·38	+0·29	−0·29	+0·34	−0·01	+0·13	−0·12	+0·08	−0·29	+0·59
1867	+1·10	−0·28	+0·79	+0·28	−0·32	−0·15	−0·18	−0·30	−0·52	−0·51	+1·04	+0·75
1868	−0·39	+0·32	+0·44	+0·74	+1·08	+0·76	+0·17	+0·37	+0·37	+0·50	+1·06	+0·52
1869	+1·33	+0·94	+0·15	+0·62	−0·02	−0·09	+0·19	+0·06	+0·32	+0·35	−0·16	−0·28
1870	−1·76	−0·79	−0·65	−0·76	−0·47	−0·45	−0·24	−0·84	−0·17	−0·16	−0·36	−0·19
1871	−0·94	−0·60	−0·17	+0·11	+0·11	−0·13	−0·05	−0·04	−0·25	−0·23	−0·65	+0·08
1872	−0·28	−0·37	−0·28	−0·51	+0·19	−0·78	−0·38	−0·54	−0·55	−0·39	−1·42	−0·94
1873	−0·93	−0·52	−0·54	−0·50	−0·75	−0·17	−0·14	−0·24	−0·14	−0·04	+0·47	+0·18
1874	+0·78	+0·34	−0·89	+0·09	−0·08	−0·43	−0·57	−0·23	−0·48	−0·31	−0·06	+0·13
1875	−0·92	−0·75	−0·31	−0·42	−0·05	−0·28	+0·11	−0·01	+0·11	−0·46	+0·26	−0·73
1876	−0·82	−0·32	−0·55	−0·93	+0·20	+0·02	+0·22	−0·08	+0·07	+0·40	+0·09	+0·83
1877	+1·35	+1·18	+0·71	+0·75	+0·40	+1·28	+1·43	+1·65	+1·38	+1·49	+0·83	+0·21
1878	+0·66	+1·28	+0·98	+0·29	−0·06	+0·15	−0·54	+0·05	−0·37	−0·73	−0·78	−1·18

PORT BLAIR (English inches).

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Means	—	—	—	—	—	—	—	—	—	—	—	—
1868	—	—	—	—	—	+·020	+·037	+·010	+·018	+·028	+·027	+·060
1869	+·079	+·035	+·002	+·012	+·007	−·022	−·009	0	−·007	−·014	+·014	−·022
1870	−·083	−·056	−·049	−·032	−·046	−·014	−·033	−·046	−·032	−·017	−·012	−·081
1871	−·043	−·022	?	?	?	?	+·007	+·014	−·011	−·009	+·007	+·013
1872	+·007	−·001	+·006	−·023	−·020	−·028	−·021	−·034	−·023	−·034	−·037	−·034
1873	−·032	−·031	−·014	−·012	+·007	−·039	−·032	−·011	−·011	−·022	+·023	+·020
1874	+·040	+·001	−·026	+·018	−·015	−·007	−·013	+·005	−·020	+·006	−·017	−·050
1875	−·008	−·039	−·019	−·037	+·020	+·007	−·009	−·001	−·001	−·006	?	+·025
1876	+·007	+·013	+·002	−·025	+·009	+·009	+·004	−·003	+·027	+·030	−·005	+·052
1877	+·082	+·045	+·039	+·055	+·035	+·046	+·048	+·035	+·076	+·081	+·051	+·028
1878	+·039	+·054	+·060	+·046	0	+·002	+·015	+·031	−·015	−·017	−·057	−·043

The registers of Colombo also (N. lat. 6° 56′) as far as they go, viz., since 1872, show a similar graduated variation, but those of the Mauritius, for which I am indebted to the kindness of Mr. Meldrum, differ considerably, and indicate a pressure below the average in 1867 and 1868, and above it in 1871. In 1876 and 1877, however, they agree with those of the other stations in showing an unusually high pressure. The following table shows the annual deviation of the mean pressure at each of the five stations since the commencement of the registers, all being reduced to English inches.

[1] Mr. Archibald mentions that the relation discussed was brought to his notice by Mr. S. A. Hill.

	Mauritius.	Batavia.	Singapore.	Colombo.	Port Blair.
Means	30·071	29·871	29·866	29·847	29·804
1861	− ·038	—	—	—	—
1862	− ·036	—	—	—	—
1863	− ·023	—	—	—	—
1864	+ ·011	—	—	—	—
1865	+ ·002	—	—	—	—
1866	+ ·010	+ ·005	—	—	—
1867	− ·004	+ ·006	—	—	—
1868	− ·012	+ ·020	—	—	+ ·029
1869	+ ·013	+ ·011	− ·018	—	+ ·006
1870	− ·003	− ·023	− ·044	—	− ·042
1871	+ ·034	− ·009	− ·011	—	− ·006
1872	− ·006	− ·020	− ·023	− ·020	− ·020
1873	+ ·008	− ·010	− ·017	− ·005	− ·013
1874	+ ·004	− ·006	+ ·018	+ ·003	− ·007
1875	+ ·005	− ·011	+ ·018	− ·004	− ·006
1876	+ ·015	− ·002	+ ·019	+ ·002	+ ·010
1877	+ ·026	+ ·042	+ ·037	+ ·037	+ ·052
1878	− ·010	− ·001	− ·002	0	+ ·010

With the perhaps doubtful exception of the Mauritius, the general conformity of the oscillation shown by these stations to that of the last cycle of sun-spot frequency is sufficiently obvious, without resorting to any expedient for smoothing the minor variations; and it is to be noticed that the maximum pressure coincides approximately with the minimum of sun-spots and *vice versâ*. Other registers, such as those of Akyab and Chittagong on the Arakan coast, of Calcutta and Bombay (as Mr. F. Chambers has shown), and of Darjiling on the Himalaya exhibit a similar oscillation, but more overlaid with irregular variations apparently, the further we recede from the equator. The registers of Calcutta and Bombay reach back to 1853 and 1847 respectively, and thus comprehend three sun-spot minima, and in the latter case three maxima also. The annual deviation of pressure from the general average at each of these two stations is given in the second and third columns of the following table, and in the fourth and fifth columns the smoothed means obtained by substituting for that of each year the mean of three consecutive years. In the last column are given Wolf's sun-spot numbers up to 1875, taken from the revised table published in vol. xiii. of the *Memoirs* of the Royal Astronomical Society.

Year.	From observ.		Smoothed.		Wolf's numbers.
	Calcutta.	Bombay.	Calcutta.	Bombay.	
1847	—	− ·012	—	—	97·4
1848	—	− ·004	—	− ·009	124·9
1849	—	− ·011	—	− ·005	95·4
1850	—	− ·001	—	− ·008	69·8
1851	—	− ·013	—	− ·006	63·2
1852	—	− ·004	—	− ·004	52·7
1853	− ·013	+ ·005	—	− ·001	38·5
1854	− ·002	− ·005	− ·003	+ ·005	21·0
1855	+ ·005	+ ·015	0	+ ·002	7·7
1856	− ·004	− ·003	− ·004	+ ·004	5·1
1857	− ·013	− ·001	− ·007	0	22·9
1858	− ·003	+ ·003	− ·002	+ ·002	56·2
1859	+ ·009	+ ·003	− ·004	0	90·3
1860	− ·019	− ·005	− ·011	− ·005	94·8
1861	− ·023	− ·012	− ·020	− ·014	77·7
1862	− ·017	− ·026	− ·021	− ·018	61·0
1863	− ·024	− ·017	− ·010	− ·003	45·4
1864	+ ·011	+ ·023	+ ·002	+ ·003	45·2
1865	+ ·018	+ ·002	+ ·011	+ ·013	31·4
1866	+ ·004	+ ·013	+ ·015	+ ·010	14·7
1867	+ ·022	+ ·015	+ ·016	+ ·018	8·8
1868	+ ·022	+ ·027	+ ·016	+ ·016	36·8
1869	+ ·005	+ ·005	+ ·005	+ ·007	78·6
1870	− ·011	− ·012	− ·005	− ·004	131·8
1871	− ·008	− ·004	− ·005	− ·010	113·8
1872	+ ·004	− ·014	− ·004	− ·005	99·7
1873	− ·008	+ ·002	0	− ·004	67·7
1874	+ ·005	+ ·001	− ·004	+ ·001	43·1
1875	− ·008	0	− ·004	+ ·003	18·9
1876	− ·009	+ ·007	+ ·009	+ ·015	—
1877	+ ·044	+ ·037	+ ·015	+ ·011	—
1878	+ ·014	− ·011	—	—	—

Both the Calcutta and Bombay registers exhibit oscillations of pressure coinciding approximately with those of the sun-spots, and more pronounced in the case of Bombay than in that of Calcutta.[1]

Hence it may be concluded that throughout the Indo-Malayan region there is a cyclical oscillation of atmospheric pressure approximately coinciding with that of the sun-spots, the maximum pressure coinciding with or immediately following the epoch of minimum frequency of sun-spots and the minimum pressure that of the sun-spot maximum. This oscillation is most distinctly and regularly developed at insular stations in the immediate neighbourhood of the equator.

The character of this coincidence is somewhat striking when considered in connection with that established by Köppen in the case of air temperature, and which I may observe has been confirmed by further experience. This is, that the air temperature of the tropics is greatest at the epoch of sun-spot minimum and *vice versâ*. In strict accordance herewith the unusual excess of pressure of 1876-78 coincided with an equally striking and persistent excess of temperature, throughout India and its dependencies. Taking the mean of all the deviations of regis-

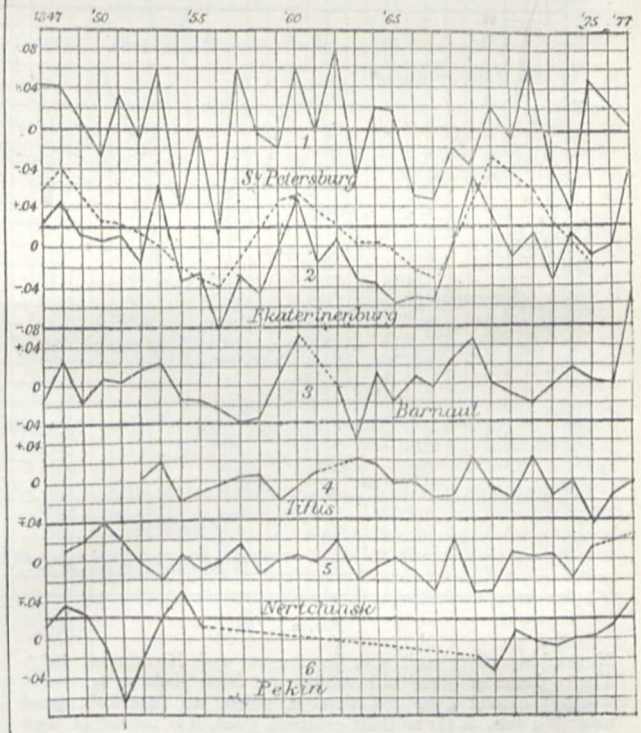


FIG. 1.

tered temperatures from the local averages at all the stations enumerated in the Indian Meteorological Reports for the four years 1875-78 (these averages, be it observed, being deduced from all the existing registers in the case of each station, and not those of the four years only), we have the following results:—

Year	1875	1876	1877	1878
Number of stations	72	72	74	74
Mean variation from average ...	−0°·29	−0°·08	+0°·17	+0°·62
Differences		−0°·21	+0°·25	+0°·45

This apparent anomaly, the co-existence of excessive pressure with excessive temperature is, however, in some measure explained, when the barometric registers of the Indian hill stations are compared with those of the plains. Of these former, Darjiling at 6,912 feet above sea-level has furnished the longest register (viz., for twelve years) and affords the best standard for

[1] A fact noticed in the Bengal Meteorological Report for 1868 points to the inference that the registers prior to 1866 are not perhaps quite so trustworthy on this point as those of Bombay. It is stated that in August, 1866, a crust of mercurous oxide was removed from the surface of the cistern, and inasmuch as this oxide is less dense than mercury (and the readings had always been taken from its surface) it is probable that a sensible error affected all such readings.

comparison. On the average of the whole period from May, 1876, to August, 1878, the atmospheric pressure at this level was relatively more excessive than on the plains of Lower Bengal, the mean excess being + 0·0375″ at Darjiling, and + 0·0298″ on the Bengal plains, which stretch away from the foot of the Sikkim Himalaya. Moreover it prevailed more steadily. From August, 1876, to August, 1878, or for twenty-five consecutive months, there was not one in which, at the hill station, the pressure did not exceed the average of the month; whereas on the plains it fell slightly below the average in

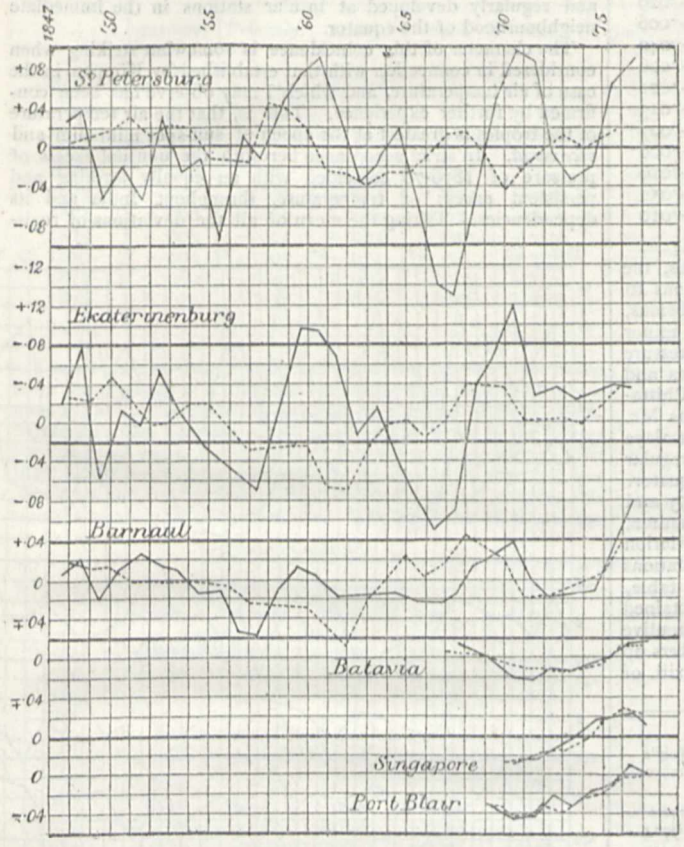


FIG. 2.

November, 1876, and also in August and November, 1877. The registers of other hill stations (at least such as are trustworthy) extend over too short a period to furnish a good average; but, as far as their evidence goes, it is consistent with that of Darjiling; and we may therefore draw a second and very important conclusion, viz., *that the excessive pressure of the two years* 1876-1878 *in India was mainly, if not entirely due, to the condition of the higher strata of the atmosphere;* to that portion, at all events, which lies above 7,000 feet. This is very important, and while it explains the apparent anomaly above adverted to, and which in other cases has been emphatically insisted on by the late John Allan Broun, it points a useful caution against the too frequent habit of arguing from conditions of temperature (as observed at the earth's surface) as if the whole thickness of the atmosphere were affected in the like manner.

Leaving now, for the moment, the Indo-Malayan region, and turning to other parts of the Europe-Asiatic continent, we find in Western Siberia and European Russia, evidence of a cyclical oscillation of pressure, which is of the opposite character to that already noticed. Of all the stations which since 1847 have furnished the registers published in the *Annales de l'Observatoire Central de Russie*, Ekaterinenburg, at the eastern foot of the Ural, is that which exhibits this oscillation in its most salient and regular form. But it is more or less distinctly traceable in the registers of Bogolowsk and Slatoust also in the Ural; of Barnaul at the northern foot of the Altai, and with considerable intensity but much masked by irregular variations in those of St. Petersburg. Tiflis, however, to the south-west, and Nertchinsk and Pekin to the east, show no distinct trace of it. Indeed the somewhat interrupted registers of Pekin give a curve which in some respects rather conforms to the Indo-Malayan type. The accompanying figures 1 to 6 represent the curves of the annual deviation of the mean pressure at the above six stations, up to 1877, and over that of Ekaterinenburg I give a dotted curve showing the variation of the sun-spots. In point of amplitude the oscillation at Ekaterinenburg and St. Petersburg greatly exceeds that of the opposite type in the Indo-Malayan region, as indeed might be expected if these oscillations are reciprocally compensating, and the tropical type prevails over a larger area than the Siberian.

We are thus led to the further conclusion that *between Russia and Western Siberia on the one hand, and the Indo-Malayan region (perhaps including the Chinese region) on the other, there is a reciprocating and cyclical oscillation of atmospheric pressure; of such a character that the pressure is at a maximum in Western Siberia and Russia about the epoch of maximum sun-spots, and in the Indo-Malayan area at that of minimum sun-spots.*

In tabulating the variations of the barometric means of Ekaterinenburg month by month, I was much struck with the greater magnitude of the anomalous deviations of the winter as compared with those of the summer months; in other words with the apparent greater variability of pressure during the winter season. In order to verify this feature and to obtain a measure of the variability, I took the mean of the deviation values of each month for the whole series of (31) years, without regard to algebraical sign, and dividing by 2 obtained the results given in the first figure column of the following table. The registers of St. Petersburg, Barnaul, Greenwich, Adelaide, and Melbourne similarly treated gave the results shown in the five subsequent columns, and those of Calcutta and the Mauritius the figures of the two final columns.

	Ekaterinenburg.	St. Petersburg.	Barnaul.	Greenwich.	Adelaide.	Melbourne.	Calcutta.	Mauritius.
	31 years.	31 years.	31 years.	23 years.	3 years.	8 years.	26 years.	18 years.
January	± ·070	± ·089	± ·045	± ·093	± ·024	± ·028	± ·015	± ·017
February ...	·078	·086	·045	·058	·026	·016	·013	·027
March	·062	·060	·031	·075	·021	·014	·012	·020
April	·067	·057	·027	·052	·020	·025	·013	·011
May	·029	·031	·022	·034	·054	·036	·016	·013
June	·033	·029	·024	·043	·066	·049	·010	·016
July	·032	·026	·021	·028	·054	·046	·015	·015
August	·038	·037	·024	·032	·036	·034	·013	·011
September ...	·055	·046	·023	·052	·033	·043	·010	·009
October	·048	·049	·029	·055	·033	·034	·014	·009
November ...	·071	·086	·039	·049	·031	·026	·014	·014
December ...	·096	·098	·047	·089	·016	·015	·010	·018

I am not aware whether the climatic features exhibited by this table have before been noticed, but they seem to have considerable significance. At Calcutta the variability of pressure is nearly the same at all seasons of the year, while at the Mauritius

it depends apparently on the comparative frequency of cyclones; but at all the extra-tropical stations it is from two to three times as great in the winter months as in the summer, and especially so in the two months December and January. Hence (excluding the case of the Mauritius) the less direct the action of the sun, the greater the vicissitudes of the atmospheric pressure.

The question now presents itself, "How far is that cyclical variation of pressure which conforms to the sun-spot period, dependent on the variation of the summer and winter pressures respectively?" It is obvious that the reply to this question must have a very important bearing in indicating the physical cause of the oscillations. If it be essentially a phenomenon of the summer months, we may be justified in regarding it as a possible effect of the more or less direct action of the sun on the continental land surface; but if it be solely or even mainly dependent on the winter variations, no such explanation is admissible. It must, then, rather be regarded as an effect produced under negative conditions to compensate an opposite effect which is due to the direct action of the sun elsewhere.

To ascertain this I have taken separately the means of the four months November to February, and May to August, for the stations St. Petersburg, Ekaterinenburg, and Barnaul, in each successive pair of years or year; and since the figures thus obtained showed irregularities which somewhat masked the periodical variation, I smoothed the original values by substituting the mean of three consecutive summers or winters for the original mean forming the middle term of the triad. I have also done the same for the tropical stations Singapore, Batavia, and Port Blair, and give the results in the following tables. The smoothed means are illustrated by the six pairs of curves in Fig. 2, the summer and winter curves being drawn to the same horizontal lines of reference, the former dotted, the latter continuous.

RUSSIAN STATIONS.

Year.	Summer means.			Smoothed summer means.			Winter means.			Smoothed winter means.			Year.
	St. Pet.	Ekat.	Barn.	St. Pet.	Ekat.	Barn.	St. Pet.	Ekat.	Barn.	St. Pet.	Ekat.	Barn.	
1847	+·036	+·063	+·014	—	—	—	+·228	+·219	+·078	+·025	+·020	+·005	1847-48
1848	−·033	−·032	+·008	+·006	+·025	+·017	−·144	−·088	−·033	+·037	+·076	+·021	1848-49
1849	+·016	+·045	+·030	+·011	+·024	+·011	+·063	+·097	+·020	−·053	−·052	−·023	1849-50
1850	+·049	+·058	−·004	+·017	+·047	+·013	−·130	−·166	−·054	−·019	+·012	+·012	1850-51
1851	−·015	+·039	+·012	+·030	+·024	−·001	−·010	+·106	+·070	−·057	−·003	+·026	1851-52
1852	+·055	−·025	−·012	+·010	−·005	−·001	−·031	+·051	+·062	+·028	+·050	+·013	1852-53
1853	−·009	−·030	−·004	+·022	+·002	−·006	+·125	−·008	−·093	−·026	+·007	+·088	1853-54
1854	+·019	+·061	−·002	+·019	+·020	−·001	−·172	−·021	+·055	−·012	−·020	−·013	1854-55
1855	+·047	+·030	+·004	−·011	+·019	−·004	+·012	−·032	−·014	−·088	−·039	−·012	1855-56
1856	−·098	−·033	−·015	−·014	−·008	−·009	−·104	−·065	−·090	+·013	+·051	−·053	1856-57
1857	+·008	−·020	−·017	−·017	−·030	−·023	+·131	−·057	−·054	−·014	−·068	−·057	1857-58
1858	+·038	−·038	−·037	+·045	−·028	−·028	−·068	−·082	−·028	+·044	+·002	−·010	1858-59
1859	+·088	−·027	−·031	+·036	−·025	−·031	+·070	+·146	+·051	+·072	+·097	+·014	1859-60
1860	−·019	−·010	−·026	+·014	−·025	−·032	+·214	+·226	+·032	+·092	+·093	+·006	1860-61
1861	−·026	−·039	−·040	−·026	−·067	−·052	−·007	−·092	−·058	+·028	+·063	−·014	1861-62
1862	−·033	−·152	−·091	−·029	−·068	−·068	−·123	+·055	−·030	−·037	−·013	−·014	1862-63
1863	−·029	−·013	−·073	−·039	−·032	−·025	+·019	−·002	+·031	−·017	+·015	−·013	1863-64
1864	−·055	+·068	+·088	−·027	−·002	+·003	+·052	−·007	−·054	+·020	−·025	−·012	1864-65
1865	+·002	−·061	−·006	−·027	+·004	+·026	−·011	−·067	−·026	−·060	−·076	−·023	1865-66
1866	−·028	+·004	−·005	−·011	−·018	+·004	−·221	−·154	−·012	−·134	−·110	−·024	1866-67
1867	−·008	+·004	+·022	+·011	+·003	+·014	−·170	−·110	−·059	−·149	−·092	−·016	1867-68
1868	+·069	0	+·025	+·016	+·040	+·043	−·057	−·013	+·005	−·050	+·039	+·015	1868-69
1869	−·014	+·117	+·081	−·003	+·038	+·036	+·076	+·239	+·114	+·043	+·068	+·024	1869-70
1870	−·063	−·002	+·003	−·046	+·035	+·022	+·109	−·022	−·024	+·098	+·122	+·040	1870-71
1871	−·061	−·009	−·017	−·021	0	−·017	+·108	+·148	+·072	+·084	+·029	−·001	1871-72
1872	+·062	+·011	−·038	−·004	+·003	−·017	+·035	−·040	−·045	−·004	+·036	−·013	1872-73
1873	−·013	+·006	+·003	+·010	+·005	−·013	−·156	−·001	−·065	−·029	+·024	−·015	1873-74
1874	−·019	−·002	−·003	−·001	−·004	−·001	+·035	+·113	+·065	−·017	+·029	−·010	1874-75
1875	+·030	−·015	−·004	+·015	+·015	+·004	+·070	−·025	−·030	+·063	+·039	+·030	1875-76
1876	+·033	+·061	+·019	+·022	+·042	+·036	+·085	+·030	+·056	+·093	+·044	+·081	1876-77
1877	+·002	+·080	+·094	—	—	—	—	—	—	—	—	—	—

INDO-MALAYAN STATIONS.

Year.	Summer means.			Smoothed summer means.			Winter means.			Smoothed winter means.			Year.
	Sing.	Bat.	P. Blair.	Sing.	Bat.	P. Blair.	Sing.	Bat.	P. Blair.	Sing.	Bat.	P. Blair.	
1866	—	0	—	—	—	—	—	−·011	—	—	—	—	1866-67
1867	—	−·010	—	—	+·005	—	—	+·017	—	—	+·015	—	1867-68
1868	—	+·024	+·022	—	+·005	—	—	+·038	+·050	—	+·008	—	1868-69
1869	−·023	+·001	−·006	—	+·002	−·006	−·044	−·030	−·037	—	−·004	−·009	1869-70
1870	−·048	−·020	−·035	−·024	−·007	−·010	−·018	−·021	−·039	−·027	−·021	−·023	1870-71
1871	−·001	−·001	+·010	−·023	−·012	−·024	−·019	−·012	+·006	−·025	−·024	−·022	1871-72
1872	−·020	−·015	−·026	−·014	−·010	−·012	−·037	−·038	−·033	−·011	−·011	−·002	1872-73
1873	−·022	−·013	−·019	−·013	−·014	−·017	+·024	+·018	+·021	0	−·012	−·013	1873 74
1874	+·003	−·013	−·007	−·002	−·012	−·007	+·012	−·016	−·028	+·018	−·005	+·003	1874 75
1875	+·014	−·009	+·004	+·015	−·009	+·001	+·012	−·016	+·015	+·021	+·001	+·010	1875-76
1876	+·029	−·004	+·005	+·028	+·012	+·017	+·032	+·034	+·043	+·028	+·016	+·034	1876-77
1877	+·042	+·047	+·041	+·024	+·013	+·019	+·033	+·029	+·043	+·007	+·018	+·021	1877-78
1878	+·002	−·004	+·012	—	—	—	—	—	−·023	—	—	—	1878 79

In these tables and figures the true nature of the oscillation is sufficiently obvious. At Singapore, nearly on the equator, both seasons of the year show an oscillation of the same kind and nearly of the same amplitude. At the other intertropical

stations, both north and south of the line, the difference, if any, is but small. It would appear, however, that both at Batavia and Port Blair, and also at Bombay (judging from the curves given by Mr. Chambers in his communication previously referred to), that the oscillation when the sun is in southern declination is slightly greater than that pertaining to the summer of the northern hemisphere. At the Russian stations, however, the oscillation of the opposite type is entirely restricted to the winter months, and is therefore far more pronounced in the winter curves in Fig. 2 than in the mean annual curves in Fig. 1. Hence it follows that the direct action of the sun on the tropical region is to produce an oscillation such that the pressure is lowest when the sun is most spotted, and it is as a compensation to this action that in the winter season an oscillation of the opposite character is set up on the plains of European and Asiatic Russia; possibly also in the Arctic regions, but this requires verification. Analogy would lead us to anticipate the existence of a similar oscillation in Antarctic latitudes when the sun is in northern declination, but perhaps less concentrated geographically owing to the absence of any dry continental land surface, corresponding to the Siberian and Russian plains. This point must remain for future inquiry.

While on the whole the Russian curves exhibit the oscillation so distinctly and strongly as to leave no room for doubt as to its reality, they show, nevertheless, that it is liable to great disturbances, which at times are so powerful as entirely to neutralise the effect. This will be very apparent if curves be drawn with the original values in the first three columns of the table above given for the winter months; but the most remarkable instance is that afforded by the winter of the year 1877 (at least of the first two months, for I have not yet received the volume of the Russian *Annales* for 1878). The mean pressure of December, 1877, at stations in Western Siberia, exceeded any on record during the whole period of thirty-one years comprehended in the registers before me; and it is not a little remarkable that in the previous July (the mid-winter of the southern hemisphere) an equally excessive, and (in the eight years for which I have registers) unprecedented pressure characterised South-eastern Australia. These accumulations of pressure were, doubtless, intimately connected with the similar phenomenon which characterised the intervening Indo-Malayan region in 1876–78, but the attendant circumstances are as yet by no means fully worked out.

With respect to the nature of the physical causes which produce that alternating oscillation of pressure between the Indo-Malayan region and the Russian plains, which conforms to the sun-spot cycle, our knowledge is still far too imperfect to allow of my attempting any exhaustive analysis. It may, however, be not wholly uninstructive to recapitulate some of the results of recent inquiry which bear upon this point, even admitting, as we must do, that in certain respects they require further verification. Such as they are, they indicate a possible explanation, which I will set forth as briefly as possible.

Among the best established variations in terrestrial meteorology which conform to the sun-spot cycle, are those of tropical cyclones and the general rainfall of the globe, both of which imply a corresponding variation in evaporation and the condensation of vapour. Now the variation of pressure with which we have to deal evidently has its seat in the higher (probably the cloud-forming) strata of the atmosphere. This is not only illustrated in the present instance by the observed relative excess of pressure at the hill stations as compared with the plains, but also follows as a general law from the fact established by Gautier and Köppen, viz., that the temperature of the lowest stratum varies in a manner antagonistic to the observed variation of pressure. It is then a reasonable inference that the principal agency in producing the observed reduction of pressure at the epoch of sun-spot maximum is the more copious production and ascent of vapour, which may operate in three different ways. First, by displacing air the density of which is $\frac{5}{8}$ths greater; second, by evolving latent heat in its condensation; and thirdly, by causing ascending currents, and thus reducing dynamically the pressure of the atmosphere as a whole. The first and second of these processes do not indeed directly reduce the pressure, but only the density of the air stratum, while they increase its volume. In order, therefore, that the observed effect may follow, a portion of the higher atmosphere must be removed, and this will necessarily flow away to regions where the production of vapour is at a minimum, viz., the polar and cooler portion of the temperate zones, and more especially those where a cold dry land surface radiates rapidly under a winter sky. Such an expanse is the great northern plain of European Russia and Western Siberia north of the Altai.

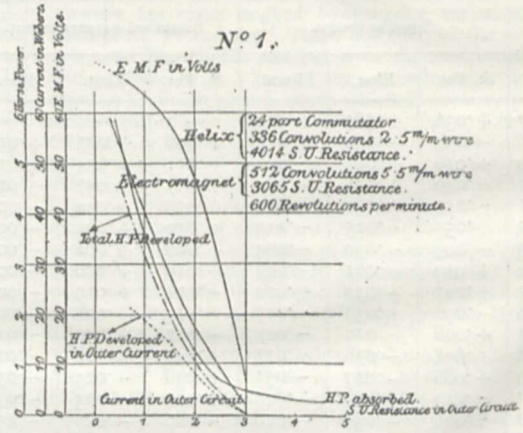
H. F. BLANFORD

SOCIETIES AND ACADEMIES

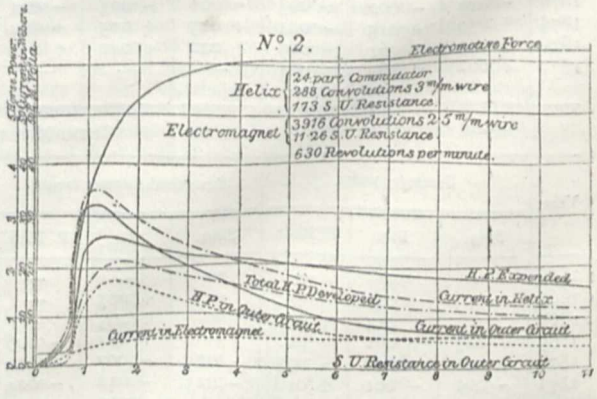
LONDON

Royal Society, March 4.—"On the Dynamo-Electric Current and on certain Means to improve its Steadiness." By C. William Siemens, D.C.L., F.R.S.

The author, after alluding to the early conception by Dr. Werner Siemens, of the dynamo-electric or accumulative principle of generating currents, makes reference to the two papers on the subject presented, the one by Sir Charles Wheatstone and the other by himself, to the Royal Society in February, 1867. The machine then designed by him, and shown in operation on that occasion, is again brought forward with a view of indicating the



progress that has since taken place in the construction of dynamo-electrical machines, particularly those by Gramme and Siemens von Alteneck. The paper next points out certain drawbacks to the use of these machines, both of them being subject to the disadvantage that an increase of external resistance causes a falling off of the current; and that, on the other hand, the short circuiting of the outer resistance, through contact between the carbon electrodes of an electric lamp, very much increases the electric excitement of the machine, and the power necessary to maintain its motion, giving rise to rapid heating and destructive sparks in the machine itself.



An observation in Sir Charles Wheatstone's paper is referred to, pointing to the fact that a powerful current is set up in the shunt circuit of a dynamo-electric machine, which circumstance has since been taken advantage of to some extent by Mr. Ladd and Mr. Brush, in constructing current generators.

The principal object of the paper is to establish the conditions under which dynamo-electric machines worked on the shunt principle can be made to give maximum results. A series of tables and diagrams are given, the results of experiments conducted by Mr. Lauckert, electrician, employed at the author's

works, which lead up to the conclusion that, in constructing such machines on the shunt principle, the resistance on the rotating helix has to be considerably reduced by increasing the thickness of the wire employed, and that on the magnets has to be increased more than tenfold, not by the employment of thin wire, but by augmenting the length and weight of coil wire employed. We reproduce two of these diagrams, No. 1 referring to the old form of winding and No. 2 to the new.

The results of this mode of distributing the resistances is summarised as follows:—

1. That the electromotive force, instead of diminishing with increased resistance, increases at first rapidly, and then more slowly towards an asymptote.

2. That the current in the outer circuit is actually greater for a unit and a half resistance than for one unit.

3. With an external resistance of one unit, which is about equivalent to an electric arc, when thirty or forty webers are passing through it, 2·44 horse-power is expended, of which 1·29 horse-power is usefully employed, proving an efficiency of 53 per cent., as compared with 45 per cent. in the case of the ordinary dynamo machine.

4. That the maximum energy which can be demanded from the engine is 2·6 horse-power, so that but a small margin of power is needed to suffice for the greatest possible requirement.

5. That the maximum energy which can be injuriously transferred into heat in the machine itself is 1·3 horse-power, so that there is no fear here of destroying the insulation of the helix by excessive heating.

6. That the maximum current is approximately that which would be habitually used, and which the commutator and collecting brushes are quite capable of transmitting.

Hence the author concludes that the new machine will give a steadier light than the old one with greater average economy of power, that it will be less liable to derangement, and may be driven without variation of speed by a smaller engine; also that the new machine is free from all objection when used for the purpose of electro-deposition.

This construction of machine enables the author to effect an important simplification of the regulator to work electric lamps, enabling him to dispense with all wheel and clockwork in the arrangement. The two carbons being pushed onward by gravity or spring power, are checked laterally by a pointed metallic abutment situated at such a distance from the arc itself, that the heat is only just sufficient to cause the gradual wasting away of the carbon in contact with atmospheric air. The carbon holders are connected to the iron core of a solenoid coil, of a resistance equal to about fifty times that of the arc, the ends of which coil are connected to the two electrodes respectively. The weight of the core (which may be varied), determines the force of current that has to pass through the regulating coil in order to keep the weight in suspension, and this in its turn is dependent upon the resistance of the arc. The result is that the length of the arc is regulated automatically, so as to maintain a uniform resistance signifying a uniform development of light.

Linnean Society, March 4.—Prof. Allman, F.R.S., president, in the chair.—Mr. Middleton exhibited two skulls of *Babirussa alfurus*, Less., from Borneo, which though quite adult, were both distinguished by unusual smallness of their tusks.—Dr. A. Günther brought forward two deep-sea fishes obtained during the *Challenger* expedition (*Echiodon* and *Scopelus*) to illustrate two kinds of metameric organs, first described by Dr. Ussow, which he described and designated as the *lenticular* and *glandular* kinds. Whilst admitting the great morphological resemblance of the former to an eye, he (Dr. Günther) gave reasons which induce him to dissent from the view that they are organs of vision. He showed that their structure is not opposed to the view that they, like the glandular kind, are producers of light, and that probably this production of light or luminosity is subject to the will of the fish.—Mr. J. Jenner Weir, on behalf of Mr. Edw. A. Nevill, showed the stuffed head of a Prongbuck (*Antilocapra americana*), shot by the latter in the Rocky Mountains, August, 1876. On the median nasal region of this specimen, what appeared to be a short unbranched third horn was developed. On discussion of the abnormality, it was suggested it might rather be an elongated warty growth than a true horn, after the type of the rear ones. A further careful examination into its structural conditions was recommended.—Mr. E. Morell Holmes read a paper on *Codiolum gregarium*, A. Braun, a new British alga discovered at Teignmouth by the Rev. R. Cresswell. The author considers that the hypnospores described by Braun do not belong to *Codiolum*, but to another alga, usually found growing with it. The growth of the plant and its fructification, contrary to Braun's supposition, last through the winter and spring. Mr. Holmes also exhibited specimens of the fructification of *Chætopteris plumosa* found in Britain for the first time by G. W. Traill, of Edinburgh. The unilocular sporangia in this instance were in a more advanced stage than those figured by Areschoug, and the multilocular sporangia differed in character from the illustration given by the last-mentioned Swedish naturalist.—Dr. Francis Day briefly recounted the peculiarities and descanted on the geographical distribution of a specimen of the Hebridal Argentine caught near the island of Skye, October, 1879. This fish has very rarely hitherto been got in the British waters. It is more often met with on the Norway coast, but its range extends southwards as far as the Mediterranean. It is supposed to frequent great depths and not to enter fresh water. A fish has been obtained in New Zealand, *Argentina decagon*, which seemingly quite corresponds with the foregoing, and it will be interesting hereafter, on further examination, to ascertain if they really are identical.—The following gentlemen were elected Fellows of the Society:—Messrs. S. M. Bairstow, J. T. Carrington, R. M. Middleton, S. O. Ridley, T. Charters-White, and Prof. P. Martin Duncan.

Mathematical Society, March 11.—C. W. Merrifield, F.R.S., president, in the chair.—Mr. W. J. Curran Sharp was admitted into the Society, and the following gentlemen elected Members:—Mr. C. S. Peirce, Johns Hopkins University, Baltimore, Mr. Emory McClintock, Milwaukie, Illinois, Prof. Seitz, Kirksville, Missouri, and Mr. E. Temperley, M.A.—The following communications were made to the Society:—Notes on a general method of solving partial differential equations of the first order with several dependent variables, by Mr. Tanner.—Note on the integral solution of $x^2 - 2Py^2 = -z^2$ or $\pm 2z^2$ in certain cases, by Mr. S. Roberts, F.R.S.—Notes (1) on a geometrical form of Landen's theorem with regard to a hyperbolic arc; (2) on a class of closed ovals whose arcs possess the same property as two Fagnanian arcs of an ellipse, by Mr. J. Griffiths.

Anthropological Institute, March 9.—Francis Galton, F.R.S., vice-president, in the chair.—The election of Mr. George Morrison as a new member was announced.—Mr. Francis Galton described the curious psychological fact of Visualised Numerals, on which he wrote a preliminary memoir in NATURE, vol. xxi. p. 252. This paper we hope to publish in our next number.

DUBLIN

Royal Dublin Society, January 19.—Physical and Experimental Science Section.—Howard Grubb, M.E., in the chair.—Note on the conductivity of tourmaline, by G. F. Fitzgerald, F.T.C.D. The author pointed out that though tourmaline did not possess unilateral conductivity for currents of uniform intensity, it might for currents of variable intensity, and that the latter was the true analogue of its unilateral heat conductivity.—Note on the construction of guard-ring electrometers, by G. F. Fitzgerald, F.T.C.D. In this paper the author shows the importance of having both the trap-door and guard-ring constructed of the same metal in order to insure a uniform distribution of electricity.—On the theory of the loud-speaking telephone, by Prof. W. F. Barrett. The author expressed his doubts as to the accuracy of the received theory which attributes the diminution of friction that occurs on the passage of a current to electrolytic action, a film of gas being thereby produced, and hence a reduction of the normal "stiction" between the chalk cylinder and the platinum faced arm which vibrates the diaphragm. One objection to this theory is the enormous rapidity of the changes that must occur and the difficulty of conceiving how the film of gas is to be got rid of, even if produced in an infinitesimal portion of time. Moreover, the author showed that even when the chalk was dry, in the ordinary acceptation of the word, the action still took place, excellent speaking being obtained from a cylinder that had been exposed for a month to a highly heated room and not once touched with water since it had been in the author's possession; doubtless if the chalk were strongly heated, its insulation would be too great and the current would not pass. The tendency of a closed electric current is to enlarge itself, and it might be to this cause the phenomenon was due. But the electrodynamic action of the current should occur equally well between a metal cylinder bearing on the metal arm; the author had therefore replaced the chalk cylinder by a polished brass cylinder, and employing a microphone transmitter at the other end of the line, the ticking of a watch was perfectly well heard as soon as the brass cylinder

was rotated. Whistling, too, was imperfectly heard, but not conversation. Here no electrolytic action could occur, and, therefore, the self-repulsion of a current on itself or other electro-dynamic action was shown to be a *vera causa*. The repulsive action of a current in passing from one conductor to another, described by Gore, and usually attributed to the production of heat and local expansion at the points of contact was another possible cause. But the author questioned the ordinary explanation of Gore's experiment, and conceived it probable that both it and the variations of friction in the Edison telephone receiver might be due to a common cause in both the currents passed from a bad conductor to a good one, and it was the opinion of the late Principal Forbes, formed after much research and careful inquiry, that a peculiar repulsive force was called into play when both electricity and heat were transmitted from a bad conductor to a good one. From any point of view the subject was one worthy of further investigation, which the author hoped to give to it. In conclusion, the author described an arrangement whereby he had adapted the magneto-telephone to the revolving cylinder in the Edison receiver, so that instead of having to do the entire work of vibrating the diaphragm, as in the Bell receiver, the magnetic action of the current simply varied the friction on the cylinder, and so varied the nature of the oscillations of the diaphragm, which were set up by mechanical means. But as much success was not obtained as was anticipated, nor did the combination in one instrument of the chalk cylinder and the magnetic action give good results, the variations in friction being probably not synchronous, from the direction of impulse not being always in the same way.—Natural Science Section.—G. Johnstone Stoney, F.R.S., in the chair.—On an application of Prof. Rossetti's newly discovered law of cooling to the question of radiation of heat from the earth, and to problems of geological climate and time, by Rev. Dr. Haughton, F.R.S.—Dr. Frazer exhibited a specimen of *Bopyrus squillarum*, parasitic on *Palæmon serratus*, from the west coast of Ireland, also an antler of red deer obtained from the Dodder bar in the River Liffey.

PARIS

Academy of Sciences, March 8.—M. Wurtz in the chair.—The mayor of Chatillon-sur-Long (Loiret), the birthplace of A. C. Becquerel, announced the opening of a public subscription for erection of a statue to Becquerel there, and the Academy willingly entered into co-operation.—On some applications of elliptic functions, by M. Hermite.—On the compensation of temperatures in chronometers, by M. Phillips. This relates chiefly to the perturbation known as the secondary error of compensation.—Chemical stability of matter in sonorous vibration, by M. Berthelot. He operated in two ways—(1) Placing substances in a vessel (of 250 cc. capacity) attached to one branch of a large horizontal tuning-fork vibrated electrically (about 100 simple vibrations per second), the other branch having an equivalent weight; (2) inclosing them in a large horizontal sealed tube, which was longitudinally vibrated by means of friction of a horizontal wheel with moistened felt, and gave 7,200 vibrations per second. The substances tried were ozone, arsenetted hydrogen, sulphuric acid in presence of ethylene, oxygenated water, and persulphuric acid. There was no decomposition, apparently, in any case.—New remarks on the heat of formation of gaseous hydrate of chloral, by M. Berthelot. He points out what he thinks the causes of M. Wurtz's non-success.—On the meeting of the two advance galleries of the great St. Gothard tunnel, by M. Colladon. This gives various interesting details. *Inter alia*, the volume of infiltrations in the south gallery attained 230 litres per second. M. Colladon's compressors at the two ends of the tunnel, sufficed throughout for ventilation, and the costly aspirating vessels required by M. Helwagg were not used. The difference of level at meeting was not over 0·10 m.; the lateral deviation less than 0·20 m. The total length measured in the tunnel was nearly 8 m. less than that calculated geometrically.—On the project of the inter-oceanic maritime canal; letter from M. de Lesseps. He gives a directive memorandum addressed to the members of the Technical Commission (which has been organised in eight brigades, each having its special work). The health of the party is reported excellent.—The President announced with regret the death of M. Zinin, at St. Petersburg, Correspondent in Chemistry.—Investigation of the coefficient of regularity of motion in transmissions by cables, by M. Leauté.—Function of velocities; extension of the theorems of Lagrange to the case of an imperfect fluid, by M. Bresse.—Syrphi and Entomophthoreæ, by M. Giard.—Memoir on the means applicable to destruction of phylloxera, by Dr. Hamm. He advises applying, about the roots, sulphide of carbon with infusorial earth or Peru guano as an absorbent; more of the sulphide can be thus applied without injuring the roots, and the evaporation is very slight. He also points out a line of experimental inquiry to find a pathogenic champignon which would be fatal to phylloxera.—On the toxical influence of the mycelium of vine-roots on phylloxera, by M. Rommier. Where a mycelium with long white filaments was developed on phylloxerised roots kept in a vessel at 15° to 20° temperature, the phylloxera disappeared, whereas it multiplied in the contrary case.—M. Pasteur spoke in favour of seeking a parasite wherewith to destroy phylloxera—as it would have been easy to destroy the silkworm race by means of the corpuscular parasite of pebrine. M. Blanchard, however, dissented; remarking on the limited extent of parasite-ravages on a given species in nature; also on the domesticity of the silkworm as contrasted with the wild independence of phylloxera. M. Pasteur replied, showing the possibilities of experimental multiplication of parasites.—Ephemerides of planet (103) Héra for the opposition of 1880, by M. Callandreau.—Laws concerning the distribution of stars of the solar system, by M. Gaussin. The distances of the planets from the sun and those of the satellites from their planet are in geometrical progression $a = a k^n$.—On the formulæ of quadrature with equal coefficients, by M. Radau.—On systems formed of linear equations with a single independent variable, by M. Darboux.—Demonstration of a theorem of Prof. Sylvester on the divisors of a cyclotomic function, by M. Pepin.—Comparison between curves of tensions of saturated vapours, by M. de Mondesir. The method described furnishes an instrument of singular power for control of the results of experiments.—Action of electrolysis on turpentine, by M. Renard. Among other results the product monohydrate of turpentine is regarded as a pseudo-alcohol, $C_{10}H_{16}H(OH)$.—On the synthesis of aromatic aldehydes; essence of cumin, by M. Etard.—On lesions of the kidney in slow poisoning by cantharidine, by M. Cornil.—On apparent death resulting from asphyxia, by M. Fort. Artificial respiration should be perseveringly practised for a number of hours (not yet determined) after apparent death.—On modifications produced in the system by albuminoid substances injected into the vessels (third series: insoluble ferments), by MM. Béchamp and Baltus. Pancreatine works grave disorder, and causes death where the proportion of it injected reaches about 0·15 gr. per kilogramme of the animal's weight. The substance is only partly eliminated by the urine, and then appears with all its characters.—On two new silicates of alumina and of lithia, by M. Hautefeuille.—On the phosphates and borophosphates of magnesia and lime from the guano deposit of Méjillones (lat. 23° to 24° S.), by M. Domeyko.—On the composition of the waters of Cransac (Aveyron), by M. Willm.—On the pliocene delta of the Rhone at Saint-Gilles (Gard), by M. Collot.

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