THURSDAY, FEBRUARY 6, 1872

ENTOMOLOGY IN AMERICA

First Annual Report of the United States' Entomological Commission. (Washington: Government Printing Office, 1878.)

WE have received the first annual report of the United States Entomological Commission for the year 1877, "relating to the Rocky Mountain locust, and the best means of preventing its injuries and of guarding against its invasions." The title-page bears the heading, "Department of the Interior, United States Geological Survey, F. V. Hayden, U.S. Geologist in charge;" but the report is by C. V. Riley, A. S. Packard, Jun., and Cyrus Thomas, and it simply passes, *pro formâ*, through Dr. Hayden's hands to the Secretary of the Interior. The amount of entomological work previously done by the Survey is well known.[1] Before speaking of this report it may be well to refer to the circumstances which have led to its being made. During the years 1873-76 the injury done by the Rocky Mountain locust in states west of the Mississippi was so great as to create a feeling that steps should be taken by Congress towards mitigating the evil. A conference of the governors of various western states and territories was held at Omaha (Nebraska) in October, 1876, the result of which was a memorial to Congress for an appropriation of 25,000 dols. and the creation of a commission of five experts to thoroughly investigate the subject. Congress acceded partially to this and an act was passed "appropriating 18,000 dols. to pay the expenses of three skilled entomologists to be attached to Dr. F. V. Hayden's United States Geological and Geographical Survey of the Territories," and the Secretary of the Interior appointed the gentlemen above-named. As soon as the commissioners were appointed they met at Washington and agreed upon the division of labour. Their scheme was laid before the Minister of the Interior on March 22, 1877, was approved, and was immediately put in operation. Within eleven months from that date the report was prepared and ready for presentation. When it is considered how vast was the district to be examined, how numerous were the records of the movements of locusts during the year that were collected, and what a range of subjects the report includes, it seems astonishing that so much should have been accomplished in the time. The locust-area was divided into three districts for convenience. Mr. C. V. Riley took the region east of the Rocky Mountains and south of the 40° N., the western half of Iowa, and conjointly with Mr. Packard, British America west of 94° W. Mr. A. S. Packard took Western Wyoming, Montana, Utah, Idaho, and the Pacific coast. Mr. Cyrus Thomas took the portion north of Mr. Riley's region, including the eastern half of Wyoming, Northern Colorado, the southern and eastern part of Dakota, Nebraska, the eastern half of Iowa and Minnesota. Circulars asking for information were distributed among farmers and others, and every assistance seems to have been offered by the officials of the different states, of the Post Office, and of the railways. On the subject of the movements of locusts as many as 2,500 observations were thus obtained for the year.

The report is divided into nineteen chapters, and the scope of the work will be most conveniently indicated by giving a brief *résumé* of each.

Chapter I. is devoted to classification and nomenclature. It is pointed out that the words "locust" and "grasshopper" are often very loosely used, including diverse insects belonging even to different orders. The limitation of the use of the word "locust" in the report is explained at p. 33. "This family [speaking of the *Acrididæ*] contains the true locusts, such as those of Oriental countries and the Rocky Mountain locust; also such so-called grasshoppers as the common red-legged species of the States and those found hopping on the ground in open waste fields, along roadsides, &c. Therefore, in speaking hereafter of these species, we shall use the term *locust*." So that, insects belonging to the family *Locustidæ*, are not here included under the general term locust. The family *Acrididæ* is divided into three sub-families, the *Proscopinæ*, the *Acridinæ*, and the *Tattiginæ*. The first is an exotic family, and dismissed from further consideration. The *Tattiginæ* are comparatively few, quite small, and seldom noticed by unscientific observers. It is, therefore, only with the *Acridinæ*, which includes all the migratory locusts, that the classification deals. This sub-family contains several subordinate groups; but of these the writers remark, "no arrangement we have seen can be considered satisfactory." Reasons are given for excluding from consideration all genera except *Acridium* and *Caloptenus*. *Acridium* is limited in its permanent region to districts south of the latitude of St. Louis. *Caloptenus* has a wider region, and causes far greater losses by its ravages. After discussing Stål's *Calliptenus* the writers describe *Caloptenus* as they understand it (p. 40). There are twenty-nine species recognised in the United States, but of these there are but three which, for the purposes of the work, have to be considered, "as they are the only ones generally distributed, which are so closely allied to each other as to render it difficult to distinguish them." These are the *C. spretus*, Thomas, *C. atlanis*, Riley, *C. femur-rubrum*, De G. Three plates are devoted to illustrating the details of their appearance in different stages of growth. Throughout the report they are spoken of by their popular names: *atlanis* is called the lesser locust; *femur-rubrum*, the common red-legged locust; and from among the many names for *spretus*, such as "the hopper," "the army grasshopper," "hateful grasshopper," "Rocky Mountain locust," &c., the commission have adopted the last. It is with this Rocky Mountain locust and its depredations the report is mainly concerned, though the damages by others are not excluded.

Chapter II. (pp. 53 to 114) gives a chronological history of the ravages in past years, beginning with the imperfect records of as far back as 1818, and this is summarised in a tabular form (p. 113). With regard to this history it is pointed out that while the later years are recorded as years of wide-spread emigrations, it must be remembered that our means of obtaining statistics have improved. "There are no facts tending to show that the locusts themselves have been any more numerous of late years than previous to, for example, the years 1866-1867."

[1] See especially 4th, 5th, 6th, and 9th reports.

Chapter III. gives "Statistics of Losses." The estimate of losses is made by taking a "locust year" for comparison with one when there was no locust visitation. Dr. Hayden in his letter to the Secretary of the Interior, which accompanied the Report, has thus summarised it. The great practical importance of an exhaustive study of this destructive insect throughout all the immense extent of the locust area, which lies between the 94th and 120th meridian, embracing nearly two million square miles, may be realised from the fact that on a careful estimate from all the data obtainable, the States and territories lying west of the Mississippi and east of the great plains, suffered by the depredations of the locusts an aggregate loss in destruction of crops alone during the years 1874-77 of 100,000,000 dols., to say nothing of the indirect loss by stoppage of business and various enterprises which must have been as much more, thus making the direct and indirect losses at not less than 200,000,000 dols.

Chapter IV. (pp. 123 to 131) is occupied with considering the agricultural bearing of the locust problem, points out what crops suffer most, and discusses what is likely to be the effect of agricultural operations in the future. Such precautions as accurately knowing the dates of invading swarms and planting early or late accordingly are referred to.

Chapters V., VI., VII. (pp. 131 to 212) are occupied respectively with an account of observations on the "permanent breeding grounds," the "geographical distribution," and the "migrations" of the Rocky Mountain locust. Previous to 1877 very little was known of the breeding grounds. The Commission has been able to map the area and also map the districts subject to invasion, while the directions taken by invading and returning "armies" are also given. It is found that, as a rule, flight is undertaken only during a part of the day and in fair, clear weather, so that the desire for food, cloudy or rainy weather, and adverse winds, may keep them from rising and taking wing. In all flights it seems the locusts rely much on the wind to carry them, usually turning their heads towards the wind and drifting backwards. When the wind is slight, however, they use their wings and turn their heads forwards. Their flights can be continued for several days over a distance of several hundred miles. The rate at which they travel is variously estimated at from three to fifteen or twenty miles an hour, determined by the velocity of the wind. There are facts which show that they can fly two miles and a half above the general surface of Kansas and Nebraska, and far out of sight of the keenest vision. This will explain their often sudden and mysterious appearance in areas without anything having been seen of them on the line along which they travelled. Sometimes two swarms have been seen moving in opposite directions, one in an upper and one in a lower current. With regard to the return migrations, the Commissioners remark that they are led to the conclusion "that by some law governing them there is a tendency in the resulting broods hatched in this visited area to return to the native habitats from which their progenitors came." The connection of meteorological phenomena with migration is entered into at considerable length, and many pages of meteorological data are given.

Chapter VIII. (pp. 212 to 257) is devoted to habits and natural history. Various observations are collected as to the quantities of eggs laid and the conditions of hatching. The laying season is from six to eight weeks; the average interval of laying is two weeks, and the average number of egg-masses is three. The idea that locusts are led by kings or queens is unfounded. The reasons assigned for migrations are (1) hunger, (2) the desire to find fresh breeding-grounds, (3) to escape natural enemies, (4) "instinctive impulse." Though by choice their food is the various cereals, they will eat almost anything at a push, even "dry leaves, paper, cotton and woollen fabrics. . . . They do not even refuse dead animals, and have been seen feeding on dead bats and birds." They often strip fruit trees of their leaves. "Forest and shade trees suffer in different degrees, and some, when young, are not unfrequently killed outright." At the end of this chapter reference is made to unnecessary alarm often caused by comparatively harmless locusts.

Chapter IX. is on "Anatomy and Embryology," and this, according to a statement in the introduction, is by Mr. Packard. Two diagrammatic drawings and several figures illustrate this part of the work; and Mr. C. S. Minot has contributed a few pages on the "fine anatomy," illustrated by plates.

Chapter X. is on "Metamorphoses." The Rocky Mountain locust requires about seven weeks from hatching to attain full growth, and during that time it passes through six stages. Plate I illustrates these. Though in European migratory species there is a difference of opinion as to whether there are four or five moults, the writers say they have "thousands of mounted and alcoholic specimens of all ages" showing the six stages. "The number of moults may vary according to the amount of nutrition and rapidity of development."

In Chapter XI. on "Invertebrate Enemies," the life-histories of many insects are given, and this part of the work occupies fifty pages.

Chapter XII., on "Vertebrate Enemies," gives a *résumé* of what is known of the usefulness of birds. Blackbirds, prairie-hens, and quail, are found to be good locust destroyers, while a special section is given to stating reasons why the English sparrow should not be introduced.

Chapter XIII., seventy pages in length, is largely of interest to mechanicians, and deals with "remedies and devices for destruction." Many of the remedies are agricultural operations to be performed at particular times, according to varying circumstances, but the special devices, both protective and for "catching or bagging" eggs and insects are numerous and are illustrated by woodcuts. The three succeeding Chapters are on "influence of prairie fires on locust increase," "influence of weather on the species," "Effects that generally follow severe locust injury." Then follows a Chapter (XVII.) on the uses to which locusts can be put, in which it is urged they form an abundant and nutritious article of food. "Why should the people of the West, when rendered destitute and foodless by these insects, not make the best of the circumstances, and guard against famine by utilising them as food?"

The different methods of cooking locusts are entered into, and an account is also given of the use of them by different nations. They were counted as clean animals by the Jews [Levit. xi. 22], and Herodotus mentions a tribe of Ethiopians which fed on locusts, which came in swarms from the southern and unknown districts.

Mr. Riley speaks of good broth being made "by boiling the unfledged *Calopteni* for two hours in a proper quantity of water, and seasoned with nothing but pepper and salt; the broth is hardly to be distinguished from beef broth." Boiled, fried, or roasted the full-grown are said to make pleasant food, and ground and compressed they will keep a long time. The other uses suggested are as fish bait, as manure, and as a source of formic acid.

There are altogether twenty-seven appendices occupying 279 pages, the last appendix giving the bibliography of the subject.

GUTHRIE'S PHYSICS

Practical Physics, Molecular Physics, and Sound. By Frederick Guthrie, Ph.D., F.R.SS. L. and E., Professor of Physics in the Royal School of Mines, London. (London: Longmans, Green, and Co., 1878.) [London Science Class-Books, edited by G. Carey Foster, F.R.S., and Philip Magnus, B.Sc., B.A.]

"THE works comprised in this series," the editors tell us, "will all be composed with special reference to their use in school-teaching; *but*, at the same time, particular attention will be given to making the information contained in them trustworthy and accurate, and to presenting it in such a way that it may serve as a basis for more advanced study."

The little word *but*, which we have taken the liberty to emphasise, seems to hint at some opposition between accurate statements and school-teaching, which, if not a fundamental necessity, is at least a universally existing phenomenon in the present order of things. This series of class-books is by no means the first attempt to procure books for children from writers of scientific reputation; and Prof. Guthrie, the author of this little book on practical physics, has himself invented several experimental methods at once interesting, ingenious, and simple.

If a child has any latent capacity for the study of nature, a visit to a real man of science at work in his laboratory may be the turning-point of his life. He may not understand a word of what the man of science says to explain his operations, but he sees the operations themselves, and the pains and patience which are bestowed on them; and when they fail he sees how the man of science, instead of getting angry, searches for the cause of the failure among the conditions of the operation.

Accordingly, in this little book the parts which are most interesting, whether to young or old, are those in which Prof. Guthrie describes his own beautiful experiments on the size of drops and bubbles, or teaches us how to blow glass. But if he once opens his ears to the siren song of the scientific imagination, floating down from heights unprofaned by experiment, through the window of the laboratory, and makes three paces through the room from the blowpipe to the lecture-table, we know that the curse has come upon him, and that for him it will never more be possible to reconcile the claims of accuracy with those of school-teaching.

What but some vile enchantment could have induced an intelligent man to begin his discourse to the poor little children in this style:—

"§ 1. **Hardness. Form-elasticity.**—The pressure required to alter the relative positions of two contiguous parts of a body measures its hardness. As this pressure is greater with greater surface of contact, some unit of surface must be fixed upon. The term hardness is generally applied loosely to difficulty of fracture. The following remarks may show that our speech and ideas in regard to hardness are deficient in precision. Glass is said to be harder than lead, yet a glass cup is more easily broken than a leaden one—more easily broken, though not so easily bent. Hard bodies are always elastic; elastic bodies are not necessarily hard, nor are they necessarily brittle, nor are soft bodies necessarily plastic. Toughness seems to imply a resistance to change of form, which resistance increases more rapidly than the displacement; thus, while a band of vulcanised caoutchouc will be extended to a degree proportional to the weight hung at one end, a leathern strap will not be extended twice as far if the weight on it is doubled. Toughness is generally associated with texture, and stretching causes partial fibration in the line of pull."

Here is a teacher who, with all the stores of science to choose from, selects, as the first lesson to a child, the necessity of fixing on a unit of surface, which, however, he makes no attempt to do, but goes on to harangue him on the deficiency in precision of our ideas and language in regard to hardness.

The poor child is not responsible for this want of precision; his first duty is not to reform his language, or even to criticise it, but to learn it, and if there is any part of human knowledge about which our speech and ideas have become tolerably precise, let us teach him that first, so that he may have some hope that knowledge is attainable before we let him see, as we must at last, how confused our own notions are.

Whether a child receives any special instruction in science or not, it is of unspeakable advantage to him if he is not put in the way of explaining things by false hypotheses. The difficulty which we have in recognising the paradoxical character of some of the most celebrated paradoxes shows how much has been done by the teachers of the last two centuries in causing false principles to be forgotten. The paradoxes are no longer paradoxical, because the dogmas which made them so are now known only to the owls and the bats.

We have selected a few statements in this book which we do not remember to have seen before.

(When a wire is stretched by a weight) "it may be assumed that the volume of the metal remains approximately unchanged, so that if the elongation is such that the length m becomes n, the original diameter d becomes $d\sqrt{\frac{m}{n}}$" (p. 4).

"A drop of water on a board strewed with powdered resin is nearly spherical." "The spherical is the form in which the mean distance of all parts from the centre of mass is the least. It is the most compact form for a given mass. This shows that cohesion moulds the drop to the spherical form" (p. 8).

Does Prof. Guthrie take his science from Rogers' verses on a tear? We refer him to Shakespeare ("King John," Act iii. Sc. 4) as a better authority on Capillary Attraction:—

"Bind up those tresses: O, what love I note
In the fair multitude of those her hairs!
Where but by chance a silver drop hath fallen,
Even to that drop ten thousand wiry friends
Do glue themselves in sociable grief,
Like true, inseparable, faithful loves,
Sticking together in calamity."

"A more exact method" (of measuring the viscosity of gases) "is to place timed chronometers under bell-jars containing various gases, and also *in vacuo*" (p. 19).

"**Diffusion of Gases into Gases.**—The unhampered diffusion of gases into gases has been little studied" (p. 39).

"Experiments show that the more a gas is soluble in a liquid the more is the liquid volatile in the gas" (p. 45).

"Whether the feeling called pitch depends upon the appreciation of the rapidity of sequence or upon the duration of each distortion of the ear-drum is not easy to decide, for the one is the inverse of the other. Perhaps the fact that a single long wave produces a different impression from that produced by a single short wave, and that this difference reminds one of the differences between grave and shrill notes, may be regarded as evidence that duration of individual impression rather than rate of sequence is to be considered as the origin of pitch" (p. 77).

After reading these statements, we have come to regard it as a decided merit, that in this book on Molecular Physics we are not told anything about molecules. The value of the book would be increased by cutting out "Molecular Physics" from the title, together with everything in the book included under that heading, and devoting the whole book to Practical Physics as adapted to the capacities and opportunities of young students.

J. CLERK MAXWELL

OUR BOOK SHELF

The Journal of the Royal Agricultural Society of England. Part II. (London: John Murray, 1878.)

THIS is no ordinary number of an agricultural journal. It is, in fact, a memoir on the agriculture of England and Wales, prepared under the direction of the Royal Agricultural Society, and presented by them at the International Congress held in Paris during the present summer. The memoir is now issued as the second part of the Society's *Journal* for the current year.

The memoir is well worthy of the Society under whose auspices it has appeared. It forms a large volume of over six hundred pages, and contains ten treatises on different aspects of English agriculture, each the work of a distinct author.

The first article in the memoir is a "General View of British Agriculture," by Mr. Caird. He commences with statistics as to the home and foreign supply of food, then glances at the changes introduced in agriculture during recent years by the increased use of machinery, and of artificial foods and manures, and last, though not least, by free trade. After a very brief notice of the differences of climate and soil in England he comes to his main subject—"the landed property of England," its character, distribution, ownership, improvement, value, and relation to Government. The whole essay is written with remarkable ability, and is full of important information.

The second article is on "English Land-law," by F. Clifford and J. A. Foote. It treats of succession, tenancies, agreements, leases, and recent legislation on the subject of unexhausted improvements. The third article is by Capt. Craigie; it deals with "Taxation," and describes the various kinds of taxation, and their incidence on the various classes connected with agriculture. This is followed by a short paper on "Farm Capital," by E. P. Squarey.

The fifth article is by much the longest in the volume; it has for its scope the whole subject of "Practical Agriculture"; it is written by Mr. J. A. Clarke. The article commences with a sketch of the climate and geology of England, and then proceeds to give statistics as to the crops produced, the number of live-stock maintained, the imports of manure and food, and the prices of agricultural products. Then follow chapters on the management of cattle, sheep, and pigs, with a description of the various breeds of live-stock, including horses. Crops and manures are then discussed, the practice of good farms in different parts of England being indicated. The concluding chapter is on machinery, and cultivation by steam. The whole article covers nearly two hundred pages; it is full of practical information, condensed into a small compass.

The sixth article treats of "Dairy Farming," and is written by Mr. J. C. Morton; to this is added an appendix on "Pastoral Husbandry," by W. T. Carrington. Mr. Morton, after reviewing the statistics of the subject, proceeds to describe the various breeds of cattle employed for dairy purposes in England, illustrating this part of his paper by wood-cuts. He then treats of the rearing of calves, the sale of milk, and the production of cheese and butter, describing in each case the practice of different parts of the country.

The seventh article treats of "The Cultivation of Hops, Fruit, and Vegetables," and is the work of Mr. C. Whitehead. It is naturally divided into three chapters. The subjects are treated statistically and practically, and much important information is given.

The next paper is of special interest at the present time, it is on "The Agricultural Labourer," and is written by Mr. H. J. Little. The past history of the British labourer is sketched, and his condition in various parts of the country described. His earnings, expenses, domestic life, education, and provident societies are treated of, and evidently by one who can speak from personal knowledge of the subject.

The ninth paper is the only one of a strictly scientific character; it deals with the "Influence of Chemical Discoveries on the Progress of English Agriculture," and is the work of Dr. A. Voelcker. The scope of this paper is hardly so large as its title, as the author generally limits his remarks to investigations made since 1860, and has nothing to say of Continental discoveries. The paper is for the most part an account of the investigations made by Messrs. Lawes and Gilbert at Rothamsted, and of the work done by the author himself. The subjects treated of are—The Soil, Continuous Cropping, Manures, Improvement of Permanent Pastures, Feeding and Rearing of Stock, Industries attached to the Farm, Experimental Stations.

The volume fitly concludes with an article on the history and work of "The Royal Agricultural Society," written by Mr. J. M. Jenkins, the Secretary of the Society.

It will be seen that the memoir issued by the Royal Agricultural Society includes a wide range of subjects; it would be hard indeed to find another volume containing as much information on English agriculture in the same compass. The whole is published at the extremely low price of six shillings. We trust that it will find a large circulation

R. W.

A Visit to South America; with Notes and Observations on the Moral and Physical Features of the Country, and the Incidents of the Voyage. By Edwin Clark, C.E. (London: Dean and Son, 1878.)

MR. CLARK'S modest little narrative is considerably superior to the ordinary run of modern books of travel, which have become as plentiful, nearly, as novels, though we are glad to say, on the average, much more worth reading. Mr. Clark has certain scientific qualifications which give him an advantage as an observer of phenomena both on sea and land, and the results of which are apparent in the volume before us. Mr. Clark's narrative relates to the years 1876-77, during which he resided for nearly two years in Buenos Ayres, Paraguay, and Uruguay. The two latter regions are yet sufficiently unknown to make any contribution from a competent observer who has visited them, welcome. The information, especially, which he gives us on Paraguay, is of much importance, and is a valuable addition to that obtained by Mr. Keith Johnston, in his visit two or three years ago. From a scientific point of view, perhaps the most valuable portion of Mr. Clarke's book are the numerous meteorological notes which he made both during his voyage out and his stay in South America. His knowledge of meteorology in its widest sense seems to us both extensive and accurate, and his observations on the instruments he used, on doldrums, tropical evaporation, and other such topics, are really interesting. But Mr. Clark knows something also of botany, as is evident from the frequent observations in this direction to be found throughout his volume. A whole chapter is devoted to the climate and meteorology of Buenos Ayres, important both from a scientific and practical point of view, as it is one of the great centres of emigration for South America. Many interesting sketches are given of the people and their mode of life in the various districts visited by Mr. Clark, and altogether his work is one of substantial value and real interest, and we trust it will find many readers.

Our Railways: Sketches Historical and Descriptive, with Practical Information as to Fares, &c., and a Chapter on Railway Reform. By Joseph Parsloe. (London: Kegan Paul and Co., 1878.)

MR. PARSLOE'S volume contains a large amount of very varied information on railways, their origin, their working; its object, he tells us, being to present a sketch of our railway system in its general details. The contents are so varied it would be difficult to give any idea of their nature without a lengthened notice. Mr. Parsloe goes back to the old days of stage-coaches, coming down to the origin of railways, then speaks of their construction, of navvies, working expenditure, signals, gauges, tickets, and a multitude of other topics all of much interest to the travelling public. The book is certainly both interesting and instructive.

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.*]

The Formation of Mountains and the Secular Cooling of the Earth

THE letters of Mr. Wallace and Mr. Fisher in NATURE, vol. xix. pp. 121, 172, 244, 267, raise the question as to whether or not it is possible that the interior of the earth can be cooling more rapidly than the exterior. The following is an attempt to answer the query as to where the loss of temperature per unit time is greatest.

Sir W. Thomson (see Thomson and Tait, "Nat. Phil.," App. D) considers the cooling of "a solid extending to infinity in all directions, on the supposition that at an initial epoch the temperature has had two different constant values on the two sides of a certain infinite plane." The solution given is—

$$v = v_0 + \frac{2V}{\sqrt{\pi}} \int_0^{\frac{x}{2\sqrt{kt}}} e^{-z^2} dz$$

where k denotes the conductivity of the solid, measured in terms of the thermal capacity of the unit of bulk;

V, half the difference of the two initial temperatures;

v_0, their arithmetical mean;

t, the time;

x, the distance of any point from the middle plane;

v, the temperature of the point x at time t.

The above solution shows that for all values of the time when $x = 0$, $v = v_0$, so that the temperature at the medial plane is constant.

Then differentiating v with regard to the time we have—

$$-\frac{dv}{dt} = \frac{V}{2\sqrt{\pi k}} \frac{x}{t^{\frac{3}{2}}} e^{\frac{-x^2}{4kt}}.$$

This expression is that required for the rate of cooling. We now wish to find where it is a maximum. Consider the function ze^{-z^2}; this is clearly a maximum when $\log z - z^2$ is a maximum, and by the ordinary rules this is a maximum when $\frac{1}{z} = 2z$, or when $z^2 = \frac{1}{2}$.

Hence it follows that $-\frac{dv}{dt}$ has its maximum value where $x^2 = 2kt$.

Now when the unit of length is a foot and of time a year, $k = 400$; hence $x = \sqrt{800t}$.

This formula shows that the seat of the maximum rate of cooling moves inwards as the time increases. If the time which has elapsed from the initial state be two hundred million years, or $t = 2 \times 10^8$, we have $x = 400{,}000$ feet, or a little less than eighty miles.

Sir W. Thomson shows, in his paper on the Secular Cooling of the Earth, that the solution of his ideal problem will be very nearly correct for the case of the earth, which is supposed to be a hot sphere cooling by radiation.

It follows, therefore, from the numerical result which is given above that the seat of the maximum rate of cooling must probably be something like 100 miles below the earth's surface.

It does not, of course, necessarily follow that the seat of the maximum rate of contraction of volume should be identical with that of the maximum rate of cooling; yet it seems probable that it would not be very far removed from it.

The Rev. O. Fisher very justly remarks that the more rapid contraction of the internal than the external strata would cause a wrinkling of the surface, although he does not admit that this can be the sole cause of geological distortion. The fact that the region of maximum rate of cooling is so near to the surface recalls the interesting series of experiments recently made by M. Favre (of which an account appeared in NATURE, vol. xix. p. 103), where all the phenomena of geological contortion were reproduced in a layer of clay placed on a stretched india-rubber membrane, which was afterwards allowed to contract. Does it not seem possible that Mr. Fisher may have under-estimated the contractibility of rock in cooling, and that this is the sole cause of geological contortion?

G. H. DARWIN

Storm Warnings

A NEW YORK telegram occasionally announces that a cyclonic storm will probably reach the coast of Europe in a few days.

Such warnings are often of great value; but many storms are deflected in the Atlantic, while others—without having touched the American coast—come unannounced with destructive violence.

A floating buoy might be constructed to serve the purpose of a marine observatory, when placed in the usual track of storms at a sufficient distance from exposed coasts to be useful for *warnings* for ships in and near harbours.

The chief meteorological "elements" which are of essential significance in such a case are the *height* and changes of the barometer, and the varying force and direction of the wind.

If an experimental buoy were fixed by means of a slightly elastic cable about eighty miles off Valencia Observatory, and connected therewith by submarine telegraph wire, a slight modification of the aneroid lodged therein would enable the observer on shore to determine to about a tenth of an inch the height and changes in its *readings*.

A wind-vane in connection with a magnetic bar, and presenting a disk to the air-current, might be made the means of registering approximately the force and direction of the wind.

If the plan were successful, other meteorological facts might be determined by passing a current through mechanical indicators attached to each piece of apparatus.

Changes of temperature, electric conditions, and rainfall, might ultimately be brought within the scope of such a plan of telegraphic registration, and three or four floating observatories might be arranged at considerable distances apart.

The problem thus presented to the mechanician is the construction of apparatus such that in passing an electric current successively through indicators specially devised for each instrument, *readings* could be made and announced to all concerned.

By such means all coasts liable to be visited by progressive storms might have timely warning of danger.

The cost of such work would be very small in comparison with the saving of life and property concerned.

The Board of Trade might be induced to offer a substantial reward for the most efficient models of such floating stations.

The essential feature of this proposal is, that new instruments should be devised as entirely different in form from those in use as the aneroid is from the old barometer.

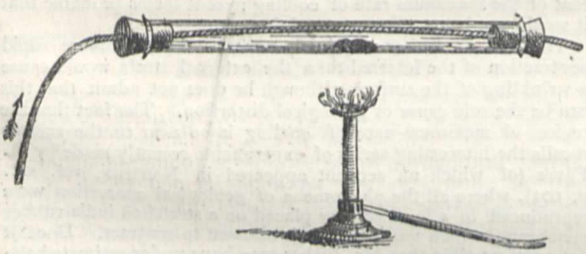
There is no reason to doubt that whenever instruments are devised in which the passage of an electric current can be made through the indicators, it will be as easy to take readings of meteorological instruments at the distance of a thousand miles as when in sight, and with sufficient accuracy for the purposes in view.

A. HUTTON BURGESS

The Dissociation of Sal-Ammoniac—An Experiment

ALL chemists admit that when sal-ammoniac is volatilised the vapour consists, if not wholly, at least in great part, of hydrochloric acid and ammonia gases in the free state. But this fact, so far as I am aware, is very seldom, if ever, demonstrated experimentally by teachers. The following modification of Pébal's original experiment renders this proof very easy and available for lecture purposes:—

The stem of a long clay tobacco-pipe is passed loosely through a couple of perforated corks fitted into the two extremities of a piece of ordinary combustion tubing about a foot long. The tube contains in the middle a small lump of sal-ammoniac, and



near each end a strip of blue litmus paper. When the middle of the tube is heated the vapour of the sal-ammoniac surrounds a portion of the pipe-stem. If, now, a rapid stream of air or any other indifferent gas is sent through the pipe, it is found to be strongly charged with ammonia, so that it answers freely to all the usual tests. At the same time the litmus papers contained in the glass tube become red owing to the accumulation of hydrochloric acid in the residue. This experiment, of course, depends upon the diffusion of the lighter ammonia through the clay more rapidly than the hydrochloric acid also present.

WILLIAM A. TILDEN

The Sting of the Bee

IN "The Origin of Species," p. 242, fourth edition, Mr. Darwin says, "If we look at the sting of the bee as having originally existed in a remote progenitor as a boring and serrated instrument, like that in so many members of the same great order, and which has been modified, but not perfected, for its present purpose, with the poison, originally adapted for some purpose such as to produce galls, subsequently intensified, we can, perhaps, understand how it is that the use of the sting should so often cause the insect's own death; for if, on the whole, the power of stinging be useful to the social community, it will fulfil all the requirements of natural selection, though it may cause the death of some few members." In a lecture given as it happens, this day ten years ago, I ventured to suggest that bees may have derived advantage, not in spite of the fatal condition annexed to the use of their sting, but from that condition itself, since "it may have proved expedient for a creature to be armed with a weapon capable of inspiring terror, yet so contrived, that its possessor should of necessity be peaceful towards its neighbours." It is very certain that many gentle-hearted human beings wage remorseless war upon wasps, who would never think of harming a bee or a bluebottle. On the other hand there are many mischievous persons ready enough to trifle with the feelings of a bluebottle, who keep at a respectful distance from a bee, simply because they know it possesses a certain power of revenge. In this way the sting is not, as your correspondent "R.A." is inclined to think, worse than useless to the individual bee, but an effective protection, albeit rather as a shield than a sword. What is needed for its efficacy is not so much intelligence in the bee as in those who would otherwise attack the bee, and though to the individual bee a single experience ending in its own death could be of no avail, yet the other animal, the wounded survivor in the fray, would have its understanding wonderfully quickened to the advantage of all bees it might meet in the future.

If, then, the bee is actually better off with its imperfect sting than it would be with one theoretically more perfect, it may be scarcely worth while to inquire whether a more effective weapon could or could not be developed on the principles of natural selection. But assuming that under given circumstances bees would derive advantage if the sterile workers had stings which they could use without sacrificing their own lives, the very statement of the hypothesis implies that a swarm, in which such workers were developed, would have an improved chance of surviving in the struggle for existence. Enemies would be more certainly vanquished; food would be more securely stored or in greater abundance; and thus the particular strain which had produced the improved variety would be more likely than others less favoured to be transmitted to future generations. The power of producing the better-armed warriors would be transmitted just as the power of producing the worse-armed warriors is transmitted, neither in the one case nor the other through the warriors themselves.

THOMAS R. R. STEBBING

Tunbridge Wells, February 1

Fossil Forests and Silicified Trunks

IN NATURE, vol. xix. p. 257, the discovery of fossil forests in the spring region of the Yellowstone River is referred to. I have visited the United States National Park, and its geysers, and observed exactly how silicified trunks *in situ* originate. All geologists suppose that this must have happened beneath water, and consequently Mr. Holmes supposes a constant alternation of land and sea throughout a long period of subsidence. My observations show the contrary, as silicified trunks originate only in air, never in water. The siliceous hot water of the geyser basins runs off periodically in another direction; if it comes to a forest, then all green leaves, all bark, and most of the branches fall off, but the trunks remain erect. Now the siliceous water rises by capillary attraction in the stem, but only on the outside of the trunk does the siliceous acid become solid by drying in the air; from the outside the silicification of the wood cells enters very slowly to the inner part; the trunks are mostly struck down by the wind before the inner part gets petrified, and then the inner part shows no ligneous structure, is only filled with foreign matter, or sometimes with other minerals, or it is hollow, for the inner wood decays. The white silicified wood is for a long time soft, less coherent than common wood, and if such trunks fall down into water, as I observed, they never get hard. Those white forests without leaves, bark, and branches, are not rare around the geysers. With my observations accord all characteristics of silicified trunks, *i.e.* such carbonaceous trunks excepted, that consist only of outfilled matter, stone kernels, for all real silicified trunks are barkless, leafless, branchless, often with inside hollow or partly filled, and always found along with common opal derived also from geysers.

Is silicification of trunks with well-preserved structure possible beneath water? No proof has yet been given. And further, would it be possible for stems, which are lighter than water, to remain *in situ* and erect by sinking under water? Scarcely—only if previously silicified and heavy.

Besides, most statements of travellers on fossil forests relate to the tropics. I saw several on my voyage round the world, which consisted only of stems lying together.

Leipzig-Eutritzsch, January 28

OTTO KUNTZE

Force and Energy

YOUR correspondent, Mr. R. H. Smith (NATURE, vol. xix. p. 194), speaks of "the fine old crusty Newtonian maxim . . . 'force is any CAUSE which,' &c." Now Newton's words are these: "Definitio IV.—Vis impressa est ACTIO IN CORPUS EXERCITA, ad mutandum ejus statum vel quiescendi vel movendi uniformiter in directum." It will be observed that Newton avoids the use of the obnoxious word CAUSE. I suppose that some translator, or commentator on Newton, adopted the word "cause" (in the sense, probably, not of an efficient cause in itself, but, by a common figure of speech, of the *action* of some cause), and that other writers transcribed the expression.

Prof. Tait, who is specially referred to by your correspondent, seems to have overlooked the above definition when he wrote ("Recent Advances," ed. i. p. 16): "the definition of force in physical science is implicitly contained in Newton's 'First Law of Motion,' and may thus be given: *Force is any cause*," &c. Newton, in that law, speaks of "vires impressæ," but forbears there to define, or explain, "vis." Clearly he refers back to Def. IV., where, as I have shown, he defines "vis impressa" by "actio," not by "causa."

In justice to Prof. Tait, however, it should be pointed out that in the passage referred to he proceeds at once to discuss the difficulty introduced by the word "cause." He has, in fact, anticipated your correspondent in the idea of his definition of force. Prof. Tait writes thus: "In every case in which force is said to act, what is really observed . . . is either a transference or a tendency to transference of what is called energy from one portion of matter to another. Whenever such a transference takes place there is relative motion of the portions of matter concerned, and the so-called force in any direction is merely the rate of transference of energy per unit of length for displacement in that direction."

J. G. H.

Electrical Phenomena

MR. GREEN, in his letter to NATURE, vol. xix. p. 220, omits to state the route by which he ascended Monte Rosa "not long since." This is a detail of interest, because the rocks of that range are decidedly magnetic, and much hidden on the north side by ice.

In 1875, much out of sorts, I was training by short climbs, and at the Kiffleberg, well known for its effect upon the magnet, strolling up the Gorner Grat in company with three other members of the Alpine Club, and several more, the sky quickly clouded over, it thundered, and the axes of the Alpine men fizzed in most orthodox fashion, especially when held up, and the long sticks of the non-climbing men also crackled. A transitory but vivid lightning storm followed.

Several days later, during an attempt to ascend the Stockhorn, in company with a young Englishman, from the north side, by the Triftje glacier, the same fizzing, concurrently with snow, thunder, and lightning, took place, and half up the last glacier a violent storm came upon us, and throwing caution to the winds, we both skeltered down the snow and ice slopes with scant respect for crevasses seen and hidden. But for the mountaineer's axiom, "never part with your axe," we were much inclined to throw ours on one side. Soon we got below this critically charged stratum of air and earth, and the fizzing ceased. I shall never forget that terrible half-hour, only to be imagined by mountaineers or seafarers. Forbes, in his splendid work on glaciers, relates a similar incident somewhere in this same range.

Positive and negative changes of earth and air, conductibility of these and of axes, and involuntary experimenters suggest themselves. In our latter case all were more than *damp!*

I have not Forbes' book here, and can therefore quote no details. Thunderstorms are characteristic. In 1849 (I think it was) I made a new pass, called the Neue Weiss Thor. Overhead it was fine. A mile below was a thunderstorm, and during our descent on the Italian side, we came into it, and were refreshed first by snow, then by rain, till we reached Macuguaga.

MARSHALL HALL

Vernex-Montreux, Canton Vaud, Switzerland, January 27

Ear Affection

SEVERAL years ago, during an attack of whooping-cough, I found that one of my ears was so affected as to cause sounds heard by that ear to seem flatter than their true pitch as heard by the other ear. The difference was about a semitone, as I ascertained by holding a tuning-fork to each ear alternately; and when I whistled I heard two notes in discord. The affection lasted about ten days.

Will one of your readers kindly render me an explanation.

Adelaide, November, 1878 P.

RELATION OF METEORITES TO COMETS[1]

I HOLD in my hand a stone that weighs about two and a half pounds. Over a part of its surface is a thin black crust. A part of its corners are cracked off, showing a gray interior, and on looking closer you see small points of iron all through it. It is heavy—about one half heavier than granite, or marble, or sandstone. Altogether it is a very curious stone, totally unlike any of our rocks.

That stone was once a part of a comet.

Do you want my reasons for saying it? Or, does any one doubt it? I propose to-night to give those reasons; to set in order, as clearly and simply as I can, the facts and lines of thought that lead me to say as I did—*that stone was once a part of a comet.*

It came to us from Iowa. Three years ago, on February 12, about ten o'clock in the evening, the light of a bright meteor was seen by nearly everybody then in the open air in the south-east part of that state. I will quote from a vivid description of the meteor given by Mr. Irish, a civil engineer of Iowa City, who has collected and published many facts about it: "The observers," he says, "who stood near to the line of the meteor's flight, were quite overcome with fear, as it seemed to come down upon them with a rapid increase of size and brilliancy, many of them wishing for a place of safety, but not having the time to seek one. In this fright the animals took a part, horses shying, rearing, and plunging to get away, and dogs retreating and barking with signs of fear. The meteor gave out several marked flashes in its course, one more noticeable than the rest. . . . Thin clouds of smoke and vapour followed in the track of the meteor. . . . From one and a half to two minutes after the dazzling, terrifying, and swiftly moving mass of light had extinguished itself in five sharp flashes, five quickly recurring reports were heard. The volume of sound was so great that the reverberations seemed to shake the earth to its foundations; buildings quaked and rattled, and the furniture that they contained jarred about as if shaken by an earthquake; in fact, many believed that an earthquake was in progress. Quickly succeeding, and blended with the explosions, came hollow bellowings and rattling sounds, mingled with clang, and clash, and roar, that rolled away southward, as if a tornado of fearful power was retreating upon the meteor's path."

From accounts collected from eye-witnesses by Prof. Leonard and Mr. Irish, I conclude that the meteor when first seen was not less than sixty miles high over Northern Missouri; that it descended at an angle of about 25° with the horizon, in a right line, and disappeared at a height of five or ten miles. Those in the east, as at Kiokuk, saw it low in the west. From St. Louis it was seen in the north-west. In the western part of Iowa it was seen to pass north across the eastern sky. To persons in the north it passed straight down on the southern sky, while to those under the path named it passed nearly overhead, rising in the south and south-west and descending in the north north-east. The path thus determined is at least 120 miles long, and was passed over in a few seconds, probably not over ten. The country near the explosion was prairie or alluvial, where stones on the surface are rarities, and about 800 lbs. of stones like this one, nearly 200 in number, have been picked up in a region seven miles by four, a little east of the end of the

[1] A lecture delivered in the Mechanics' Course at the Sheffield Scientific School of Yale College, U.S., by Prof. H. A. Newton.

meteor's path. These are all supposed to come from the meteor. Some were picked up on the surface of the frozen ground. One was found on the top of a snow-bank, and about forty feet away were marks of a place where it had first struck the ground. Some were ploughed up in the spring. The two largest found, of 74 lbs. and 48 lbs., fell by the roadside, and a law-suit to settle whether they were the property of the finder as being wild game, or of the owner of the lands adjacent as being real estate, was decided in favour of the owner of the land.

No one saw this stone come from that meteor. But in many cases peculiar stones very like to this one have been seen to fall from meteors, and this is one of a group of about twenty stones belonging to Yale College which were gathered at the places and directly after the time of the fall. They are in the Peabody Museum in a case by themselves, and are about one-tenth of all that has been found.

But though we have no eye-witnesses to speak of its fall and finding, the stone as we look at it tells its own story. This rounded side is not waterworn. From your seats you cannot see them, but over these rounded hills and down these valleys run streaks showing that melted matter has flowed over them. On two of the smaller sides is collected a real lava deposit, giving in smallest miniature the twisted gnarled forms that some of you have possibly seen in the large lava beds at the foot of the cone of Vesuvius. This other surface had just begun to be melted, as though the fracture that formed it had been made late in the meteor's flight. This larger face is only smoked, and we might even doubt whether the stone had not been broken here after its fall. But the rounded edges of the thin black crust at the angles of the stone show clearly that, except perhaps at some of the corners, the stone was in its present shape when it struck the ground.

Now what caused that brilliant light, that terrific explosion which was heard for forty miles around, that rain of stones? The only explanation which we can admit is that a stone weighing not less than 800 lbs.—how much more we know not—perhaps two, perhaps fifty times as much, came into the air from without.

What ought to happen upon the passage of such a stone through the air? At the height of thirty to eighty miles, the region where the meteor-tracks are most frequently seen, the air is very rare, rarer than in the so-called vacuum of an air-pump. Yet the rapid velocity of the stone condenses the air in front of it. If we admit the truth of the kinetic theory of gases we must regard the molecules of air as in rapid motion, each molecule driven this way or that, coming in contact with and bounding back from other molecules. The average velocity of these dancing molecules of air at usual temperatures is a fraction of a mile per second. They therefore bound back from any heavy body that moves only a few hundred feet per second, only slightly checking its velocity. But the air is here met by a stone moving, say, fifty times as fast as the average molecule. The molecules are driven together beyond the possibility of getting away, until the temperature of the air is raised enormously. Probably the air is liquefied by the pressure, and then pushed aside by main force till the meteor has passed, when it is driven back again into the vacuum behind, giving us a flame shaped like that of a candle.

What effect has all this on the stone? *It* is solid and firm, as you see, and can withstand not a little pressure. It is not, therefore, heated within; but on the outside it is in contact with, or rather rubbed hard against, an intensely hot stratum of air. It is therefore melted off just as a piece of tallow would be melted if drawn across a white hot iron. There is no time for the heat to pass by conduction deep into the stone. The melted matter is wiped off by the air. A part clings to these hinder faces of the stone, but the far greater portion helps to make up the meteor's train. It is scattered in eddying currents in a long, narrow, whitish cloud, at first straight, then twisted. That cloud broadens and floats away in contorted forms, remaining visible sometimes a second, sometimes an hour even. The pressure and the heat generally keep cracking the stone, just as any stone is cracked by pressure or when thrown into a hot fire. Parts may survive this treatment and reach the ground. Those who have picked them up as they fell have generally said they were hot, as they must be on the outside. But some have been found, it is said, that were very cold. This, too, we may well believe, for they should retain in their interior the intense cold of space.

This stone in my hand shows the breaking up, one fracture being very clearly more recent than another, and if you were near me you might even see fractures that were begun but not ended when the stone reached the ground.

We often *see* this breaking up. On the wall is a picture of the principal explosion of the Iowa meteor, as given by one who saw it, representing, it may be, the cracking when this fragment was broken off from the main mass. There is also one of a meteor seen in Greece in 1863 by Dr. Schmidt. He was standing on the roof of his house in Athens when he caught sight of a magnificent fireball, moving so slowly that he was able to turn his telescope upon it. The head had two main parts, which were chased by a motley troop of followers, each drawing a bright line on the sky, all of which, at a distance of three or four degrees, melted into a reddish cloud of light. Often a meteor is to the naked eye made up of a group of smaller ones, the whole being like a flock of birds.

I have traced back the history of this stone to its entrance into the air on February 12, 1875, when it was part of a mass not less than two feet, and I suspect not more than ten feet each way. It looked larger, but men saw the flame around the stone, not the stone itself. By itself, and strictly taken, this history has gaps; but taken along with the history of like stones and meteors that are numerous in the records of science, the story is easily filled out as I have given it above. No scientific man today would question it.

The next step in my argument, though admitted by most, is not admitted by all of those whose opinions in this matter are entitled to special respect. I am not aware, however, that anybody has given any formal reasoning against it. I claim that between this stone-producing meteor of Iowa and the faintest shooting-star which you can see on a clear night in a telescope there is no essential difference as to astronomical character. In all their characteristic phenomena there is a regular gradation in the meteors from one end of the line to the other. They differ in bigness, but in their astronomical relations we cannot divide them into groups. They are all similar members of the solar system.

To prove this we must of necessity rehearse the points in which the large and small meteors are alike and unlike.

First. They are all solid bodies. The Iowa meteor sent down these stones, and we know that they are solid. This other stone which I show you is one of about 4,000 which fell from a meteor in Poland in 1868, and this you can see is solid. In the Peabody Museum is a goodly collection of such stones from other meteors.

A year ago last December, early on the evening of the 21st, a meteor entered the air sixty miles or more in height over the north-west corner of the Indian Territory, or it may be still farther west. It crossed at a height of between sixty and thirty miles the states of Kansas, Missouri, Illinois, Indiana, and Ohio and passed on over Lake Erie and the state of New York. No sound was heard, so far as I know, in the state of Kansas; but in Missouri, and still more, in Illinois, the explosions were fearful, and multitudes of fragments were seen to fly off by every one who saw the meteor. In Indiana it was thought that the explosions were heard at Bloomington 150 miles from the nearest point of the path. In New York State the sky was wholly overcast, so that of course nothing was seen. But at many places the people thought there was an earthquake. Was this a solid body? As if to remove this from the class of detonating into that of stone-producing meteors, one single small fragment three-fourths of a pound in weight, was heard to fall and was picked up the next morning on the snow in Indiana. A piece of this is in the Peabody Museum.

In 1860 a meteor went north-west across Georgia and Tennessee and exploded, disappearing nearly over the southern boundary of Kentucky at a height of about twenty-eight miles. There was the same terrific explosion heard, the same scattering of fragments seen. The meteor was seen over all the region from Pittsburgh to New Orleans, and from Savannah to St. Louis. But from this meteor no stone was found, but you cannot doubt for all that that it was a solid body.

So, a few weeks ago a meteor fell in broad daylight in Southern Virginia, the sound of which, over a limited region, seemed like an earthquake. It, too, must have been solid.

In July, 1860, some of you, I presume, saw a meteor cross from the west to the east. It came from over Northern Michigan, and was seen until it had passed at least 200 miles east of us, passing between us and New York City at a height of a little more than forty miles. One pear-shaped ball chased a second and a third across the sky. People listened for the sound to come, and one or two thought that they heard it but would not affirm that it was sound from the meteor. I cannot doubt that that too was solid. It was seen to break in two, and the parts passed on one after the other for hundreds of miles. To be sure no stone was found from it, and perhaps no sound heard, yet that it was solid seems to me almost as sure as if I had a piece of it in my hands.

Again, going one step farther, how can we avoid calling all the meteors solid which are seen to break into pieces, and all those which glance, describing a curved course, or a course having an angle? The number of such cases is large, and often they are very faint shooting-stars. But it is doubtful whether a small gaseous mass could exist permanently as a separate body in the solar system. Its repulsion would keep the parts so far asunder that the sun's unequal attraction would scatter the substance beyond all its own power of recovery. A liquid would probably freeze and become solid. In any case neither a gas nor a liquid could for an instant sustain the resisting pressure which a meteor is subjected to in the air, much less could it travel against it ten, or forty, or a hundred miles. In short, every shooting-star *must be* a solid body.

Second. The large meteors and the small ones are seen at about the same height from the earth's surface. The larger meteors may become visible a little higher than shooting-stars, though that is doubtful; they come down in general a little lower, some of them even come to the ground, but that is due rather to the size of the body. The air is a shield to protect us from an otherwise intolerable bombarding. Some of the larger balls come through that shield, or, at least, are not all melted before their final explosion, when the fragments, their original velocity all gone, fall quietly to the ground. The small ones burn up altogether, or are scattered into dust.

In the *third* place, the velocities of the large and small meteors agree. These velocities are never very exactly measured directly; but we are sure that in general they are more than two and less than forty miles per second. This is true both for small and for large meteors. The average velocities for each class are not widely different.

We sometimes need a name for the small body that will, if it should come into the air, make a shooting-star or larger fireball. We call such a body a meteoroid. Now, velocities of from ten to forty miles a second imply that the meteoroids are bodies that move about the sun as centre, or else move through space. These velocities, as well as other facts, are utterly inconsistent with a permanent motion of the meteoroids about the earth, or with a terrestrial origin, or with a lunar origin.

Fourth. The motions of the large and small meteors, as we see them 'cross the sky, have no special relations to the ecliptic. If either the one or the other kind had special relations to the planets in their origin or in their motions we should have reason to expect them, if not always, at least in general, to move across the sky *away from* the ecliptic. But the fact is otherwise. We see both small and large meteors move *towards* the ecliptic as often as *from* it. Neither class seem, therefore, to have any relation to the planets.

Again, in general character the two classes are alike. They have like varieties of colour, they have similar luminous trains behind them; in short, we cannot draw any line dividing the stone-producing meteor from the shooting star, at least in their astronomical relations. We cannot say that the Iowa meteor is different from the Georgia meteor of 1860, on the ground that stones were found in one case and not in the other; or that the meteor of December, 1876, was different from that of July, 1860, on the ground that one had a series of terrific explosions and the other was only seen to break into parts; or that the meteor that is seen to break into parts differs from one evidently solid, that burns up without any appearance of explosion. They all are astronomically alike. They differ in bigness; but this has nothing to do with their motion about the sun or in space.

When, therefore, we learn something about the origin and motions of the smaller meteoroids, we can infer like facts about the larger ones. I propose, then, to show that shooting stars were once pieces of comets.

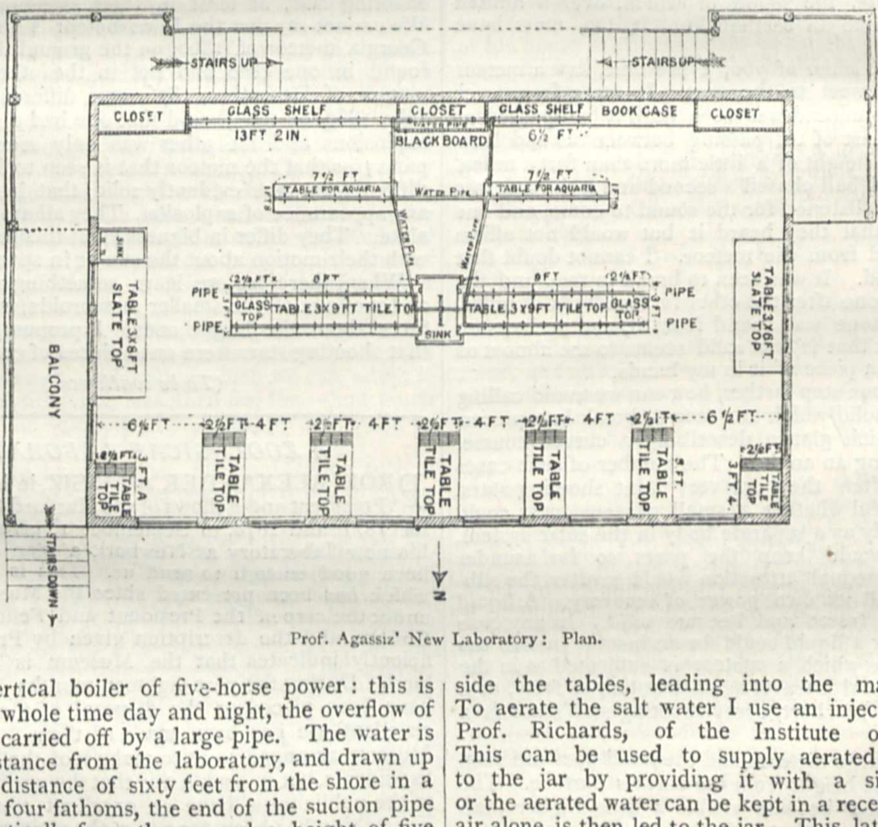
(*To be continued.*)

A ZOOLOGICAL LABORATORY

PROF. ALEXANDER AGASSIZ, in his Report to the President and Fellows of the Harvard College Museum for 1877 and 1878, to September 1, gives an account of his new laboratory at Newport, a plan of which he has been good enough to send us. This is the first report which has been presented since the Museum has come under the care of the President and Fellows of Harvard College, and the description given by Prof. Agassiz sufficiently indicates that the Museum is a model of its kind. During the past eighteen months increased funds have been placed at the disposal of the Museum, and excellent use has been made of them. Not only is the Museum arranged so as to make it of the greatest service to students, but in such a way that the portion thrown open to the public must have an excellent educational effect. Everything has been done to make visitors clearly understand what they see, and evidently this attention is appreciated and is answering its purpose.

The new laboratory, erected by Prof. Agassiz at his own cost, and which is a model of what such a place should be, is described by Prof. Agassiz as follows:—

The new laboratory erected by me at Newport is twenty-five feet by forty-five. The six windows for work are on the north side, and extend from the ceiling to within eighteen inches of the floor. In the spaces between the windows and the corners of the building are eight work-tables, three feet by five, covered with white tiles, one foot of the outer edge being covered, however, with black tiles for greater facility in detecting minute animals on a black background. Between the windows, movable brackets with glass shelves are placed; while similar brackets extend across the windows and between the tables, thus providing a shelf at any desired height. The tables for microscope work are three-legged stands of varying height, adapted to the different kinds of microscopes in use. The whole of the northern side of the floor upon which the work-tables and microscope stands are placed is supported upon brick piers and arches independent of the main brick walls of the building, which form at the same time the basement of the building. The rest of the floor is supported entirely upon the inside walls and upon columns with stretchers extending under the crown of the arches reaching to the northern wall. This gives to the microscopic work the great advantage of complete isolation from all disturbance caused by walking over the floor. This will be duly appreciated by those who have worked in a building with a wooden floor, where every step caused a cessation of work, and was sure to disturb any object just at the most interesting moment. The floor is cemented and covered by a heavy oil-cloth. The centre of the large room is occupied by a sink, on each side of which extend two long tables, three feet by twelve. These are covered with different coloured tiles, imitating mud, sand, gravel, sea-weed, black and white tiles, as well as red, yellow, blue, green, violet, to get all possible variety of background. A space at each end is covered by a glass plate, allowing the light to come from underneath, thus enabling the observer to examine larger specimens from the under-side, without disturbing them when fully expanded. Two shorter and narrower tables, eighteen inches by seven feet, are placed halfway between these central tables and the southern face of the building. These tables are intended for larger aquaria or dishes, and are covered with common marble slabs. There is a blank wall on the south side, the whole of which is occupied by closets and shelves for storing glass jars, reagents, bottles, dishes, and so forth. A space is devoted to books. The open shelves for jars and dishes are of heavy rolled glass, supported upon iron brackets. The basement is used for the storage of alcoholic specimens, dredges, trawls, and other similar appliances. In the attic there is a large tank for salt water and another for fresh: the rest of the attic space will be eventually devoted to photographic rooms and room for an artist. The laboratory is supplied with salt water by a small steam-pump



Prof. Agassiz' New Laboratory: Plan.

driven by a vertical boiler of five-horse power: this is kept going the whole time day and night, the overflow of the tank being carried off by a large pipe. The water is taken some distance from the laboratory, and drawn up at a horizontal distance of sixty feet from the shore in a depth of some four fathoms, the end of the suction pipe standing up vertically from the ground a height of five feet, and terminating in an elbow to prevent its becoming choked. The water is led through iron pipes coated inside with enamel. From the tank the salt water is distributed in pipes extending in a double row over the central tables, over the long narrow tables for aquaria, and along the whole length of the glass shelves on the south wall. Large faucets to draw off salt water are placed at each sink, and by a proper arrangement of valves it is possible to lead fresh water to a part of the pipes, in case it is needed. The pipes leading over the tables and shelves are provided with globe valves and nozzles, to which rubber pipe can be attached and the water led to a vessel below: there are fifty such taps, each of which can supply water or air to at least three or four jars. The overflow runs into gutters laid alongside the tables, leading into the main drain-pipe. To aerate the salt water I use an injector invented by Prof. Richards, of the Institute of Technology. This can be used to supply aerated water directly to the jar by providing it with a siphon overflow, or the aerated water can be kept in a receiver, from which air alone is then led to the jar. This latter course is the only practical one for delicate specimens and for the bulk of the work of raising embryos. The east and west sides have large windows and doors provided with blinds; they always remain open with the blinds closed to keep out sunlight, and serve to ventilate the laboratory thoroughly. Large tables for dissection, covered with slate and adjoining a sink provided with fresh and salt water, are placed across the windows of these sides. Ever since the closing of the school at Penikese it has been my hope to replace, at least in a somewhat different direction, the work which might have been carried on there. It was impossible for me to establish a school on so large a scale, but I hope by giving facilities each year to a few advanced students from the Museum and teachers in our public schools, to prepare, little by little, a small number of teachers who will have had opportunities for pursuing their studies hitherto unattainable. The material to be obtained at Newport is abundant. The dredging is fair and not difficult, as the depth in the immediate neighbourhood does not exceed twenty to thirty fathoms. The pelagic fauna, however, is the most abundant. During the course of each summer, by the use of the dip-net, representatives of all the more interesting marine forms are sure to be found. With my small steam launch a large space can always be traversed any evening and advantage taken of the condition of the wind and tide, the launch being amply large for easy dredging in the moderate depths of the entrance of Narragansett Bay. The laboratory is placed on a point at the entrance of Newport Harbour, past which sweeps the body of water brought by each tide into Narragansett Bay and carrying with it everything which the prevailing south-westerly winds drive before it. Newport Island and the neighbouring shores form the only rocky district in the long stretch of sandy beaches extending southward from Cape Cod—an oasis, as it were, for the abundant development of marine life along its shores.

BIOLOGICAL NOTES

CASPIAN SEA ALGÆ.—Herr A. Grunow has quite recently published a detailed catalogue of a collection of algæ, made by himself at Baku and Krasnowodsk, on the Caspian, and also of some collections made by his friend Czermak in Baku Bay and by Thieme in Krasnowodsk Gulf, in addition some specimens preserved in spirits were given him by Dr. Schneider. Excluding the diatoms only eleven species are alluded to, and but two (Cladophora) appear as new. Of the diatoms there is a goodly list. Many of the species of these diatoms appear to occur everywhere. Go where one will, they are to be found, and what a marvellous geographical distribution!—Baku on the Caspian, St. Paul's Island in the Southern Ocean, and then the Frith of Clyde, or the mouth of the Thames. Two beautiful plates representing the new species of diatoms accompany the paper. Many of the species are marine forms.

NATURAL HISTORY OF THE CAUCASUS.—A very important contribution to the natural history of this région has been made by Dr. Oscar Schneider based on collections made by himself during a summer spent there in 1875. The series of memoirs before us, edited by Dr. O. Schneider, has been reprinted from the *Journal* of the "Isis" Society of Dresden, and consists of an account of the mollusca, by the editor; the arachnoids, by Dr. L. Koch, many new species are figured; the hemiptera, by Dr. G. v. Horvath; the algæ, by Dr. A. Grunow, a memoir we have already noticed; the minerals, by Dr. A. Frenzel; the rocks, by Dr. Moehl; the fossils, by Dr. Geinitz. These reprints form a small volume of 160 pages with five plates.

ON SPROUTING IN ISOETES.—K. Goebel records in some detail and with illustrative figures the fact that he has found buds developed from the base of the leaves below the lingule in *Isoetes lacustris*. The specimens were collected in Longemer Lake in the Vosges, and the discovery was made during an investigation into the embryology of both *I. lacustris* and *I. echinospora*. The examples in question showed neither macro- nor microsporangia, but in their place were found on the leaves little Isoetes plants. The first appearance of the buds was under the lingule in the furrow of the still young leaves. A pretty compact swelling made its appearance on the under half of the glossopodium. This swelling was the commencement of a conical protrusion of the cellular tissue, in which a side cell did not take any leading part; later on this swelling appeared to be more rounded off; the stages between this and that in which one to two leaves were found, was not specially observed. A section through the young bud shows that the median plane of the young leaves is precisely that of the mother leaves, and they lie so tightly packed together that the lingule of the first new leaf is parallel with the surface of the mother leaf. The root formation of these buds appears to be quite normal. Some of the leaves only gave rise to these buds. The author thinks this is an instance of De Bary's apogamy. Interesting and novel as these observations of Goebel are, they yet leave a good deal to be desired (*Bot. Zeitung*, i., 1879).

THE BRITTLE STARS OF THE *Challenger*.—In order that persons who are interested in echinoderms may get early information, and to secure a just priority of discovery to the *Challenger* expedition, Mr. Th. Lyman has just published, as No. 7, vol. v. of the *Bulletin* of the Museum of Comparative Zoology at Harvard College, Cambridge, Mass., a Part I. of a catalogue of the new species found, which contains brief diagnoses, with figures, of the more essential parts of no less than thirteen new genera, and ninety-six new species of Ophiuroids. Part II. will contain some remaining species of the family Ophiuridæ, and those of Astrophytidæ. All matter beyond the mere necessary description is reserved for the volume to be devoted to this group, and which is to be brought out by the British government under the general superintendence of Prof. Sir Wyville Thomson.

SPINES OF ECHINI.—The last published part of the *Transactions* of the Royal Irish Academy (vol. xxvi., Science, part 17) contains a memoir by H. W. Mackintosh on the structure of the spines in the sub-order of the Desmosticha (Hæckel). In indicating four series into which, judging from the structure of the spines, this sub-order may be divided, the author expresses his opinion that the characters derived from the spines are just as useful as any other characters drawn from the comparison of individual parts. He finds it just as easy and as certain to recognise a Diadema, an Echinus, or an Arbacia by the structure of its spines as by the arrangement of its pores, or the disposition of its anal or genital plates. The memoir is accompanied by three plates containing twenty-seven figures, all drawn by the author with the assistance of a Wollaston's camera lucida. The figures represent transverse sections of primary inter-ambulacral spines of some twenty-six species, and have been drawn on stone by Tuffen West with great care and accuracy.

THE FOOD OF FISHES.—Mr. S. A. Forbes publishes a very interesting paper on the food of fishes in the *Bulletin*, No. 2, of the Illinois State Laboratory. The importance of the subject to the scientific student and to the practical fish-breeder cannot be doubted. Some valuable fishes are found dependent on food too liable to injury or destruction by man or nature to make it worth while to cultivate them, while others, equally valuable, may subsist on food absolutely indestructible. The contents of the stomachs of some fifty-four species of Illinois fish were carefully examined, and the details of the food found are in each case given. In some instances the enormous quantity of food devoured, especially in insect-feeders, is noteworthy, and much of the food consisted of land-insects which had fallen into the water, thus bringing fish and land birds into competition for food. Some of the species were herbivorous, others carnivorous, and several, such as the cat-fishes, were quite omnivorous; the dog-fish (*Amia calva*) was herbivorous, but only one small specimen was examined. The shovel-fish (*Polyodon folium*), supposed by the fishermen to live on the slime and mud of the river-bottom, was found to feed to an enormous extent on Entomostraca, and fully one-fourth of the entire food was made up of vegetable matter, algæ being largely eaten, and there was very little mud found mixed with the food. The interlacing of the gill-rakers of this species, which are very numerous and fine, and arranged in a double row on each gill arch, doubtless form a strainer which allows the passage of the fine silt of the river out with the water, but arrests everything as large as a cyclops.

THE ELECTRICITY OF THE TORPEDO[1]

II.

4. *CURRENTS induced by a torpedo discharge are all produced at the beginning of each wave. There are currents induced on the completion of a circuit,* i.e., *the inverse of the inducting currents, as is shown by the electrometer.*

Fig. 7 will show the arrangement of the experiment to prove that the torpedo's discharge in the inductive coil

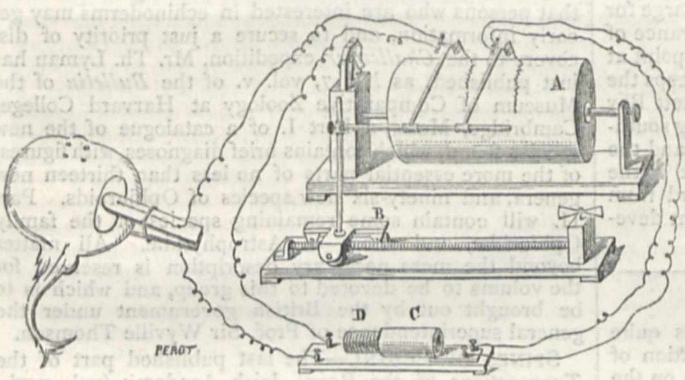


FIG. 7.

(D) produces, in the secondary coil (C) currents of sufficient energy to cause movement in the second signal placed in the circuit of the inducted coil. It must be remarked, however, that the electric apparatus which furnishes the indications of the passage of the discharge is not, as shown in the diagram, that which produces the inducted currents. Currents of sufficient intensity would not have been obtained to act upon the electro-magnetic signal, if we had opposed to the passage of the discharge a resistance so considerable as that of the coils of the electro-magnet. The difficulty has been averted by using the opposing apparatus for signalling; and this we are authorised in doing, since the discharges are absolutely symmetrical to the right and left when the nervous centres are excited by the magnet.

That exception made, let us examine the results of the experiment. The traces were placed one over another; one (as 1 in Fig. 8) indicating the successive waves of the discharge, and the other (as 2 in Fig. 8) the currents inducted by the waves. This figure already shows an important fact: that the number of inducted currents is equal to that of the inducting waves; and that each inducted current is produced at the commencement of each wave, just as in a galvanic current an inducted current is produced at each completion. But here we only find currents inducted by the completion or, more exactly, at the commencement of the waves; none are produced during the decreasing phase of each wave, or at least if they are produced they do not act upon the electro-magnetic signal.

From the preceding it should be inferred that the currents, inducted by the torpedo-waves and produced at the commencement of these waves, must in that be analogous to the inducted currents resulting from the completion of a galvanic circuit.

No instrument could be better than Lippmann's electrometer for giving us information as to the direction of the currents inducted by the torpedo waves. Its instantaneous action enables it to indicate, by a sudden displacement in a determinate direction, the direction of each inducted current.

If a weak current derived from the main discharge is passed through the electrometer, we see the column after moving to one side of the reticule always oscillate to the same side, thus showing that the successive waves are

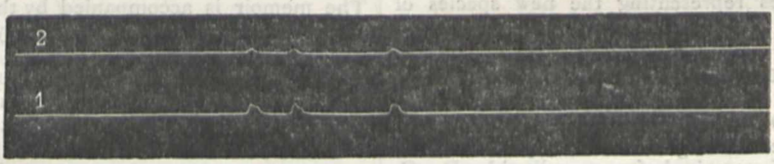


FIG. 8.

joined one to another, so that there is never an absolute break in the current. In Fig. 9 the arrows show the oscillation of the column towards the right side.

If the induced currents are directed through an electrometer by the discharge which causes the column of the instrument to deviate to the right, the direction of oscillation is immediately reversed (Fig. 10).

The comparison of those two diagrams showing that the inducted current has a contrary effect to that of the inducting current, brings together the inducted currents of the torpedo and those obtained by completing a galvanic circuit. To be more exact, since the circuit which comprises the torpedo remains always complete, we shall say that the inducted currents are produced at the beginning of each electric wave of the animal. Thus the torpedo calls forth in each of its electric waves an initial inducted current and does not give a terminal inducted current. This conclusion goes to support what we learned from the wave-writing of the electro-dynamograph, viz., that the initial phase of each wave has a suddenly increasing intensity, whereas the terminal phase presents a gradual decrease.

5. *The discharge of the torpedo is analogous to muscular tetanus; every electric wave in the discharge corresponds to a muscular shock.*

In what precedes we have endeavoured to give an idea of the torpedo discharge from the nature of the successive acts which constitute it, insisting only upon points relating to experimental science and to the direct results of M. Marey's investigations.

We are now enabled to meet the question on higher

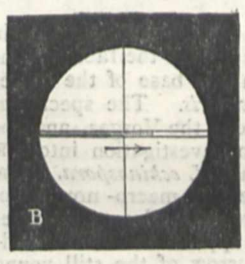


FIG. 9.

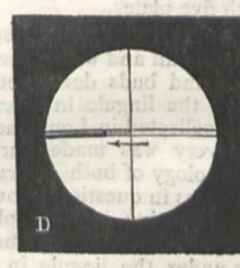


FIG. 10.

ground and consider the electric function from a philosophical point of view, by classing it with the muscular function.

Let us first compare the elementary action of electric discharge to the elementary action of muscular contraction, *i.e.*, the electric wave to the muscular shock.

[1] Continued from p. 297.

The simple excitation of the remote end of an electric nerve produces a single wave, as the simple excitation of a motor nerve produces a single shock. In both cases, at the moment of the nerve-excitation produced in the neighbourhood of the electric apparatus or of the muscular apparatus, the amount of delay is sensibly the same, about seven-hundredths of a second. The electric wave, like the muscular shock, has a phase of increase and a phase of decrease; the former, as we have seen, is abrupt or sudden from one part to another; the decreasing phase is much more gentle. The same agents modify the wave and shock in the same manner; heat renders both these actions more speedy and more energetic up to a certain point at which both electric reaction and muscular reaction disappear; cold acts equally upon movement and electric action, rendering both more slow, more feeble, more extended, and at last extinguishes them when the temperature is lowered to about zero C.

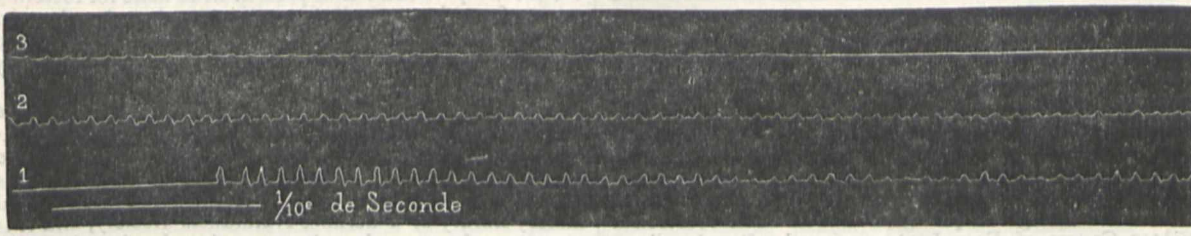


FIG. 11.

In the complex muscular act which is called contraction, as in the electric act which constitutes the discharge, the elementary phenomena which we have just been comparing, the waves and the shocks are added on one to another in the same manner; they succeed each other with a rapidity so great that each has not time to complete all the phases before its successor is produced. The floor and the shock are interrupted during their decreasing period by a new wave or shock coming to join on its effect to what remained of the preceding act. But, as there are imperfect muscular contractions, cases of tetanus where the shocks are not completely fused together, not being rapid enough in their succession, so in the same way certain electric discharges present a remarkable discontinuity, such that the elements of the perfect act are seen arranging themselves, the waves following each other with less rapidity, the shocks separated from each other by a larger interval of time.

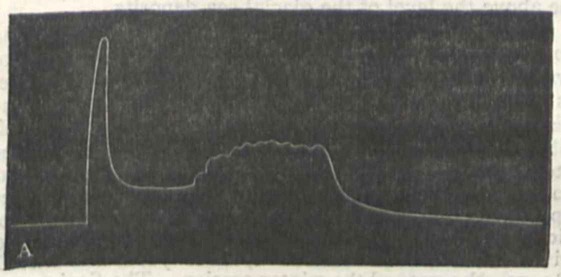


FIG. 12.

Let us now compare the effects of fatigue upon muscular contraction and upon the discharge, as we have compared them upon the muscular shock and upon the electric wave; we shall see the two acts modified in the same direction. It is even possible to see the torpedo-wave and discharge gradually becoming extinguished, just as muscular shocks disappear under the influence of exhaustion. This gradual extinction of the electric waves is very evident in Fig. 11, obtained by means of the electro-dynamograph.

Poisons which act directly or indirectly upon the muscular function modify in the same manner the electric function. Thus strychnine, for example, which in a very special manner exaggerates the excito-motor power and that which might be termed the excito-electric power of nervous centres; a complex reaction, a muscular tetanus on one side and a real electric tetanus on the other, is produced in reply to a simple excitation, the mere touch of the skin, or a slight noise.

Fig. 12 shows a type of muscular strychnine contraction in the frog. Here we observe a diminution of intensity produced in the middle of the muscular tetanus between two maxima, one at the beginning and the other at the close.

In agreement with this characteristic phenomenon, the cause of which is unknown, we observe in torpedo poisoning by strychnine a weakening or interruption towards the middle of the discharge. Fig. 13 shows on line A a type of this species of interruption which must be compared with that which we have just seen on the tracing of muscular tetanus.

We might still further extend the comparison of those two functions, the electric and the muscular, by studying the action of other fishes, such as the *Gymnotus*, the electric ray, &c.; and by showing that the results are identical when heat and cold act upon muscular contraction and upon the discharge of the torpedo. The preceding paragraphs are sufficient to justify the functional assimilation which, let us hasten to say, is in accordance with the anatomical assimilation.

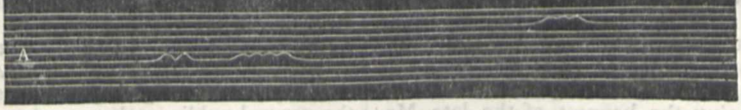


FIG. 13.

We shall only add that these identifications are of higher interest than curiosity; the more our knowledge of muscular phenomena and electric phenomena becomes perfected, the more enlightened is our knowledge of the motor nerves. Does the fact that a voluntary discharge of the torpedo is a complex act not prove that the voluntary contraction of the muscles is also a complex act? Very certainly, the comparison of the voluntary contraction of the muscles with the tetanic phenomena produced by electricity or by strychnine, the existence of a muscular sound during the contraction, the quivering or dissociation of the shocks which are produced under the influence of cold, all these seem arguments in favour of the theory which considers muscular contraction as the result of very frequent shocks; but the complexity of the voluntary discharge of the torpedo, the manner in which the waves composing it succeed each other and are added together, forms a very important confirmation of the numerous presumptions already made.

FRANCOIS FRANCK

SCIENCE IN LANCASHIRE AND CHESHIRE

AT Liverpool the annual associated *soirée* of the Literary, Scientific, and Art Societies, eighteen in number, of which twelve are scientific, held at St. George's Hall on the 31st, was a marked success, and will tend much not only to foster scientific tastes in this district, but inculcate an element of scientific co-operation, in the various institutions of the town, that will be of the highest practical value. The fourteenth Winter Course of Free Lectures for the People, given at the Free Library and Museum, by order of the Corporation, commenced on the 6th of last month. Amongst the forty-one lectures announced, thirteen are on scientific subjects, given by the Rev. W. H. Dallinger, Mr. Moore (Curator), Mr. De Rance, Rev. H. H. Higgins, and others. The Liverpool Geological Society is also doing good work; a valuable paper on the carboniferous limestone of Denbighshire was lately read by Mr. Morton, and a short but important mineralogical paper was given by the President, Mr. Semmons. Geological knowledge has been increased by a boring at Bootle, sunk to determine the water-bearing properties of the new red sandstone at great depths, by Messrs. Mather and Platt, for the Liverpool Corporation, who were urged to this course by Alderman Bennett. The boring has reached a depth of 1,300 feet, is 25 inches in diameter, is filled with water up to a height of 50 feet from the surface, and, according to Messrs. De Rance and Morton, has proved the pebble beds of the Bunter to reach the extraordinary thickness of 1,200 feet, and the existence of the lower mottled sandstone beneath. The pumps not yet being fixed, it is impossible to judge how far the well will add to the supply of 6,000,000 gallons a day at present pumped from the corporation wells.

At Wigan, in addition to the ordinary course of lectures given at the Mining and Mechanical School, a special course has been arranged for candidates for colliery managers' certificates, and gives to the teaching of the school a special technical direction. The extension scheme for turning the very numerously attended evening classes of this school into a Mining Collegiate Centre for Lancashire, has necessarily languished under the unexampled and continued depression in the coal trade, though from the number and extent of the promised subscriptions and donations to the building-fund, there can be little doubt that, when better times again visit this country, this school will develop into an important centre of technical education. The town has lately had the good fortune to have presented to it a magnificent library, stored in a handsome building erected for the purpose, the former being the bequest of the late Mr. Winnard, the latter the gift of Mr. Thomas Taylor. The reference library is well stored with standard scientific works in all branches, and the selection reflects great credit on the industry and acumen of Mr. Gerrard Finch, barrister-at-law, who selected them, under the terms of the will. Some important works are of course conspicuous by their absence, but doubtless this will soon be remedied. The reference portion of this library will henceforth be opened on a Sunday to readers who have asked for special tickets, the extra cost of assistants being defrayed for three years by Mr. Taylor, the donor of the building. This town has also now a flourishing Literary and Scientific Society, with Lord Lindsay as president; it is divided into botanical, microscopical, and other sections, at which papers are read by the members, and discussed, and, in addition, special lectures are given to the united sections; amongst those delivered have been "Spectrum Analysis," by Lord Lindsay, and "Local Geology," by Mr. de Rance: others are announced by Prof. McKenny Hughes and Prof. Rudler.

At Southport there is at present little done for fostering a taste for either technical or scientific education, but the very fine aquarium is maintained in great efficiency, the contents of the table tanks, to which we have previously referred, being especially beautiful.

At Preston, meetings of the Scientific Society have been numerously attended, and the president, Dr. Arminson, and others, do good microscopical work. The meetings are held at the Avenham Institution, which is well filled with scientific works, including the natural history library of a defunct Naturalists' Society, and it is a matter of regret that the town, in adopting the Free Libraries Act, should not have carried out an amalgamation scheme, instead of running a new and inefficient library in opposition to the existing useful and self-supporting institution. The Gilchrist Trust lecturers here and at Burnley have been listened to with much interest by large audiences; and at the latter place Prof. Boyd Dawkins has inoculated his hearers with his taste for cave-hunting investigations, and searches have been organised into the wild hills which fringe the county boundary of Lancashire and Yorkshire, and form the backbone of England, a district which for the most part appears to be above the level of the glacial sea deposits.

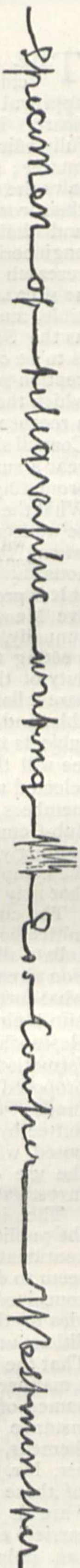
At Chester the flourishing Natural Science Society that looks back with pride to Kingsley, its founder, and forward with hope to its president, Prof. McKenny Hughes, is divided into several sections like a small British Association. The most noticeable paper read was one by Mr. Shrubsole, on the Fenestellæ of the carboniferous limestone, which was an important and valuable contribution to our knowledge of this group, proving from perfect specimens that several supposed species are, in fact, portions of the same organism. General lectures have been given to the united sections by Prof. Judd and Mr. De Rance, who opened the winter session. The Society possesses a very good local museum, but unfortunately it is exhibited in the disused ball-room of an ancient hotel in an out-of-the-way part of the city, and is known to few of the scientific visitors of Chester, and is but seldom visited by the inhabitants. The collection would, however, form an admirable nucleus of a museum for teaching purposes, should the Corporation ever recognise the need of technical education in this town, and erect a building to hold a library, museum, and science and art schools by the side of their fine town hall. Towards filling museums of this class, great advantage would accrue if the duplicate specimens at the British and Jermyn Street Museums were either given, or allowed to circulate, in the same manner as the art treasures from South Kensington Museum. For valuable as are *local* collections for the scientific *specialists*, no one can doubt the importance of giving wide and varied knowledge to the general public, such as, perhaps, can only be imparted by the inspection of typical specimens of the natural and artificial products of all countries. Such a collection may be seen on a small scale in the admirable little museum at Castleton, in Derbyshire, formed by Mr. Rooke Pennington, which at once furnishes the visitor with all that can be collected for forming a mental local picture of the past, and affords the inhabitants of the district an opportunity of knowing something of the world around them.

At Manchester the museum at Owens College now includes the entire collections of the Manchester Natural

History Society and Manchester Geological Society, as well as a small typical collection originally belonging to the College and the complete mineralogical and metallurgical collections of the late David Forbes; the series are admirably arranged for the purposes of study. Prof. Boyd Dawkins is curator.

A REAL TELEGRAPH

A NEW invention of a real practical character, not a mere "paulo post futurum" invention like many we have heard of lately, has just been made by Mr. E. A. Cowper, the well-known mechanical engineer. It is a real telegraphic writing machine. The writer in London moves his pen, and simultaneously at Brighton another pen is moved, as though by a phantom hand, in precisely similar curves and motions. The writer writes in London, the ink marks in Brighton. We have seen this instrument at work, and its marvels are quite as startling as those of the telephone. The pen at the receiving end has all the appearance of being guided by a spirit hand. The apparatus is shortly to be made public before the Society of Telegraph Engineers. We give a facsimile of the writing produced by this telegraphic writing machine.



GEOGRAPHICAL NOTES

THE Spanish Ministry of Public Instruction has just issued a very important publication, being a collection of letters of Christopher Columbus, and of his contemporaries, as well as of reports sent in, during the sixteenth century by governors of the new American provinces, the originals of these letters and reports being now in the State Archives of Spain. The work, which bears the title "Cartas de India" (Letters from India), and forms a large volume of 877 folio pages, contains the following highly interesting documents: (1) Two autograph letters from Columbus, written in 1502 to King Ferdinand and Queen Isabella, the first letter dwelling upon the necessity of measures for increasing the population of the island "Española" (San Domingo), and the second being a discussion on the art of navigation; (2) a letter from Amerigo Vespuchi to the Cardinal Gimenes di Cuneros, Archbishop of Toledo, dated Sevilla, 1508, and dealing with the merchandise to be sent to the Antilles; (3) two letters from Fra Bartholomeo de las Casas, Archbishop of Nicaragua, to the Infanta Don Filippo, dated Gracias a Dios, in Guatemala; (4) two letters from Bernaldo Diaz del Castillo, one of the warriors of the small army of Cortes, and author of a history of Mexico, to Charles the Fifth (1552), and to Philip the Second (1558); (5) letters from the baccalaureates Don Pedro de Gasca and Don Christophor Vaca de Castro, dated Quito, 1541 and Cusco (1542), announcing to Charles the Fifth the death of the Marchese Don Pizaro and the insurrection of Don Diego de Almagro; both letters are very interesting, being accounts of eye-witnesses; (6) a very interesting letter of Donna Isabella Quivara to the Regent, Donna Huana, about the remarkable courage displayed by women during the expedition of Cortes, when all male members of the expedition were exhausted by disease. The work contains 652 pages of text and 225 pages of appendix, in which we find twenty-nine autograph letters and reports of various important historical persons; twenty-one sheets of autographs of Columbus, Vespuchi, Las Casas, Diaz del Castillo, Gimenez, &c.; a map of the fortifications where the gems of the Incas were found; and maps of Australia, of the River Amazon, the Antilles Archipelago, and Magellan Strait, drawn in the sixteenth century. We are sure that all friends of historical geography will feel grateful to the Spanish Government for this valuable publication.

COL. PRJVALSKY has left St. Petersburg to make another trip in Central Asia. He will proceed by Orenburg, Omsk, and Semipalatinsk to the Chinese frontier, thence to Hami, Hansu and Lassa. From Lassa he intends to reach the Himalaya by the Brahmapootra. Returning then to Lassa, he will visit Khotan, Kashgar, and cross the intervening plateaux to Russian Khokand. The journey is to occupy two years.

PÈRE HORNER has addressed a letter, dated Zanzibar, December 12, to *Les Missions Catholiques*, announcing that the members of the German scientific expedition have returned in bad health. This expedition, under the command of Herr C. Denhardt, started from Melinda, and explored the course of the River Dana, which has hitherto been supposed to take its rise in the slopes of Mount Kenia. They experienced many difficulties, and did not succeed in getting more than about sixty miles into the interior. According to Père Horner's report, in the place of Mount Kenia, covered with snow, they found only plains, and though they questioned more than 200 persons on the subject, they could find no one who had heard of the mountain. Père Horner thinks that the German travellers have not been far enough into the interior, and he says that they are going back again shortly to solve the problem. The truth, however, we believe is that Herr Denhardt has found that the Dana has a widely different course from that generally assigned to it, and that it does not flow anywhere near Mount Kenia. The party obtained a very complete series of meteorological observations, and they report that at some distance from the coast they met with a quiet and industrious tribe called the Vakopomo, who, it is thought, would welcome missionaries among them, if the fanatic Somalis of the coast region would allow them to pass.

IN the February number of the Geographical Society's new periodical we find a curious and learned paper by Sir Henry Rawlinson, entitled "Rough Notes on Prehistoric Cyprus, and another on the "Upper Basin of the Kabul River," from Mr. Markham's versatile pen, accompanied by a carefully drawn map of the Hindu Kush. Some of the geographical notes are of considerable interest. A St. Petersburg correspondent reports finding Prjvalsky restored to his habitual vigorous state of health and busy preparing for his next expedition, in which he hopes to reach Lhassa by the Hami and Sha-chau road, accompanied by young Eklon. Prjvalsky's Lob-Nor plant-collection turns out to be not very rich, the number of species being exceedingly few. Under the heading "Explorations North of India," we have the leading features of an unpublished report by Capt. Woodthorpe, R.E., and Lieut. Harman, of their recent work in the unexplored Miri and Mishmi Hills. In the latter region Capt. Woodthorpe obtained a fairly accurate knowledge of the sources of the Dihong River and the course of its main stream in the hills. The result of these explorations proves that the volume of the Subansiri is only one-fourth of that of the Dihong, which tends more than ever to identify the latter with the great river of Thibet. Some particulars are also furnished respecting the Dar-es-Salaam road in East Africa.

AT the last meeting of the Berlin Geographical Society several interesting communications were read. Gerhard Rohlfs had left Tripolis about Christmas, and proceeded southwards for twelve days' journey, there awaiting the presents intended for the Sultan of Wadai, sent by the German Emperor. The Society has also received news from Count Szechenyi, who has undertaken the task of investigating the Lo-floa. He arrived at Pekin in October last, and succeeded in obtaining passes for his journey to Thibet, a favour which has never before been bestowed upon any European by the Celestials.

HERR J. M. HILDEBRANDT is about to start on a scientific tour through Madagascar, at the request of the Berlin Academy of Sciences. He will direct his principal attentions to the botany, zoology, and topography of the island. A report has reached Bremen through the French Secretary for the Navy, that the young Bremen traveller, Dr. Rutenberg, who is also investigating Madagascar, has been murdered there. Direct news from Nossi-Bé, however, states that Dr. Rutenberg stayed there till November 29 last. He was then about to start on a tour through the interior in a southerly direction, and hoped eventually to reach Fort Dauphin, near the southern extremity of the island.

THE Paris Geographical Society intend holding a meeting in commemoration of Capt. Cook on the 14th inst., that being the hundredth anniversary of his death. M. W. Hüber, Dr. E. H. T. Hamy, and M. Crosnier de Varigny have agreed to address the meeting respectively on Capt. Cook's life, the ethnographical results of his voyages, and the present state of the countries discovered by him. Mr. J. Jackson has taken charge of the bibliographical researches, and Mr. W. Blakeney, R.N., secretary to the hydrographer, has been requested to lend the assistance of his knowledge concerning the great voyager. The Royal Geographical Society have been invited to be represented at the meeting. It seems strange that it should be left to a foreign society to commemorate the death of England's greatest scientific voyager.

A PHENOMENON causing much anxiety amongst the inhabitants of the shores of the Amazon is the continued rapid decrease of that generally colossal river. It appears that navigation above Manaos has become an impossibility. The cause of the continued decrease of the quantity of water is entirely unknown at present, and it is most desirable that men of science should thoroughly investigate the matter.

THE "Berlin Central Union for Commercial Geography and for the Furthering of German Interests Abroad" has just issued its first publication under the title "Geographische Nachrichten für Welthandel and Volkswirthschaft;" the editor is Dr. O. Kersten, and the publishers Herren Puttkammer and Mühlbrecht of Berlin.

A SINGAPORE paper states that the suitability of the soil of Perak for planting enterprise is exciting more and more attention. Five or six more planters from Ceylon are now there engaged in examining the soil. A similar remark applies to Johore, where the Maharajah has invited an ex-planter in Ceylon to become a sort of Minister of Lands; he is expected to arrive early this year, accompanied by several planters, who intend to explore Johore.

THE position of the missionary settlement at Blantyre which lies to the east of the Murchison Falls on the Shiré, East Africa, has never hitherto been known within several miles. It will, therefore, be interesting to record that as the result of a series of observations taken some five months since, Mr. Louis Carr has determined it to be in S. lat. 15° 45′ 25″, and E. long. 35° 14′ 11″.

ENGINEERING RESEARCH

THE Institution of Mechanical Engineers have decided to take a step which must meet with the approval of all who have the progress of engineering at heart. Like all other arts, that of the engineer, to be fully efficient, must be based on the laws which govern matter; and it is evident that the better we know these laws the more efficiently will our engineers be able to do their work. The only method of discovering these laws and their action under all the conditions with which engineering has to deal, is by systematic and thorough research; and since in this country our Government are so slow to see its true interests, the work, as far as possible, must be undertaken by individuals and bodies such as the Society of Mechanical Engineers. That Society is to be congratulated on its enterprise and the clear perception possessed by its members of the foundation on which their all-important art should be established. At a recent meeting of the Society it was resolved that the Council should be empowered to expend during the present year a sum of not more than 300*l*. "for the purpose of promoting practical research in mechanical subjects." What the nature and aims of this research are likely to be we learn from a circular which has been distributed among the members for the purpose of eliciting suggestions.

It is proposed that a Research Committee, consisting of five Members of Council, be appointed by the Council annually, and that a sum be voted at each annual general meeting to be expended by the Committee. The first duty of this Committee, when appointed, will be to prepare a list of subjects on which further research is desirable, and present it to the Council, recommending certain subjects to be first investigated. The Research Committee will then appoint a Sub-Committee for each of the selected subjects, and invite gentlemen (not necessarily members of the Institution), to give assistance to such Sub-Committees. This proposed condition we think exceedingly praiseworthy and liberal, and augurs well for the comprehensiveness and thoroughness of any research that may be undertaken.

The circular referred to proposes that each Sub-Committee be instructed that its first duty is to collect and collate all the records of experiments and other information already existing on the subject; then to determine what further experiments, if any, are needed, and ascertain their probable cost; and to present a report to the Research Committee, embodying a summary of the information so obtained, a description of the experiments proposed to be made, and an application for the requisite funds. Upon the approval of any report of a Sub-Committee by the Research Committee, the latter, it is proposed, will apply to the Council for a suitable sum for the use of the Sub-Committee in carrying out their investigations.

Then it is proposed that ample provision be made for the publication of the results of any research, and for the continuation of investigations as far as circumstances seem to demand. The whole scheme seems to us to be conceived in a thoroughly liberal spirit, and with a true idea of the value of scientific research, and of the conditions under which it can be carried out with efficiency. That the scheme is likely to be carried out in as intelligent a manner as it has been devised will be evident from the names of those who have been appointed in the first instance as a Research Committee. These are: Dr. Siemens, Mr. Wm. Anderson of Erith, Mr. E. A. Cowper, Mr. A. Paget, and Mr. F. W. Webb. "The names of these gentlemen," as the *Engineer* rightly remarks, 'are a sufficient guarantee that the work will be carried out both with energy and discretion; and we can only conclude by wishing them success in their labours."

NOTES

THE Council of the Royal Society of Edinburgh has recommended for the four vacancies in their list of Foreign Honorary Members the names of Donders of Utrecht, Asa Gray of the United States, Janssen of Paris, and Listing of Göttingen.

AT the meeting of the Royal Society on Monday last the Keith Prize was presented to Prof. Heddle of St. Andrew's for his papers on the Rhombohedral Carbonates and the Felspars of Scotland.

OUR readers will be glad to hear the latest news from Madeira, that Prof. Clifford is certainly better, and able to be carried out in the sunshine.

THE following are the lecture-arrangements at the Royal College of Surgeons for the present season:—Prof. Parker commences a series on Monday, "On the Evolution of the Vertebrata," to be continued on Mondays, Wednesdays, and Fridays, to March 3. On the same days of the week, from March 5 to 24, Prof. Flower will lecture "On the Comparative Anatomy of Man," in continuation of his course of last year. In June, Prof. Jonathan Hutchinson will give six lectures: "On Certain Diseases of the Eye, Skin, and Joints which are produced through the Influence of the Nervous System;" and in the same month Mr. B. T. Lowne, F.R.C.S., will give three lectures "On the Physiology of the Nervous System," in continuation of his course of last year.

AT the General Monthly Meeting of the Royal Institution of Great Britain on Monday, Dr. Warren De La Rue, F.R.S., was elected Secretary of the Institution, and Dr. William Spottiswoode, Pres. R.S., was elected Manager.

WE learn from the *Journal de St. Pétersbourg* that the epidemic in Astrakan was discussed before the Russian Medical Society at a gathering where 800 were present. It seems that the people call it the plague, though it is not officially so known. M. Botkine mentioned that at the time of the last plague at Moscow in 1770, the question was discussed whether it was the true plague or a marked form of typhus, and he added that the diagnosis of the various forms of typhoid infection in Russia is very difficult. He believes that the spots on the body and the quickness with which death follows indicate that the present epidemic of Vetlianka is not a European malady. Dr. Nicolaïew, describing the symptomatology of the plague, said that its action is both physical and moral, and that to impose quarantine often helps rather than retards the spread of the disease by the fear it awakens.

ADMIRAL MOUCHEZ will soon resume, at the Paris Observatory, the series of *soirées scientifiques* which had been commenced by Leverrier. The first will be given at the end of the present month or the beginning of March. M. Wolf will lecture on astronomy.

THE second International Meteorological Congress will be opened at Rome on April 14 next. At the same time an exhibition of meteorological instruments will take place, and the Italian Government invites home and foreign institutions and private men of science to participate in the Congress.

WE regret to announce the death of Herr Georg Peter Winther, of Copenhagen, an eminent Danish naturalist, well known through his excellent treatises on the fishes of Denmark. He died on January 14 at the early age of thirty-five years.

A CELEBRATION of the fourth centenary of the introduction of the art of printing into Leipzig will take place during this year and will be coupled with an exhibition comprising all branches of the graphic arts.

THE little town of Hohenstein in the Erzgebirge will celebrate the centenary of one of its most celebrated sons on April 26, 1880. The eminent naturalist and philosopher, Gotthilf Heinrich von Schubert was born at Hohenstein, in 1780, and died at Munich on July 1, 1860. It is intended to erect a monument to his memory and to establish a school under the name of Schubert Institution.

A BOTANICAL society is in course of formation at Strassburg. Its object, apart from a special study of the botany of the Reichsland, is to provide all the higher schools of the country with complete herbaria.

WE hear that the coal-mining experiments at Kaiping in the north of the Chinese province of Chihli are proceeding successfully. The boring has reached a depth of nearly 500 feet, passing through six seams of good coal, one of which is three feet and another eight feet thick. It is proposed to bore to a depth of 550 feet.

A CORRESPONDENT asks us whether the "microphone electromagnetique," said to be invented by Dr. Frank, rue St. Honoré, Paris, is really a useful invention for deaf persons, or not? We have not yet heard of any microphone which in any way assists the deaf.

ON January 30, when the National Assembly of Versailles, was voting on a successor to Marshal MacMahon, M. Paul Bert, a representative of Yonne, was lecturing on Claude Bernard and his works, in the large hall of the Sorbonne, before more than 2,000 persons, belonging mostly to the high schools and learned professions. The only reference made to political matters by the lecturer related to the funeral of Claude Bernard, which took place at the expense of the Government. M. Paul Bert reminded his hearers that it was the first time such an honour had been paid to a man of science. Up to that time they had been exclusively reserved for men who had earned their reputation on the battle-field, or who belonged by blood to the reigning family.

IN his lecture on Claude Bernard, M. Paul Bert narrated a singular stratagem which was invented by Bernard during the last Franco-German war, and might be utilised without difficulty, under similar circumstances. It was proposed to re-victual Paris, which was strictly blockaded by German forces. A large number of cattle had been collected, waiting for an opportunity to cross the German lines. But a difficulty was to silence these animals, as their cries would attract the attention of the enemy. Claude Bernard proposed to practise upon them the section of the nerve which enables them to emit their usual cries. The operation is so easy that it could be executed in a few seconds by an ordinary butcher. None of the animals appeared to suffer in any way by the mutilation which had made them mute. But the military movement proved a failure, and for other causes the re-victualling could not take place.

SOME of our readers may be interested to know that there exists in Berlin an exceedingly efficient and comprehensive scientific agency, that of Friedländer und Sohn. Not only do they issue, at short intervals, catalogues of works and papers in all departments of science, published all over the world, but they undertake to assist individuals and associations in carrying out almost any scheme of a scientific kind. To any one, *e.g*, anxious to pursue a particular line of research, they will furnish a methodical list of all the best researches that have been published on the subject; they assist museums, libraries, &c., in forming collections of scientific specimens and books, and are, in short, the guides, philosophers, and friends of all desirous of accomplishing almost any purpose connected with science. Their "Bücher-Verzeichniss," No. 293 (Physics and Chemistry), is marvellously complete; nothing of any value, published in any country in any form, seems to have escaped the compiler. Friedländer und Sohn have been at this work for twenty-eight years, and their catalogues issued during that time must be of great interest and value to the student of science.

THE *Times* Geneva correspondent, under date February 3, telegraphs that a singular and almost unprecedented meteorological phenomenon has been observable during the past ten or fifteen days in many parts of Switzerland. While the temperature in the valleys and plains has been low, the waters covered with ice, and snow resting on the ground, a warm south wind has prevailed in the uplands and among the higher Alps, where the streams remain unfrozen and the snow has almost disappeared. This has been especially the case in Uri, Schwytz, the Grisons, Neuchatel, and the Bernese Oberland. Mr. Coolidge, an Englishman, with four guides, made the ascent of the great Schreckhorn last week at four o'clock in the afternoon, when the thermometer on the summit of the mountain marked several degrees above freezing-point. The Oberland Alpine Club propose to buy some of the ibex forming part of the collection of the late King Victor Emmanuel, for the purpose of re-stocking the mountains of Switzerland.

A SHOCK of earthquake was felt at Foochow and Amoy on December 17.

A FINE meteor was observed at Prague and many other towns and villages of Bohemia on January 11, at 7.30 P.M. It appeared in the north-western part of the sky and moved towards the south-west, disappearing with a loud report, and leaving a long luminous train behind. The colour of the meteor was white at first and reddish violet at the end; the duration of the phenomenon was ten seconds.

THE project of a canal between the Rhine and the Maas seems at last to approach realisation. The city of Crefeld has declared its readiness to pay the sum of 500,000 marks (25,000*l.*) towards it, and it is confidently hoped that now both the Prussian as well as the Dutch Government will grant the necessary additional funds.

WE believe that the changes in the Government of the French Republic will be favourable to the development of education all over the land. The extension of public instruction is to be a part of the programme of the Ministry, which will not be published before our present impression will be in the hands of our readers.

ANOTHER of the London gas companies has been trying to show what gas-lighting can be made if only the public are willing to go to the necessary expense. On Friday last the Gas Light and Coke Company lit up part of Regent Street in much the same way that the Phœnix Company recently did the Waterloo Road. The result is described as admirable. By the use of Sugg's improved form of burner, a light framework, and the proper adjustment of suitable reflectors, a light was obtained very much brighter than that to which we have been so long accustomed. We believe if some enterprising company undertook to light one of our principal thoroughfares for some months at their own expense by this method, they would most likely be rewarded by a demand on the part of the public that the new form of light should be made general and permanent. Some comparative experiments which have been made at Westgate-on-Sea with the Jablochkoff candles have led the experimenters to the conclusion that this form of electric lighting is much more expensive than gas, and is surrounded with so many difficulties that no amount of improvement is likely to fit it for adoption. It is rumoured that an experiment is likely to be made in lighting the reading-room of the British Museum with the electric light.

THE Austrian Tourist Club has offered two prizes of 100 and 50 florins respectively for the best and next-best monograph of a mountain group or single mountain from the district of the Austrian Alps. Particulars respecting the competition can be learnt upon application to the Committee of the Club, Gusshausstrasse, Vienna.

CONTINUING his researches on the scintillation of stars, M. Montigny has examined the influence of atmospheric temperature and pressure, moisture in the air, fogs, snow, different winds, &c. His observations are detailed in a recent number (11, of 1878) of the Belgian Academy's *Bulletin*. The general conclusion to which the various facts point is thus stated:—It is the presence of water in greater or less quantity in the atmosphere, that exerts the most marked influence on scintillation, and which most modifies the character of it, either when the water is dissolved as vapour in the air, or when it falls to the surface of the ground in the liquid state, or in the solid state, in the form of snow."

IN spectacles designed purely for amusement there occur from time to time exhibitions of muscular dexterity and strength which are highly interesting to the physiologist. *La Nature* mentions that there was lately to be seen at the Hippodrome, in Paris, a gymnast, named Joignerey, who discharged a piece of cannon, not supporting it on the shoulder, as others have done, but like a rifle. The same man, suspended by his legs from a trapeze, raised with his teeth a horse and its rider. About the same time visitors to the skating theatre were astounded by the feats of the juggler Treniz, who entwined himself in a long streamer wound as an aerial helix, a feat which has been peculiar to the Japanese; and, with cubes of wood thrown into the air and caught, sketched the rudiments of unstable architectural forms, modifying their arrangement with unfailing dexterity and certainty.

AT a recent meeting of the French Physical Society M. Benoit showed a thermo-regulator of his invention, based on the increase of maximum tension of a saturated vapour with the temperature. A small vessel, containing methylic ether, is placed in the stove whose temperature is to be kept constant; it communicates with a mercury manometer, the movements of which, again, serve to regulate the flow of the coal-gas which heats the stove. M. Benoit has thus been able to maintain a temperature of 85° C. constant to within one-tenth of a degree. The apparatus owes this rare precision to the smallness of its mass and the rapidity with which the tension of the vapour increases with the temperature. The author showed that after having regulated it for the surrounding temperature, one had merely to blow rapidly on the small vessel of liquid in order to produce the extinction of the gas-burners governed by the apparatus.

SEVERAL Parisian photographers have tried to use electric light for obtaining *clichés*, and have been wonderfully successful. MM. Pierre Petit and Lebert are the most prominent amongst them.

SCARCELY a month passes but we receive the first number of a new journal devoted to science. Last week we referred to a new Italian *Nature*, and we have before us several other journals which are at least new to us. *L'Athénæum Belge*, which has entered on its second year, devotes a portion of its space to science, as well as to literature and art; it seems to us to be well conducted. The first number of the second year of *Le Monde* *de la Science et de l'Industrie* is extremely satisfactory, containing much and varied information both in pure and applied science. The *Telephone Journal*, of which also No. 1 of vol. ii. lies before us, we have seen for the first time. It seems to be an organ of the Chicago branch of the Bell Telephone Company, and contains mostly a list of persons and firms telephonically connected with each other through the Central Office in Chicago. The list of names is a long one, and as the "calls" of the Company are stated to average 5,500 daily, we infer they are doing a paying business. We have already referred to the Spanish *Crónica Cientifica;* Nos. 25 and 26 are exceedingly creditable, containing a fair selection from the scientific work being done both in Spain and in other countries. Altogether science has taken a prominent and influential place in the journalism of the day.

"THE Magic Lantern Manual," by Mr. W. J. Chadwick, is a plentifully illustrated little volume likely to be of great service to those, and they are many, who work with this useful apparatus in one or other of its many forms. Warne and Co. are the publishers. Equally useful in its own department is Dr. Sylvester Marsh's little manual on Section Cutting, a practical guide to the preparing and mounting of sections for the microscope, special prominence being given to the subject of animal sections. Messrs. Churchill are the publishers.

SOME excavations made at Merten, near Bolchen, in German Lorraine, have given remarkable results. The remains of a gigantic equestrian statue were found, of which the figure of the rider is particularly well preserved. Investigation of other remains tend to show that the origin of the statue is Roman; parts of mosaic floors, &c., have also been discovered.

A NEW agricultural school is about to be established at Meissen, Saxony.

THE cultivation and consumption of opium continues to increase largely in China, but notwitstanding this extended cultivation, the Persian drug is extensively consumed on account of its comparative cheapness. In a report from Amoy it is stated that the poppy is cultivated in the neighbourhood with the knowledge and sanction of the mandarins; but so far the production of opium appears in no way to affect the foreign produce, as, from the imperfect system of manufacture practised by the natives, they are unable to produce a drug in any way approaching the foreign article, either in quality or flavour. As regards the habit of using opium, Mr. Alabaster says: "It is now so general that I assume there is little probability of much increase in the demand unless the population of Formosa increase, where, as the use of opium is almost a necessity of life in the plantations there, to counteract the malarious influences of the climate there must be a larger export thither. Nor is it to be desired that the consumption should become greater, for although I cannot agree with those who so vigorously denounce the trade as a source of every evil, and am inclined to think from observation that many more lives are annually saved by its moderate use than are sacrificed to inordinate indulgence in it, an increase would now rather mark the spread of the abuse of the drug, than of its employment as a stimulant to counteract the lowering effects of climate, and damp and ill-drained houses."

THE additions to the Zoological Society's Gardens during the past week include two Macaque Monkeys (*Macacus cynomolgus*) from India, presented respectively by Mr. E. E. Barclay and Mr. Eardley Holt; a Weeper Capuchin (*Cebus capucinus*) from South America, presented by Mr. W. Fridrick; two White-Fronted Capuchins (*Cebus hypoleucus*) from South America, presented by Mr. Geo. Backhouse; a Short-Tailed Wallaby (*Halmaturus brachyurus*) from West Australia, presented by Mr. G. Bowen; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mr. B. Baverstock; a Golden-Naped Amazon (*Chrysotis auripalliata*) from South America, presented by Mrs. H. A. Hopkins; three Canada Geese (*Bernicla canadensis*) from North America, presented by Mr. W. Bonorton; a Black-Winged Pea-fowl (*Pavo nigripennis*) from Cochin China, presented by the Hon. A. S. G. Canning, F.Z.S.; a Giraffe (*Camelopardalis giraffa*) from Nubia, deposited; a Golden-Fronted Parrakeet (*Brotogerys tuipara*), an American Tantalus (*Tantalus loculator*), a Rough Terrapin (*Clemmys punctularia*) from South America, four River Jack Vipers (*Vipera rhinoceros*) from West Africa, received in exchange.

FOREST GEOGRAPHY

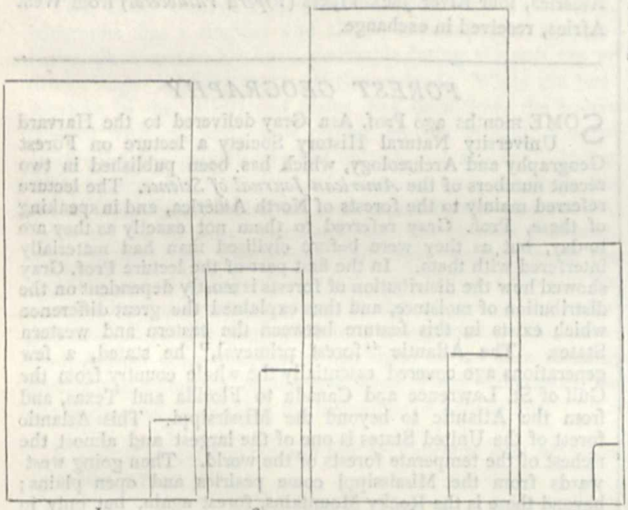
SOME months ago Prof. Asa Gray delivered to the Harvard University Natural History Society a lecture on Forest Geography and Archæology, which has been published in two recent numbers of the *American Journal of Science.* The lecture referred mainly to the forests of North America, and in speaking of these, Prof. Gray referred to them not exactly as they are to-day, but as they were before civilised man had materially interfered with them. In the first part of the lecture Prof. Gray showed how the distribution of forests is mostly dependent on the distribution of moisture, and thus explained the great difference which exists in this feature between the eastern and western States. The Atlantic "forest primeval," he stated, a few generations ago covered essentially the whole country from the Gulf of St. Lawrence and Canada to Florida and Texas, and from the Atlantic to beyond the Mississippi. This Atlantic forest of the United States is one of the largest and almost the richest of the temperate forests of the world. Then going westwards from the Mississippi come prairies and open plains; beyond these is the Rocky Mountains, forest again, but only in narrow lines and patches; but after passing the Sierra Nevada, the western rim of the basin, we come to what is in some respects the noblest and most remarkable forest in the world. In the long valley of California it almost disappears again, to resume its sway in the Coast Ranges, with altered features, some of them not less magnificent and of greater beauty. Thus there are two forest-regions in North America—an Atlantic and a Pacific, each dependent on the oceans which they respectively border. Prof. Gray then goes on to show how the distribution and nature of these forests are dependent mainly on moisture and temperature, proceeding to prove that the difference in the composition of the Atlantic and Pacific forests is not less marked than that of the climate and geographical configuration to which the two are respectively adapted.

"With some very notable exceptions, the forests of the whole northern hemisphere in the temperate zone (those that we are concerned with) are mainly made up of the same or similar *kinds.* Not of the same species; for rarely do identical trees occur in any two or more widely separated regions. But all round the world in our zone, the woods contain *pines* and *firs* and *larches, cypresses* and *junipers, oaks* and *birches, willows* and *poplars, maples* and *ashes*, and the like. Yet with all these family likenesses throughout, each region has some peculiar features, some trees by which the country may at once be distinguished."

With regard to the Pacific forests the greater part of the Atlantic trees are conspicuous by their absence.

"For example, it has no magnolias, no tulip-tree, no papaw, no linden or basswood, and is very poor in maples; no locust-trees—neither flowering locust nor honey locust—nor any leguminous tree; no cherry large enough for a timber-tree, like our wild black cherry; no gum-trees (*Nyssa* nor *Liquidambar*), no sorrel-tree, nor kalmia; no persimmon, or bumelia; not a holly; only one ash that may be called a timber-tree; no catalpa, or sassafras; not a single elm, nor hackberry; not a mulberry, nor planer-tree, nor maclura; not a hickory, nor a beech, nor a true chestnut, nor a hornbeam; barely one birch tree, and that only far north, where the differences are less striking. But as to coniferous trees, the only missing type is our bald cypress, the so-called cypress of our southern swamps, and that deficiency is made up by other things. But as to ordinary trees, if you ask what takes the place in Oregon and California of all these missing kinds, which are familiar on our side of the continent, I must answer, nothing, or nearly nothing. There is the *Madroña* (arbutus) instead of our kalmia (both really trees in some places); and there is the California laurel instead of our southern red bay tree. Nor in any of the genera common to the two does the Pacific forest equal the Atlantic in species. It has not half as many maples, nor ashes, nor poplars, nor walnuts, nor birches, and those it has are of smaller size and inferior quality; it has not half as many oaks, and these and the ashes are of so inferior economical value, that (as we are told) a passable waggon-wheel cannot be made of California wood, nor a really good one in Oregon."

Prof. Gray then illustrates graphically by diagrams, which we here reproduce, this poverty of the western forest in species in



1 2 3 4

1. Atlantic American Forest. 3. Japan-Manchurian Forest.
2. Pacific American Forest. 4. European Forest.

type (of timber-trees); it has only 31 genera and 78 species to 66 genera and 155 species on the Atlantic side. In the appended diagrams the short side of the rectangle is proportionate to the number of genera and the long side to the number of species. The geographical areas of the two forests are not very different, the length of the Pacific forest making up to some extent for its comparative narrowness.

"How can so meagre a forest make so imposing a show? Surely not by the greater number and size of its individuals, so far as deciduous (or more correctly non-coniferous) trees are concerned; for on the whole they are inferior to their eastern brethren in size if not in number of individuals. The reason is, that a larger proportion of the genera and species are coniferous trees; and these, being evergreen (except the larches), of aspiring port and eminently gregarious habit, usually dominate where they occur. While the east has almost three times as many genera and four times as many species of non-coniferous trees as the west, it has slightly fewer genera and almost one-half fewer species of coniferous trees than the west. That is, the Atlantic coniferous forest is represented by eleven genera and twenty-five species; the Pacific by twelve genera and forty-four species. This relative preponderance may also be expressed by the diagrams, in which the smaller inclosed rectangles, drawn on the same scale, represent the coniferous portions of these forests.

"Indeed, the Pacific forest is made up of conifers, with non-coniferous trees as occasional undergrowth or as scattered individuals, and conspicuous only in valleys or in the sparse tree-growth of plains, on which the oaks at most reproduce the features of the 'oak openings' here and there bordering the Mississippi prairie region. Perhaps the most striking contrast between the west and the east, along the latitude usually traversed, is that between the spiry evergreens which the traveller leaves when he quits California, and the familiar woods of various-hued round-headed trees which give him the feeling of home when he reaches the Mississippi. The Atlantic forest is particularly rich in these, and is not meagre in coniferous trees. All the glory of the Pacific forest is in its coniferous trees: its desperate poverty in other trees appears in the annexed diagram. These diagrams are made more instructive, and the relative richness of the forests round the world in our latitude is most simply exhibited, by adding two or three similar ones. Two will serve, one for Europe, the other for North-East Asia . . . .

"Keeping as nearly as possible to the same scale, we may count the indigenous forest trees of all Europe at 33 genera and 85 species. And those of the Japan-Manchurian region, of very much smaller geographical area, at 66 genera and 168 species. I here include in it only Japan, Eastern Manchuria, and the adjacent borders of China. The known species of trees must be rather roughly determined, but the numbers here given are not exaggerated, and are much more likely to be sensibly increased by further knowledge than are those of any of the other regions. Properly to estimate the surpassing richness of this Japan-Manchurian forest, the comparative smallness of geographical area must come in as an important consideration.

"To complete the view, let it be noted that the division of these forests into coniferous and non-coniferous is, for the

European non-coniferous,	26 genera,	68 species.
,, coniferous	7 ,,	17 ,,
	33 ,,	85 ,,

Japan-Manchurian non-coniferous	47 genera,	123 species.
,, ,, coniferous	19 ,,	45 ,,
	66 ,,	168 ,,

In other words, a narrow region in Eastern Asia contains twice as many genera and about twice as many species of indigenous trees as are possessed by all Europe; and as to coniferous trees, the former has more genera than the latter has species, and over twice and a half as many species.

"The only question about the relation of these four forest regions, as to their component species, which we can here pause to answer, is to what extent they contain trees of identical species. If we took the shrubs, there would be a small number, if the herbs a very considerable number, of species common to the two New World and to the two Old World areas respectively, at least to their northern portions, even after excluding arctic-alpine plants. The same may be said, in its degree, of the North European flora compared with the Atlantic North American, of the North-East Asiatic compared with the northern part of the Pacific North American, and also in a peculiar way (which I have formerly pointed out and shall have soon to mention) of the North-Eastern Asiatic flora in its relations to the Atlantic North American. But as to the forest trees there is very little community of species. Yet this is not absolutely wanting. The Red Cedar (*Juniperus Virginiana*) among coniferous trees, and *Populus tremuloides* among the deciduous, extend across the American continent specifically unchanged, though hardly developed as forest trees on the Pacific side. There are probably, but not certainly, one or two instances on the northern verge of these two forests. There are as many in which eastern and western species are suggestively similar. The hemlock-spruce of the Northern Atlantic States, and the yew of Florida are extremely like corresponding trees of the Pacific forest; indeed the yew-trees of all four regions may come to be regarded as forms of one polymorphous species. The white birch of Europe and that of Canada and New England are in similar case; and so is the common chestnut (in America confined to the Atlantic States), which on the other side of the world is also represented in Japan. A link in the other direction is seen in one spruce tree (called in Oregon Menzies spruce) which inhabits north-east Asia, while a peculiar form of it represents the species in the Rocky Mountains."

Prof. Gray then asks why the Pacific forest region, which is rich and in some respects unique in coniferous, should be so poor in deciduous trees. And how came California to have the monopoly of the two *Big-trees*, Sequoias, which have no near relatives anywhere? "Such relatives," he goes on to say, "as the Sequoias have are also local, peculiar, and chiefly of one species to each genus. Only one of them is American, and that solely eastern, the taxodium of our Atlantic States and the plateau of Mexico. The others are Japanese and Chinese. Why should trees of six related genera, which will all thrive in Europe, be restricted naturally, one to the eastern side of the American continent, one genus to the western side and very locally, the rest to a small portion of the eastern border of Asia? Why should coniferous trees most affect and preserve the greatest number of types in these parts of the world? And why should the north-east Asian region have, in a comparatively small area, not only most coniferous trees, but a notably larger number of trees altogether than any other part of the northern temperate zone? Why should its only and near rival be in the antipodes, namely, here in Atlantic North America? In other words why should the Pacific and the European forests be so poor in comparison, and why the Pacific poorest of all in deciduous, yet rich in coniferous trees?"

Prof. Gray ventures to conclude that this richness is normal, and that what we really have to explain is the absence of so many forms from Europe on the one hand, from Oregon and California on the other. He shows that most of the forms, even of shrubs and herbs, which are peculiar to the Atlantic forest, have their close counterparts in Japan and North China. Prof. Gray noticed the feature long ago, and evidences of the remarkable relationship have multiplied year after year.

"The result, as to the trees, is seen in these four diagrams. As to number of species generally, it cannot be said that Europe and Pacific North America are at all in arrears. But as to trees, either the contrasted regions have been exceptionally favoured, or these have been hardly dealt with. There is, as I have intimated, some reason to adopt the latter alternative.

"We may take it for granted that the indigenous plants of any country, particularly the trees, have been selected by climate. Whatever other influences or circumstances have been brought to bear upon them, or the trees have brought to bear on each other, no tree could hold its place as a member of any forest or flora which is not adapted to endure even the extremes of the climate of the region or station. But the character of the climate will not explain the remarkable paucity of the trees which compose the indigenous European forest. That is proved by experiment, sufficiently prolonged in certain cases to justify the inference. Probably there is no tree of the northern temperate zone which will not flourish in some part of Europe. Great Britain alone can grow double or treble the number of trees that the Atlantic States can. In all the latter we can grow hardly one tree of the Pacific coast. England supports all of them, and all our Atlantic trees also, and likewise the Japanese and North Siberian species, which do thrive here remarkably in some part of the Atlantic coast, especially the cooler-temperate ones. The poverty of the European sylva is attributable to the absence of our Atlantic American types, to its having no magnolia, liriodendron, asimina, negundo, no æsculus, none of that rich assemblage of leguminous trees represented by locusts, honey-locusts, gymnocladus, and cladrastis (even its cercis, which is hardly European, is like the Californian one, mainly a shrub); no nyssa, nor liquidambar; no ericaceæ rising to a tree; no bumelia, catalpa, sassafras, osage orange, hickory, or walnut; and as to conifers, no hemlock spruce, arbor-vitæ, taxodium, nor torreya. As compared with north-eastern Asia, Europe wants most of these same types, also the ailantus, gingko, and a goodly number of coniferous genera. I cannot point to any types tending to make up the deficiency, that is, to any not either in east-north America or in north-east Asia, or in both. Cedrus, the true cedar, which comes near to it, is only north African and Asian. I need not say that Europe has no sequoia, and shares no special type with California.

"Now the capital fact is, that many and perhaps almost all of these genera of trees were well represented in Europe throughout the later tertiary times. It had not only the same generic types, but in some cases even the same species, or what must pass as such, in the lack of recognisable distinctions between fossil remains and living analogues. Probably the European miocene forest was about as rich and various as is ours of the present day, and very like it. The glacial period came and passed, and these types have not survived there, nor returned. Hence the comparative poverty of the existing European sylva, or at least, the probable explanation of the absence of those kinds of trees which make the characteristic difference."

Before answering the question as to why these trees perished out of Europe but survive in America and Asia Prof. Gray inquires how these American trees came to be in Europe. From certain considerations he is led to the inference that all species closely related to each other have had a common birthplace and origin. So that when we find individuals of a species or of a group widely out of range of their fellows, we wonder how they got there. When we find the same species all round the hemisphere—and a very considerable number of species of herbs and shrubs, and a few trees are so found—we ask how this dispersion came to pass. Prof. Gray goes on to say:—

"I take it that the true explanation of the whole problem comes from a just general view, and not through piecemeal suppositions of chances. And I am clear that it is to be found by looking to the north, to the state of things at the arctic zone first, as it now is, and then as it has been. North of our forest-regions comes the zone unwooded from cold, the zone of arctic vegetation. In this, as a rule, the species are the same round the world; as exceptions, some are restricted to a part of the circle. The polar projection of the earth down to the northern tropic, as here exhibited, shows to the eye—as our maps do not—how all the lands come together into one region, and how natural it may be for the same species, under homogeneous conditions, to spread over it. When we know, moreover, that sea and land have varied greatly since these species existed, we may well believe that any ocean-gaps, now in the way of equable distribution, may have been bridged over. There is now only one considerable gap.

"What would happen if a cold period were to come on from the north, and were very slowly to carry the present arctic climate, or something like it, down far into the temperate zone? Why, just what has happened in the glacial period, when the refrigeration somehow pushed all these plants before it down to southern Europe, to middle Asia, to the middle and southern part of the United States; and at length receding, left some parts of them stranded on the Pyrenees, the Alps, the Apennines, the Caucasus, on our White and Rocky Mountains, or wherever they could escape the increasing warmth as well by ascending mountains as by receding northward at lower levels. Those that kept together at a low level, and made good their retreat, form the main body of present arctic vegetation. Those that took to the mountains had their line of retreat cut off, and hold their positions on the mountain-tops under cover of the frigid climate due to elevation. The conditions of these on different continents or different mountains are similar, but not wholly alike. Some species proved better adapted to one, some to another, part of the world; where less adapted, or less adaptable, they have perished; where better adapted, they continue—with or without some change;—and hence the diversification of alpine plants, as well as the general likeness through all the northern hemisphere.

"All this exactly applies to the temperate zone vegetation, and to the trees that we are concerned with. The clue was seized when the fossil botany of the high arctic regions came to light; when it was demonstrated that in the times next preceding the glacial period—in the latest tertiary—from Spitzbergen and Iceland, to Greenland and Kamtschatka, a climate like that we now enjoy prevailed, and forests like those of New England, and Virginia, and of California, clothed the land. We infer the climate from the trees; and the trees give sure indications of the climate.

"I had divined and published the explanation long before I knew of the fossil plants. These, since made known, render the inference sure, and give us a clear idea of just what the climate was. At the time we speak of, Greenland, Spitzbergen, and our arctic sea-shore had the climate of Pennsylvania and Virginia now. It would take too much time to enumerate the sorts of trees that have been identified by their leaves and fruits in the arctic later tertiary deposits.

". . . . Long genealogies always deal more or less in conjecture; but we appear to be within the limits of scientific inference when we announce that our existing temperate trees came from the north, and within the bounds of high probability when we claim not a few of them as the originals of present species. Remains of the same plants have been found fossil in our temperate region, as well as in Europe.

"Here, then, we have reached a fair answer to the question how the same or similar species of our trees came to be so dispersed over such widely separated continents."

Prof. Gray then shows what would naturally follow from a gradual pushing of the Arctic vegetation southwards, and that the modifications resulting from differences of climate in the divergent continents, and on their different sides, might well account for the present diversification. The siftings and resiftings which have since taken place from changes of climate, submergence, and re-emergence, and other causes, have left their impress on the actual vegetation, especially on the trees. They furnish probable reason for the loss of American types sustained by Europe.

"I conceive that three things have conspired to this loss. First, Europe, hardly extending south of latitude 40°, is all within the limits generally assigned to severe glacial action.

Second, its mountains trend east and west, from the Pyrenees to the Carpathians and the Caucasus beyond, near its southern border; and they had glaciers of their own, which must have begun their operations, and poured down the northward flanks, while the plains were still covered with forest on the retreat from the great ice-wave coming from the north. Attacked both on front and rear, much of the forest must have perished then and there. Third, across the line of retreat of those which may have flanked the mountain-ranges, or were stationed south of them, stretched the Mediterranean, an impassable barrier. Some hardy trees may have eked out their existence on the northern shore of the Mediterranean and the Atlantic coast. But we doubt not, taxodium and sequoias, magnolias and liquidambars, and even hickories and the like were among the missing. Escape by the east, and rehabilitation from that quarter until a very late period, was apparently prevented by the prolongation of the Mediterranean to the Caspian, and thence to the Siberian ocean."

Prof. Gray shows that on the American continent on the other hand the trees, when touched in the north by the incoming refrigeration, had only to move their southern border southward, along an open way, as far as the exigency required; and there was no impediment to their due return. The still greater richness of north-east Asia in arboreal vegetation may find an explanation in the prevalence of particularly favourable conditions, both anteglacial and recent.

"The case of the Pacific forest is remarkable and paradoxical. It is, as we know, the sole refuge of the most characteristic and wide-spread type of miocene coniferæ, the sequoias; it is rich in coniferous types beyond any country except Japan; in its gold-bearing gravels are indications that it possessed, seemingly down to the very beginning of the glacial period, magnolias and beeches, a true chestnut, liquidambar, elms, and other trees now wholly wanting to that side of the continent, though common both to Japan and to Atlantic North America. Any attempted explanation of this extreme paucity of the usually major constituents of forest, along with a great development of the minor, or coniferous, element, would take us quite too far, and would bring us to mere conjectures."

Prof. Gray concludes his interesting lecture by saying:—

"I have done all that I could hope to do in one lecture if I have distinctly shown that the races of trees, like the races of men, have come down to us through a prehistoric (or pre-natural-historic) period; and that the explanation of the present condition is to be sought in the past, and traced in vestiges, and remains, and survivals; that for the vegetable kingdom also there is a veritable archæology."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Cambridge Smith's Prizes have been awarded to Micaiah John Muller Hill, B.A., St. Peter's College, and Arnold Joseph Wallis, B.A., Trinity College, bracketed equal. These gentlemen were also bracketed equal as fourth wranglers in 1879.

A UNIVERSITY for ladies will be opened shortly in Odessa. It will have three faculties—History and Literature, Mathematics, and Natural Science. The programme will be the same as in the other Russian Universities for male students, with a few changes. Greek will not be obligatory in the Historico-Literary Faculty; there will be in the same faculty a Chair of Political Economy and Statistics. Pedagogy and hygiene will be obligatory in all faculties.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 12, 1878.—In an inaugural dissertation here given, Herr Nahrwold studies atmospheric electricity; his method of experiment having been to electrify air in a cylindrical vessel fitted with a (mercury) dropping collector. His first attempts, with points, convinced him that only the dust, not the air, could be thus electrified; he then successfully used a fine platinum wire kept glowing with a battery (the air having been first freed from dust), and a condenser or galvanic element connected with the circuit. Interesting data are furnished with regard to the charge of the air, the ratio of this to the source of electricity used, and the decrease of the charge. Some of the observations seem to throw doubt on Thomson's conclusions as to the distribution of electricity in the upper regions of the atmosphere.—Herr Wiedemann offers a theory on the nature of spectra, deduced from the kinetic theory of gases. Line-spectra are attributed to oscillatory motions of atoms, isolated at high temperatures; band spectra of elements and spectra of compounds to vibrations of atoms in the molecule, or of the ether-envelopes. —A quantitative verification of the electrodynamic law, regarding the reciprocal action of closed circuits, for the case in which the circuit suffers deformation, is furnished by Herr Niemöller.—Herr Korteweg discusses the velocity of propagation of sound in elastic tubes, and Herr Rühlmann gives formulæ for measurement of ocean depths with the manometer.—There are several notes on crystallography.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 23.—"Researches on Lactin," by Edmund J. Mills, D.Sc., F.R.S., "Young" Professor of Technical Chemistry in Anderson's College, Glasgow, and James Hogarth.

The authors have investigated lactin with the aid of polarised light, their object being to gain further insight into the chemical nature of that compound. Their conclusions are as follows:—

1. The initial specific rotation of lactin is 92°·63.
2. The permanent specific rotation of lactin is 59°·17.
3. The change of rotation of a solution of lactin can be expressed by a mathematical equation.
4. When the specific rotation 64°·8 is reached, the law of change must be expressed by a different equation.
5. The initial solubility of lactin is one part lactin in 10·64 parts water.
6. The permanent solubility is one part lactin in 3·23 parts water.

"Researches on Chemical Equivalence." Part II. Hydric Chloride and Sulphate. By Edmund J. Mills, D.Sc., F.R.S., and James Hogarth.

While carrying out their researches on lactin, it struck the authors that use might be made of it to compare the dynamical equivalents of acid bodies. They accordingly selected hydric chloride and hydric sulphate for the measurements in question.

The results show that though 2HCl may be the "equivalent" of H_2SO_4 in weight for saturation (*i.e.*, in the ordinary sense), it certainly is not the equivalent in the dynamical sense. They also render it highly probable that HCl is equal dynamically to H_2SO_4. Ostwald, by a method based on the alteration of the specific volume of solutions, has shown that the ratio $\frac{2HCl}{H_2SO_4} = 1·93$, a result which their numbers, though not as perfect as the authors could wish, nevertheless strongly confirm.

"Limestone as an Index of Geological Time," by T. Mellard Reade, C.E.

January 30.—"On Certain Means of Measuring and Regulating Electric Currents." By C. William Siemens, D.C.L., F.R.S.

The dynamo-electro machine furnishes us with a means of producing electric currents of great magnitude, and it has become a matter of importance to measure and regulate the proportionate amount of current that shall be permitted to flow through any branch circuit, especially in such applications as the distribution of light and mechanical force.

On June 19 last, upon the occasion of the *soirée* of the President of the Royal Society, was exhibited a first conception of an arrangement for regulating such currents, which the author has since worked out into a practical form. At the same time a method has been realised by which currents passing through a circuit, or branch circuit, are measured, and graphically recorded.

It is well known that when an electric current passes through a conductor heat is generated, which, according to Joule, is proportionate in amount to the resistance of the conductor, and to the square of the current which passes through it in a unit of time, and advantage has been taken of this well-established law of electro-dynamics, in order to limit and determine the amount of current passing through a circuit.

The paper refers to three instruments, in the first of which one end of a thin strip of metal is attached to a screw, by which its tension can be regulated; it then passes upwards over an elevated insulated pulley, and down again to the end of a short lever working on an axis, armed with a counter-weight and with a lever whose angular position will be materially affected by any small elongation of the strip that may take place from any cause. The apparatus further consists of a number of prisms of metal, supported by means of metallic springs, so regulated by movable weights as to insure the equidistant position of each prism from its neighbour.

A series of comparatively thin coils of wire of German silver or other resisting metal, connect the alternate ends of each two adjoining springs, the first and last spring being also connected to the lever and terminal respectively.

The strip is put under a glass shade, and the instrument itself should be placed in a room where a tolerably uniform temperature of say 15° C. is maintained.

When the minimum current is passing, the thin metallic strip is at its minimum working temperature, and all the metallic prisms are in contact, this being the position of least resistance. As soon as the current passing through the apparatus shall increase in amount, the thin metallic strip will immediately rise in temperature, which will cause it to elongate, and will allow the lever to recede from its extreme position, liberating one contact piece after another. Each such liberation will call into action the resistance coil connecting the spring ends, and an immediate corresponding diminution of the current through the additional resistance thus thrown into the circuit.

Suppose that the current intended to be passed through the instrument is capable of maintaining the sensitive strip at a temperature of say 60° C., and that a sudden increase of current takes place in consequence either of an augmentation of the supply of electricity or of a change in the extraneous resistance to be overcome, the result will be an augmentation of temperature, which will continue until a new equilibrium between the heat supplied and that lost by radiation is effected. If the strip is made of metal of high conductivity, such as copper or silver, and is rolled down to a thickness not exceeding 0·05 millim., its capacity for heat is exceedingly small, and its surface being relatively very great, the new equilibrium between the supply of heat and its loss by radiation is effected almost instantaneously. But, with the increase of temperature, the position of the regulating lever is simultaneously affected, causing one or more contacts to be liberated, and as many additional resistance coils to be thrown into circuit: the result being that the temperature of the strip varies only between very narrow limits, and that the current itself is rendered very uniform, notwithstanding considerable variation in its force, or in the resistance of the lamp, or other extraneous resistance which it is intended to regulate.

The resistance coils, by which adjoining contact-springs are connected, may be readily changed, so as to suit particular cases; they are made by preference of naked wire, in order to expose the entire surface to the cooling action of the atmosphere.

For feeble currents, disks of carbon are substituted for the wire rheostat, the electrical resistance of carbon varying inversely with the pressure to which it is subjected. A steel wire of say 0·3 millim. diameter is drawn tight between the end of a bell-crank lever and an adjusting screw, the pressure of the lever being resisted by a pile of carbon disks placed in a vertical glass tube. The current, passing through the steel wire, through the bell-crank lever, and through the carbon disks, encounters the minimum resistance in the latter so long as the tension of the wire is at its maximum; whereas the least increase in temperature of the steel wire by the passage of the current causes a decrease of pressure upon the pile of carbon disks, and an increase in their electrical resistance; it will thus be readily seen that, by means of this simple apparatus, the strength of small currents may be regulated so as to vary only within certain narrow limits.

The apparatus first described may be adapted also for the *measurement* of powerful electric currents. The variable rheostat is in this case dispensed with, and the lever carries at its end a pencil pressing with its point upon a strip of paper drawn under it in a parallel direction with the lever by means of clockwork. A second fixed pencil draws a second or datum line upon the strip, so adjusted that the lines drawn by the two pencils coincide when no current is passing through the sensitive strip. The passage of a current through the strip immediately causes the pencil attached to the lever to move away from the datum line, and the distance between the two lines represents the temperature of the strip. This temperature depends, in the first place, upon the amount of current passing through the strip, and, in the second place, upon the loss of heat by radiation from the strip; which two quantities balance one another during any interval that the current remains constant.

In order to facilitate the process of determining the value of the diagram produced by motion of pencil in Weber's or other units of current, it is only necessary, if the variations are not excessive, to average the ordinates, and to determine their value from a table prepared for that purpose. The error committed in taking the average ordinate instead of the absolute ordinates, when the current varies between small limits, is evidently small, the variation of the ordinates above their mean value averaging the variations below the same.

The thin sensitive conductor may thus be utilised either to restrict the amount of electricity flowing through a branch circuit, within certain narrow limits, or to produce a record of the amount of current passed through a circuit in any given time.

Physical Society, January 25.—Prof. G. C. Foster, vice-president, in the chair.—Prof. E. Ray Lankester and Mr. Alex. Macdonald, B.A., were elected Members.—Dr. Erck exhibited a constant bichromate of potash battery. The ordinary bichromate battery soon loses power when in use, and in order to secure a powerful constant battery to drive a small astronomical clock, Dr. Erck devised the modified form shown. It consists of a narrow lead trough 12 inches long by 3 inches wide and 1 inch deep, lined along both sides with two carbon plates. The zinc plate 10 inches long is immersed in the solution to the depth of an inch midway between the two carbons. A continual circulation of the bichromate solution is kept up by allowing fresh solution to drop into the cell at one end, and the exhausted solution to drop away by a tap at the other end. As the space between the two carbons is only about half an inch wide, there is merely a thin layer of solution between the positive and negative poles. The internal resistance of the cell is, therefore, very low, when short circuited only about ¼ ohm. To obtain the maximum current about 8 oz. of solution per hour should be applied. Dr. Erck also showed a battery formed of zinc and carbon circular plates mounted on an axle which is rotated by wheelwork, thus mechanically stirring the bichromate solution.—Dr. F. Guthrie, F.R.S., described some of the results he had obtained from experiments on the vibration of metal rods or lathes fixed in a vice at one end and free to vibrate at the other. The experiments were carried on by dusting sand on the rod and observing the nodal lines formed by it when the rod was vibrated, so as to give out notes determined by a monochord. Dr. Guthrie's results show that the two final segments at the free end are together equal in length to the inner segment at the fixed end. It appears from these experiments that if a free lathe vibrating with a node in the middle, but having an even number of segments, be clamped at where there is a node, we alter its conditions of vibration. When the lathe is half free, the end segment breaks up into two parts together equal to the segment at the fixed end. In the case of a torsional vibration of the lathe, the position of the longitudinal nodal lines depended to some extent on the clamping of the lathe in the vice. Prof. Foster pointed out that in a natural node the direction of the tangent is varying, whereas in an artificial node it is always horizontal. Prof. Unwin explained that the sand accumulated at nodes because the particles, when thrown off the lathe, make certain horizontal excursions which tend to move them nearer the points of repose of the lathe.—Messrs. Elliot Brothers exhibited sundry electric commutators and resistance boxes.

Anthropological Institute, January 21.—Mr. John Evans, D.C.L., F.R.S., president, in the chair.—The Director read a communication from Dr. Paul Topinard on resemblances between a Galtcha and a Savoyard skull. The similarity between these skulls is such that the author is inclined to regard the Galtchas of Eastern Turkistan and the Celts of Western Europe as branches of one common stock, of which the Slavs of Eastern Europe are also members.—M. Elie Reclus read a paper on circumcision, its significance, its origin, and its kindred rites. The practice of this custom was traced over a large portion of the inhabited globe, including Australia and South America, though among the nations of antiquity the Egyptians and Jews are those among whom it is best known to have prevaile .

Photographic Society, January 14.—James Glaisher, F.R.S., in the chair.—Capt. Abney, R.E., F.R.S., read a paper on the fading of the undeveloped photographic image, and on soluble bromide in emulsions; and Col. Wortley explained a new instantaneous shutter, designed by him. Capt. Abney, in his paper, stated that one cause of the fading arose from impure pyroxyline, which, during decomposition, liberated nitrous acid; and that this acid would destroy (before development) a photographic image on collodion, made from such pyroxyline.—Capt. Abney then discovered that as an excess of alkaline bromide would not diminish sensitiveness, or rather not prevent an image being formed, consequently, if a nitrite of some alkali, in conjunction with an excess of bromide, were added, the formation of any acid would be prevented, so that by the application of an alkaline carbonate to the film, all nitrous acid liberated from pyroxyline is absorbed to form an alkaline nitrite, and the destruction of the photographic image avoided.

Cambridge

Philosophical Society, December 2, 1878.—Prof. Liveing, president, in the chair.—Dr. G. W. Royston-Pigott made a communication to the Society on a new method of determining the limits of microscopic vision. The author referred to his method of forming miniatures by reversing an object-glass which has been described in the *Philosophical Transactions*, and showed how he had applied it to determine the limit of smallness of objects that could be detected by the microscope. The process employed was to form a miniature of an object such as a spider-line, and then examine the miniature with the microscope. In this manner Dr. Royston-Pigott had found that objects even as small as the millionth of an inch in diameter could be seen, contrary to the generally received view of opticians that it was useless to attempt to perfect the microscope further, as it could not show objects smaller than the hundred-thousandth of an inch in diameter. Dr. Jurin found that with the naked eye he could discover a pin fixed in a window forty feet away from him, subtending an angle of two or three seconds, but if he placed two pins together he could not distinguish them as separated except they were so far apart as to make an angle of forty seconds. Thus a bright interval could not be discovered unless it were ten or fifteen times larger than the objects forming it; but Dr. Royston-Pigott found that the excellence of modern objectives was such as to enable the eye to discern an interval only four times larger than the diameter of the web miniature, reckoned at one millionth of an inch. The microscopes and apparatus employed to produce the miniature were exhibited to the Society, and the precautions to be taken in the use of the method were explained.—Mr. W. M. Hicks communicated some results of an investigation on the motion of two cylinders surrounded by fluid.

Paris

Academy of Sciences, January 27.—M. Daubrée in the chair.—The following papers were read:—Third reply to M. Berthelot, by M. Pasteur.—On the development of the perturbative function where, the excentricities being small, the mutual inclination of the orbits is considerable, by M. Tisserand.—On a formula giving approximately the moment of torsion, by M. de Saint-Venant.—Researches on the relations of spectrum analysis to the spectrum of the sun, by Mr. J. Norman Lockyer.—On the electric clutch-gear on board ships, by MM. Trève and Achard. An arrangement for managing marine engines or helms at a distance electrically.—On the composition of banana and attempts at utilisation of this fruit, by MM. Marcano and Muntz. The banana keeps the ground moist round it, and this property is utilised in Venezuela to help the coffee-plant in dry weather. But only a little of the banana's fruit is there used, and the authors call attention to the flour and the alcohol obtainable from it, recommending exportation. The flour is a food essentially feculent.—On the application of his atomic theory to various minerals, by M. Gaudin.—On the diameters of the sun and of Mercury, deduced from the transit of May, 1878, by M. Cruls (Rio de Janeiro). The solar semi-diameter is found 15′ 59″·982, agreeing nearly with Leverrier's 16′ 0″·0 (deduced from previous transits). The value for the planets' diameter, got from observations of ingress, was 10″·78, by another method 10″·74.—Hydro-electricity and hydro-magnetism; analytical results, by M. Bjerknes.—On a development in series, by M. Picard.—Displacement of spectral lines due to motion of rotation of the sun, by M. Thollon. His experiments on this with his new prism convince him that with a suitable arrangement the displacement may be produced in an incontestable manner. The telluric lines did not show any change, and some of them, near those of nickel, enabled one to see very distinctly how the latter were displaced.—On the radiation of incandescent platina, by M. Violle. He measured this from 900 to 1,775 degrees. The intensity of a given radiation does not increase indefinitely with the temperature, but passes through a maximum and then decreases to a point, where it becomes insensible. The luminous heat of fused platinum transmitted through alum is $\frac{1}{4\cdot5}$ of the total heat transmitted through rock-salt.—On the illumination of lines of molecular pressure, and on the trajectory of molecules, by Mr. W. Crookes. M. Du Moncel said the dark space is not only manifested in vacuo; it is distinctly seen round the negative electrode, on sending an induction spark between two plates of glass, and examining it with a microscope. (A figure is given.)—On electrodynamic phenomena, and especially on induction, by M. de Meaux. In a closed circuit, you do not change the intensity of the current produced by induction of an indefinite cylindrical conductor on another of the same form, by surrounding one or other, or even both, of these conductors with a concentric metallic envelope, communicating with the ground throughout its length.—On a new Bell telephone speaking with loud voice, by M. Gower. The two magnet poles are placed opposite each other; the diaphragm is thick, large, and tense; the inclosing case is metallic and sonorous, and a speaking trumpet is added.—On the amalgams of chromium, manganese, iron, cobalt, and nickel, and on a new process of preparation of metallic chromium, by M. Moissan. This method is, stirring a concentrated solution of protochloride of chromium in water with pasty sodium-amalgam; the amalgam of chromium obtained is then heated to 350° in a current of hydrogen. Amalgams of the other metals named may be had similarly.—On a preparation of methylformic ether and of pure methylic alcohol, by MM. Bardy and Bordet.—On the principles which give *Sarracenia purpurea* its therapeutic properties, by M. Hetet.—On the termination of the visceral arterioles of *Arion rufus*, by M. Jourdain.—Researches on the action of *grenat*, or the residue of the manufacture of fuchsine, by M. Jousset de Bellesme. This is used to colour wines. It may be taken in large quantities without causing death; but it is hurtful, producing uræmia, &c.—On the quantity of light lost in actuating the visual apparatus, and its variations under different conditions, by M. Charpentier. A light being gradually increased from zero, you note when the eye perceives it; it may then be reduced considerably without the eye ceasing to perceive it. This difference is much greater, if the eye have been kept in the dark five minutes or more. But this effect of rest in the dark does not apply (or very little) to chromatic sensibility. The author considers the sensation of light wholly independent of that of colour.—On the phosphorescence of the lobster's flesh, by MM. Bancel and Husson. They consider it due to a kind of fermentation.—M. Mége Mouris presented a note on the properties of marine salt; and MM. Nasse and Decharme, notes on a liquid rain which lately covered the ground with a thick surface of ice.

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