THURSDAY, FEBRUARY 14, 1889.

ALPINE PHYSIOGRAPHY.

Die Gletscher der Ostalpen. Von Dr. Eduard Richter. Mit sieben Karten, zwei Ansichten, und vierundvierzig Profilen im Text. (Stuttgart: J. Engelhorn, 1888.)

The Alps. By Prof. F. Umlauft, Ph.D. Translated by Louisa Brough. With 110 Illustrations. (London: Kegan Paul, Trench, and Co., 1889.)

THE first of these two works—an elaborate memoir of 306 pages—forms the third volume of the "Handbücher zur Deutschen Landes- und Volkskunde," issued by the Centralkommission für wissenschaftliche Landeskunde von Deutschland. About one-sixth of the whole is occupied by some preliminary remarks, and a discussion of the snow-line and the methods of estimating it. As the author points out, this expression is a rather vague one, and in a later part of the book he indicates that it may be or has been used in four different senses: (1) the lower limit of the patches of *firn* or *névé*, which chiefly depends on the steepness and ruggedness of the mountains; (2) the lower limit of the connected permanent fields of snow and ice, excluding the glaciers which descend from them, which may be called the practical snow-line,—this depends mainly on the nature of a declivity and its aspect; (3) the "climatic" snow-line, a theoretical estimate of the snow-line arrived at by considering climatic factors only; (4) the normal snow-covering, estimated by the line up to which the snow melts away from the mountains. In proportion as the mountains become regular in form, the first, second, and fourth approach one another, and tend to coincide with the third, and all must be considered in arriving at a general estimation of the snow-line for any mountain group.

The author then passes in review the various districts of the Eastern Alps, and enters into details as to the distribution, arrangement, levels, and limits of the snow-fields and glaciers. In this section of the work a large amount of statistical information is collected, which, together with the references to the literature, cannot fail to be of much value to anyone engaged upon questions relating to climate, and especially investigations bearing upon glacial geology.

In the concluding part of the work the author gives a summary of the conclusions which follow from the foregoing collection of facts. These are rendered more readily intelligible by means of a map. A short description of this will perhaps be the simplest way of indicating the general results at which the author has arrived. As its scale is comparatively small, details of mountain topography are omitted for the sake of distinctness; but the chief river courses are clearly shown, and the boundary between the mountain and lowland regions, north and south, is indicated by a thin dotted line. But all the ground above the 2600 metres contour-line (a very rough mean for the snow-line of the whole region) is shaded. Thus treated, we may remark in passing, the map gives an excellent idea of what would be the structure of a group of islands produced by the submergence of a mountain region, and a comparison of it with a map of the Lofoten Islands, or indeed with many parts of the Scandinavian and even North British coasts, is not without interest. The "isochional" levels, as perhaps they might be called, are indicated by a series of dotted lines, these being graduated in hundreds of metres, the zones included between them having the snow-line at heights differing by this amount. Obviously, this is only a rough representation of the facts, because, as the author carefully points out, there are numerous minor variations, even in one and the same district, due to the form or composition of the mountains, the aspect of the slope, and the like.

In the zone of 2500 metres, only a small portion of the Eastern Alps is included, viz. the higher summits of the northern limestone zone, such as the Zugspitz and the Dachstein. The southern limit of this district trends slightly north of east. The line limiting the zone of 2600 metres on the western side runs a little south of Landeck and Innsbruck, and so does not include any important summit; but east of the Brenner it has a rather southerly trend, and practically passes along the crest of the Höhe Tauern. The limit of the zone of 2700 metres runs roughly parallel with the last, till at the Glockner group it turns sharply to the south, and then, bending back, it passes to the south of the Adamello group. Thus the Brenta Alta group, the Marmolata and other peaks of the South Tyrol Dolomites, are in the 2700 metres zone, though a few summits of the Julian Alps, at the extreme east of the map, are marked 2600 metres. There is yet one other contour-line—that including the region where the snow-line is at 2900 metres or even more. This is rudely elliptical in shape, and includes the greater part of the Bernina, Ortler, and Oetzthal groups, together with many of the peaks on the left bank of the Upper Innthal. It is thus obvious that the snow-line is not wholly dependent on mountain form, or disposition, or on general temperature. The Adamello stands well to the south of the Oetzthal, yet its snow-line is full 100 metres lower. The northern part of the Oetzthal is only a very little south of the Glockner, yet the snow-line in the one district is 200 metres higher than in the other. But the configuration of the Oetzthal group is, if anything, more favourable to the accumulation of snow, and one would have expected, at first sight, to find the difference incline in the other direction. It is, then, evident that other climatic factors are of great importance, not the least of these being the amount of precipitation during the winter months. On this subject some interesting evidence is adduced.

The book is in clear good type, and the maps and sections at the end are printed with a blank space, equal to a page, on the inner side, so that they can be kept in sight when the book is read—a very convenient arrangement too often neglected. Most of the illustrations in the text are only diagrammatic sections, but the two "views" of the Gaisberg Glacier and of the Marmolata Glacier are excellent of their kind. The former is really no more than a "pen-and-ink sketch," yet it gives a very good idea of an Alpine view, and is far better than the wretched caricatures of mountain scenery which too often do duty in English scientific text-books. It may be commended to our publishers.

The second volume before us is one larger in size, characterized in parts by the same laborious minuteness but with little scientific value. It is the work of a geographer "pure and simple," and of one, as we suspect from internal evidence, who knows the Alps better from books than from personal experience. The larger half is devoted to Alpine topography, but this is often hardly more intelligible or interesting than a catalogue of names and altitudes. In our opinion Prof. Umlauft's plan of work is defective. At the outset, instead of impressing on the reader the relation of the Alps to the mountain ranges with which they are connected, he obscures it by an elaborate disquisition on their boundaries. The dominant physical features of the chain and its component ranges should have been at once sketched in bold outline, after which a more detailed description of the several districts might have been given. The reader would then have been furnished with a frame-work on which he could arrange the subordinate facts: now, unless previously familiar with the Alps, he will wander bewildered among a labyrinth of names and statistics. In short, Prof. Umlauft appears to be a geographer of the old school. If he has any scientific knowledge, whether as geologist or naturalist, this book affords not only no evidence in favour, but also not a little to the contrary.

For instance, in any notice of the geology of the Alps his statements are commonly unsatisfactory, and sometimes absurd. For the latter, perhaps, the translator is partly responsible, for occasionally a sentence occurs which is devoid of meaning, such as this, "Many of the lofty peaks are composed of Triassic limestones up to the metamorphic dachstein, which, inclosed in cardita, forms the peak." The paragraphs treating of valleys, lake basins, ice-caves, glaciers, erosion, and weathering, are all inadequate and unsatisfactory: all show traces of the unskilled compiler's hand. For example, in the chapter devoted to the last-named subject, the author, in speaking of "giants' caldrons," omits to state that the most remarkable examples, those, indeed, to which this name is commonly applied, and we think usually restricted, have been made by the action of streams which once plunged down the *moulins* of glaciers. It is quite true that these are not excluded by the author's words, but no hint of their occurrence is given, and no mention is made of the remarkable instance at the "glacier garden" near the Lion monument at Lucerne. It is difficult, without long quotations accompanied by a running commentary, to give an idea of the number of small defects or inaccuracies which abound in the book. We may, however, select, without actual quotation, the pages 127–36, which deal with the orography of the St. Gothard district. Here the Rhone glacier is said to be "over twenty miles long,"—probably fifteen would be nearer the mark. The "granite" of the table-land of the St. Gothard is "famed for its great crystals of feldspar." True, these crystals are fairly large, but not remarkable—much less than those occurring on the Lukmanier, which are often quite 3 inches long. Not the granite but the schist is famed "for the great number of minerals found in it." Among these minerals are enumerated various "zoolites" (zeolites), but neither albite, for which the St. Gothard is a rather noted locality, nor garnets, nor tremolite, nor actinolite, which are so abundant near the Val Tremola. One or two more slight inaccuracies, on which it is needless to dwell, may be noted in these pages.

Perhaps one of the most conspicuous instances will be found on p. 49, in a table of the eleven Alpine peaks which surpass 14,800 feet in height. First comes "Mont Blanc, highest point 15,779"; then, "*id.*, Mont Maudit, 15,651"; and third, "*id.*, Cour Mayeur (*sic*), 15,602." This is misleading. It is quite true that the actual summit of Mont Blanc lies a little north of a slight prominence which from Courmayeur appears to be the summit. The latter, however, is not a separate peak in any respect comparable with the Mont Maudit. It is a case very similar to the "Wengern Jungfrau" and the true summit, and on this principle separate peaks might be manufactured to any extent in the Alps. Further down is a more serious error. We find "Mischabelhörner, Täschhorn, 14,972 feet"; and a little lower in the list, "Mischabelhörner, Grabhorn, 14,949 feet." But the latter, more usually called the Grabenhorn or Dom, is the higher peak, as is correctly stated elsewhere in the volume, though there the altitudes given are not the same. There is yet another error. The author enumerates three of the actual peaks of Monte Rosa; then at the end of the list he places "Monte Rosa, Lyskamm, 14,887 feet," and "*id.*, Weisshorn, 14,804 feet." But the Lyskamm is always regarded as a separate mountain, and the depression between the two, crossed by the well-known Lysjock, though it is only 800 or 900 feet lower, is so wide and well marked as to justify the separation. But to rank the Weisshorn as a peak of Monte Rosa is hopelessly indefensible. The mountains are more than ten miles apart as the crow flies, and separated by the deep trench of the Visphal.

One rather short chapter is devoted to the fauna and flora of the Alps, and the information there given is extremely scanty, and not seldom inaccurate. For example, the rhododendrons only appear under the vague and misleading trivial name of the "Alpine rose," and it is not even hinted that there is a true *Rosa alpina*. Heaths, again, are hardly to be enumerated among the higher Alpine plants, and azaleas are only represented by the abundant but very inconspicuous *Azalea procumbens*. The account of the fauna is equally unsatisfactory. The chamois receives only a passing mention, and is not enumerated among the animals frequently found above the snow-line. The steinbock (*Capra ibex*) is briefly alluded to under the name of the "wild goat." The birds are vaguely enumerated, and, while undue prominence is given to some, others, which as a rule especially attract the traveller's notice, are passed over in silence. The insects are almost wholly neglected; yet, without entering into many scientific details, it might have been possible to give some idea of the crowds of little blue butterflies (*Polyommatus*) that flutter about the puddles on the pathways, of the coppers (*Lycæna*), ringlets (*Hipparchia*), fritillaries (*Argynnis* and *Melitæa*), clouded-yellows (*Colias*), and Apollos (*Parnassius*), which impress the traveller accustomed only to the European lowlands, when first he rambles among the true Alpine regions. It would be easy to name more than one similar work, by no means of recent date, which in this respect is far superior to Prof. Umlauft's.

The illustrations are numerous, but rather unequal in quality. Some are fairly good, but frequently, while accurate in general effect, having probably been engraved from photographs, they are defective in character. A glance at the representation of the gorge of the Tamina on p. 48, or that of Monte Cristallo from the Dürrensee (facing p. 86), will indicate the nature of our objection. The rocks might be moulded from plaster or canvas. There is, however, a very clearly printed geological map of the Alps, which appears to us generally accurate, though we doubt the correctness of placing a considerable patch of Silurian and Devonian about the upper part of the Brenner Pass.

T. G. BONNEY.

THE PLANTING AND AGRICULTURAL INDUSTRIES OF CEYLON.

Review of the Planting and Agricultural Industries of Ceylon, and Statistics of the Planting Enterprises in India and the Colonies. By J. Ferguson. Pp. 168. (Colombo: A. M. and J. Ferguson, 1888.)

THIS is a reprint, in the form of a small octavo volume, of information contained in Ferguson's "Ceylon Hand-book and Directory," specially relating to the tropical cultures of Ceylon. It affords much authentic information in a handy and accessible form, and is a valuable summary of the results attained in the cultivation of most economic plants suited to a tropical country. Ceylon itself is a singularly interesting island. It is usually described as the largest, most populous, and most important of the Crown Colonies of Great Britain. It has in recent years become the seat of planting industries which have in one or two instances almost monopolized the markets of the world. It is six times the size of Jamaica, and about five-sixths the size of Ireland. Of its sixteen million acres, at present only about three millions are under cultivation, and these support a population of exactly the same number. The value of the imports and exports amounts to about ten millions sterling. The total number of European residents in Ceylon is under five thousand, while the mixed or coloured population called Eurasians or Burghers amounted to about nineteen thousand. The bulk of the population, amounting to nearly two million souls, is composed of Sinhalese—a remarkably tractable and inoffensive people—while the remainder is made up of Tamils, Moormen, Malays, and Veddahs. The latter are an aboriginal race, comparatively few in number, inhabiting the forests of the north-east.

Although the number of the Sinhalese is relatively so large, they contribute very little to the labour supply of the European plantations. Plantation labour is furnished by Tamil coolies from Southern India. According to a Report published by the Government of Madras, out of a population of thirty-five millions of human beings in that Presidency there are sixteen millions whose annual earnings do not average more than £3 12*s.*, or a little over 2½*d.* per day. Thus it is that the plantations of Ceylon, paying about 6*d.* or 9*d.* per day, are abundantly supplied with cheap free labour.

The purely European enterprises consist of tea, coffee—both Arabian and Liberian—cacao, cardamoms, rubber, annatto, vanilla, pepper, fibres, nutmeg, cloves, dye-plants. In these is invested English capital to the amount of about eight millions sterling. The native industries are associated with the cultivation of the cocoa-nut palm—yielding oil, coir, and copra—rice, cinnamon, palmyra palm, kitul or jaggery palm, areca palm citronella and lemon grass, tobacco, cotton, sugar-cane, dry grains such as kollu, millet, kurakkan, maize, and numerous vegetables and fruits. It is estimated that there are nearly fifty million cocoa-nut palms in Ceylon, and the yearly yield cannot be less than about 500 million nuts. Next to the cocoa-nut palm, the palmyra palm (*Borassus flabelliformis*) is regarded as one of the richest plants known. According to a Tamil proverb, "It lives for a lac of years after planting, and lasts for a lac of years when felled." Jaggery sugar is made from the sap, and in the dry, arid regions of the north-east of Ceylon more than seventy million nuts are annually produced. The young sprouting nuts are used as a vegetable. The kitul (*Caryota urens*) is another sugar-palm, which, in addition, yields a coarse black fibre used in broom-making. Cinnamon is essentially a native industry. The island has been famous for this spice "from the dawn of historical records." There is a Sinhalese caste of cinnamon peelers, and these, the Chaliyas, hold practically a monopoly in preparing the bark for the market. The dry grain cultivation is associated with that baneful *chena* practice of recklessly cutting down and burning virgin forests—now, we are glad to notice, in course of being kept within proper bounds. The natives of Ceylon have imitated the Europeans in many industries, but by far the greater number are content to follow in the footsteps of their ancestors, and cultivate only such plants as cocoa-nuts, rice, fruits, and vegetables, necessary to supply their daily wants.

For many years the chief European industry was that of coffee. From 1825, when Sir Edward Baines started the first upland coffee plantation near Kandy, to 1875, when Ceylon exported nearly a million hundredweights, "coffee was king." In 1869, a microscopic fungus (*Hemeleis vastatrix*) made its appearance on the leaves of the coffee-plant. This spread with such rapidity, and with such destructive effect, that within a few years the Ceylon coffee plantations were doomed. The disease extended also to Southern India, to Sumatra, and Java; it invaded Mauritius, Madagascar, and Natal, and reached even the young and promising plantations of Fiji. After twenty years' experience of this pest, the Ceylon coffee plantations have so dwindled that the present exports are only one-tenth of what they once were. Fortunately the decline of coffee was accompanied by the extension of cultivation of cinchona, cardamoms, cacao, and tea Ceylon cinchona has been produced in such quantities that the markets have been completely glutted. In consequence the price of bark has fallen so low that the cultivation is unremunerative. The attention of Ceylon planters is now being concentrated, with their accustomed energy, on the cultivation of tea. Coffee, cinchona, and everything not immediately remunerative are being uprooted to give place to the new staple. Although the industry is not more than ten or twelve years old, Ceylon tea is already being exported to the value of £600,000. Tea therefore bids fair to take the place of coffee, and thus the cloud which has overshadowed the prosperity of the island during the last few years is gradually passing away. Ceylon cacao is excellent, but the industry is small and apparently stationary. It is doubtful whether the island possesses any really large extent of land suitable for the growth of the cacao-plant. The rubber industry in Ceylon, as elsewhere, is mysteriously unproductive, while the cultivation of vanilla, pepper, and fibres, is only in the experimental stage. The total areas under the various cultivations at present are: tea, 183,000 acres; coffee (Arabian), 77,000 acres; coffee (Liberian), 916 acres; cinchona, 36,000,000 trees over two years old; cacao, 12,000 acres; cardamoms, 5000 acres; rubber-trees, 386 acres; croton, castor-oil, aloes, cinnamon, vanilla, pepper, cloves, plantains, and citronella grass, 7400 acres; gum-trees, fruit-trees, sapan, sapu, cocoa-nuts, areca-nuts, nutmegs, 4600 acres.

Such are a few of the gleanings from this useful account of the planting and agricultural industries of Ceylon. Mr. Ferguson is favourably known as a successful journalist, and as the author or joint-author of numerous publications connected with the island in which he has spent the greater part of his life. Indeed, it would not be too much to say that Mr. Ferguson and his uncle have contributed by their writings in no small degree to promote the various industries upon which the prosperity of Ceylon depends. To those whose interest or whose business is connected with tropical cultures this summary will prove most useful. It covers a wide field, but, so far as Ceylon is concerned, it contains information available in no other way. The historical and statistical facts, no less than the points respecting the treatment of tropical plants, are collected from trustworthy sources, and are of interest wherever such plants are cultivated, and we may add scarcely a single tropical product is passed unnoticed. D. M.

PALÆONTOLOGY.

Die Stämme des Thierreiches. Von M. Neumayr. "Wirbellose Thiere." Erster Band. (Wien und Prag: Tempsky, 1889.)

THE palæontologist has been defined as a variety of naturalist who poses among geologists as one learned in zoology, and among zoologists as one learned in geology, whilst in reality his skill in both sciences is diminutive. The division of zoology into palæontology and neontology is one which is, no doubt, logically defensible, and so would be a division of the subject-matter of zoology into as many branches as there are periods recognized by geologists—cambriontologists, siluriontologists, anthrakontologists, &c. On the other hand, it must be admitted that such divisions seem unlikely to tend to the furtherance of our knowledge of animal life in the past. The fragmentary remains of extinct animals can only be interpreted by the application to them of a very thorough knowledge of the form and structure of living animals, and accordingly it would seem desirable that, as is more usually the case in regard to the study of plant remains than in regard to that of animal remains, the study of palæontology should be relegated to those who also occupy themselves with neontology. The botanists, with few exceptions, pursue this plan; but curiously enough, a special class of palæontological zoologists exists and flourishes. A further advantage to be derived from the suppression of palæontologists seems to be this—that there would be a better chance for the cultivation of true geology, which now, to some extent, has its professorial positions, its museums, and its publications invaded by these specialists. Whatever may be said in favour of the palæontologist, he cannot be allowed to claim geology as his own; nor should the capable geologist, as is unfortunately and so frequently the case, venture beyond his last, and discourse on zoology in the disguise of a palæontologist, for the disguise cannot effectually conceal his incompetency to deal with zoological problems.

Whilst believing that it is increasingly desirable that the truth of the above propositions should be recognized and acted upon, we are yet prepared to admit that, as a practical division of labour in the great field of zoological science, palæontology must be recognized. Human knowledge does not develop according to abstract conceptions of the relations of one branch of study to another, but on a much more homely basis, open to philosophical objections of the most severe character. The way in which things have presented themselves to the hands and minds of students in consequence of practical demands or special opportunities of study is that which has determined the existence of the various divisions of natural history and the consequent groups of naturalists devoted to one or another unphilosophically limited pursuit. The collecting of "fossils," the hammering out of the fragments of a past world from their stony graves, the cultivation of the faculty of recognizing the significance of minute and detailed portions of fossilized shells and bones, is a definite hobby, which has excited the enthusiasm and stimulated the ingenuity of a long list of remarkable men, such as Woodward, Mantel, Barrande, and a host of less-known collectors. It seems not improbable that, were the remains of extinct animals in our great public and educational collections classified and placed with those of recent forms, an injustice, not to say an injury, would be done to the special phase of scientific activity which has produced these collections, and the important knowledge of the history of life on the earth which they represent. The morphologist, dealing with the complete structure of recent forms, is liable to neglect all but the more perfect remains brought to light by the collector of fossils; whilst, on the other hand, the palæontologist interprets the most obscure fragments, and speculates, it may be audaciously, but not unwisely, upon the significance of all that comes to his hand.

The volume which has led to these remarks is the first part of a treatise which is improperly named. It is not a treatise upon the pedigree of the animal kingdom, but an account of extinct animals treated in zoological order—in fact, a manual of palæontology. As an introduction, there is an extensive essay on Darwinism, and a discussion of Lamarckism and the causes of variation, which are becoming more and more the absorbing topics of the day. Dr. Neumayr does not appear to make any contribution of general importance to the discussion; but he makes the doctrine of descent and the Darwinian theory of natural selection the guiding principles of his treatise. The neontologist, if we may venture to call anyone by that name, will find in Dr. Neumayr's pages many facts of great value in the elucidation of biological problems, and a number of excellent woodcuts. The work promises to be one of considerable size, since this first volume consists of six hundred pages royal octavo. It is written from the point of view of the author's nationality, and naturally such new matter as it contains is chiefly in reference to the palæontology of the Austrian Empire. E. R. L.

OUR BOOK SHELF.

Text-book of Physiography. By Edward Hull, M.A., LL.D., F.R.S. (London: Deacon and Co., 1888.)

FROM the Director of the Irish Geological Survey we should naturally expect a text-book of exceptional merit, but we must confess at the outset that he has disappointed us. In the first place, he does not seem to have a clear conception as to the scope of his subject. Physiography is essentially an introduction to the study of natural forces and their effects, and consequently not only comprises the various movements and physical features of the earth, but also includes a study of the various forms of energy and the properties of matter. Of the latter, Prof. Hull has written nothing. Again, it is difficult to see for what class of students the book has been written. It is evidently not for beginners, being avowedly addressed to those who have access to the Transactions of the learned Societies; and the treatment is far too superficial for advanced students.

The first part of the book is designated "Astronomical and Introductory," the earth being considered in relation to the other planets. The questions of latitude and longitude, and a chapter on the moon, fall under this head. This part of the subject is treated so briefly that very careful reading will be necessary on the part of those who are not previously acquainted with it.

Part II. deals with "Terrestrial Physics and Dynamics," and discusses the form and structure of the earth, volcanoes, and earthquakes. The theory of a viscous stratum beneath the earth's crust is put forward as confidently as if it were the law of superposition of strata, and all reference to the objections which have been urged against it is omitted. It would be hard to compress more debatable matter into a page than has been effected in the diagram which illustrates this theory (p. 55).

The physical features of the globe, such as surface forms, oceans, coral islands, tides, air currents, and the functions of rivers and glaciers, are treated in Part III. Terrestrial magnetism also falls under this head, and this is really an excellent outline of the subject, as far as results go; but practically nothing is said about the instruments which are employed. As a compromise between the views of Darwin and Murray regarding coral reefs, Prof. Hull suggests (p. 110) that "the volcanic islands and banks of organic materials are themselves planted on a floor formed by the surface of a continent, which once occupied the region of the Central and Western Pacific." We will leave the opposing parties to form their own opinions as to the value of this suggestion.

The geographical distribution of plants and animals forms the subject of Part IV., and here there is little to complain of.

The book is illustrated with thirteen coloured plates and maps, and eleven diagrams. Some of these, as, for example, the map showing the lines of equal magnetic variation and declination for the British Isles, are excellent. The whole book bears traces of having been written hastily, and we cannot but regret that the author of "The Coal-fields of Great Britain" should have added one more to the already too large number of text-books that seem to present physiography as a subject in which no originality is possible.

The Clyde, from its Sources to the Sea. By W. J. Millar, C.E. (London: Blackie and Sons, 1888.)

MR. MILLAR has succeeded in writing an interesting book about the Clyde, and about Glasgow in particular. The subject is worthy of the care devoted to it by the author, for what river or city in the United Kingdom has more varied industries to boast of, and where are the applications of science more numerous?

Probably no river owes its improvements more to the engineer than the Clyde. We are told how eminent engineers were called in, and surveys made, in order to deepen the river and make it more navigable; Smeaton and James Watt each had their turn, and afterwards many well-known men in their time reported on the same subject. The result is that the Clyde of to-day is able to float the largest ocean steamers in its harbour, a state of things of which the people of Glasgow are justly proud.

The growth of the steam-ship, of course, occupies much space, since it was on the Clyde the first successful attempts at steam navigation were made. These are duly described, and the boats illustrated. On recent Clyde-built ships our author has much to say, and, among other things, he gives an account of some experiments conducted by the late Mr. William Denny to investigate the relation existing between speed and resistance of ships. Messrs. Denny, at their ship-building yard at Dumbarton, have constructed an experimental tank with all the requisite machinery for the purpose, thus carrying on the investigations initiated by the late Dr. Froude.

This volume gives one a good insight into the varying industries carried on in Glasgow and its neighbourhood, and contains much general information about the district. The book is well written, nicely printed and illustrated, and should find a place in the libraries of the citizens of St. Mungo, and others interested in the progress of the district.

A Playtime Naturalist. By Dr. J. E. Taylor, F.L.S. (London: Chatto and Windus, 1889.)

DR. TAYLOR explains that he has a liking for intelligent English lads, "just as some people have for blue china and etchings"; and he "ventures to think the former are even more interesting objects." Accordingly he has written this little book for the instruction and entertainment of his "human hobbies." The work contains abundant evidence of the author's knowledge and enthusiasm, and any boy who may read it carefully is sure to find something to attract him in the chapters on birds, Lepidoptera, land shells, toads, frogs, newts, invisible life, microscopic plants, and other subjects. The style is clear and lively, and there are many good illustrations.

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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Climate of Siberia in the Mammoth Age.

PROF. A. NEWTON, in his remarks on my letter, says that the similarity of the birds of Japan and of Europe has been long known. Of course it has. It is an elementary postulate in geographical zoology; but this is not the fact to which I called special attention, and from which I drew my inference. That fact is that, while the birds of Japan and England are in certain species undistinguishable, the corresponding birds of Siberia are sufficiently different to be classed as separate species. This could not be known, in the sense of being proved, until the avifauna of Siberia had been worked out from end to end, resulting in the formation of such a continuous series of skins as that in the possession of my friend Mr. Seebohm.

Prof. Newton goes on to argue that the remarkable fact here referred to is to be explained by the hypothesis that the birds of

Japan and Europe live in insular climates, while those of Siberia occupy an area with a continental climate. I do not think many biologists can accept this explanation. England and Japan are 3700 miles apart. That a single bird whose normal type is found in Siberia should vary from that type in two areas thus remote from one another in precisely the same way is perhaps possible. That a whole string of birds (and I only mentioned a sample) should do the same is, it seems to me, when tested by the doctrine of chances and the infinite variability of bird structure and colour, an impossibility.

Apart from this *a priori* argument, we have the fact—which is, of course, known to Prof. Newton—that Blakiston's line separating Yesso and the southern island of Japan also separates two avifaunas, and that the species on each side of the narrow strait of Yesso are in many cases different, although they live in insular areas close to one another, and subject to virtually the same insular climate, while those of England and Japan, whose climate is not so like, are undistinguishable. I cannot, therefore, for a moment accept Prof. Newton's theory as in any way meeting the facts which are admirably met at every point by the theory which I have propounded, and which is not based on the variation of the birds alone, but upon a whole *catena* of converging evidence from many sides, the evidence of the birds being only a subsidiary support.

I am sorry that I had overlooked Prof. Newton's article in the "Encyclopædia," and am glad that my suggestion about the red grouse, which I can assure him was quite independently made, had already occurred to and been countenanced by so distinguished an ornithologist, against whom I hear continual complaints, which ought to be very flattering, that he writes too little.

Reverting to the main issue, it is a great pleasure to me to have Prof. James Geikie's permission to publish an extract from a letter which he has sent to me, in which he is completely at one with me in the conclusion that, when the mammoth lived, the climate of Siberia was temperate, and that it lived where its remains are found. This is particularly gratifying to me, not only because Prof. J. Geikie is the most learned and voluminous writer upon the so-called Pleistocene age, his stout volumes being marked as much by their extraordinary profusion of references and of facts as by their lucid arrangement, but because upon some of the main conclusions I have arrived at he takes a very different view. Prof. J. Geikie says:—

"I do not need to be converted to the view that Siberia formerly enjoyed a temperate climate. If you will consult the first edition of my 'Great Ice Age' (p. 494), you will see that my belief for the last fifteen years has been that the mammalian remains of North Siberia are the relics of a fauna that lived and died in those now dreary regions. Indeed, I had that notion when I first began to read what had been written upon the subject some five-and-twenty years ago! I was willing, however, to admit the possibility of some of the remains having been drifted north by rivers. But it has always seemed to me inconceivable that this drifting would account for the presence of such great ossiferous accumulations as travellers have described. I likewise long ago discarded the notion of seasonal migrations, such as Dawkins and others have maintained (see *Geol. Mag.*, 1872, p. 164; 1873, p. 49)."

I shall not labour the argument further, nor shall I enlarge upon what I deem to be an inevitable corollary from it—viz. that if the climate of Siberia was temperate when the mammoth lived, and if it lived where its remains occur, on the now bare and almost perpetually frozen *tundra*, it follows that its extinction there must have been followed by a most rapid, if not a sudden, change of climate. The existence of its *undecayed carcasses* in all parts of Siberia, from the Obi to the Indigirka, is consistent only with this conclusion. If the change of climate had been gradual, the flesh of the great beasts could not have been preserved intact, but would have putrefied and decayed. This was long ago seen and emphasized by Cuvier, and even Lyell was constrained to write:—"It is certain that, from the moment when the carcasses both of the rhinoceros and the elephant above described were buried in Siberia, in lat. 64° and 70° N., the soil has remained frozen, and the atmosphere as cold as at this day." Again, he says:—"One thing is clear, that the ice or congealed mud in which the bodies of such quadrupeds were enveloped has never once been melted since the day when they perished, so as to allow the percolation of water through the matrix, for, had this been the case, the soft parts of the animals could not have remained undecomposed." It was to avoid the necessarily awkward inference from this conclusion, for one who preached uniformity so continuously, that Lyell was forced to invoke his theory of river portage, which is no longer tenable, and, so far as I know, is no longer held by any serious student. HENRY H. HOWORTH.

Bentcliffe, Eccles, February 3.

Peripatus in Victoria.

IT may interest some of the readers of your journal to know that last week, while collecting in a fern-tree gully at Warburton, on the Upper Yarra, Victoria, I had the good fortune to discover two specimens of *Peripatus*, belonging, as I think, to a new and certainly to a very beautiful species.

I hope to publish a full description, with figures, of the species as soon as possible, but I am now preparing for a visit to Tasmania, and some time must necessarily elapse before I can complete the work. I should therefore be greatly obliged if you could find space for this letter in NATURE.

In his "Monograph on the Species and Distribution of the Genus *Peripatus*," recently published in the *Quarterly Journal of Microscopical Science*, Prof. Sedgwick makes no mention of the occurrence of the genus in Victoria; though he describes in detail the Queensland and New Zealand species. In a note in the Proceedings of the Linnean Society of New South Wales (vol. ii. Part 1, 1887), however, Mr. Fletcher has recorded the discovery of the genus in Victoria. He says, "The specimen which I exhibit this evening was given to me a fortnight ago by my friend Mr. R. T. Baker, of Newington College, who had obtained it a few days previously either in or under a rotten log at Warragul, Gippsland, Victoria. It has fifteen pairs of claw-bearing appendages, and has nearly the same dimensions as are given in the abstract referred to; it is therefore in all probability an example of *P. leuckartii*, Sänger."

From Mr. Fletcher's account I am not able to say definitely whether the specimens obtained by me belong to the same species as the single specimen which he mentions; but after carefully studying Prof. Sedgwick's full description of *P. leuckartii*, I am fairly certain that they do not belong to that species, but to a new one which I for the present refrain from naming.

Both of my specimens were captured under fallen logs, where they were lying quite still. The first appeared to be dead soon after it was caught, and was therefore placed at once in alcohol. The second was found under a damp, rotten log, probably of *Eucalyptus*, in the same gully. It was taken home alive and put to crawl about on a newspaper, when it appeared very active. It elongated considerably when crawling, so that the legs came to be much further apart than when the animal was at rest, and when crawling it measured about 39 millimetres in length, excluding the antennæ. When irritated at the head end it ejected a surprisingly large quantity of an intensely sticky fluid, of a whitish colour, from the oral papillæ.

The species has, as in the two already described Australasian forms, fifteen pairs of claw-bearing legs, but it differs very strikingly indeed both from *P. leuckartii* and from *P. novæ-zealandiæ* in the colour and markings of the body. The general tint is brownish red, with only traces in one specimen of the bluish colour so characteristic of the two above-mentioned species. The markings on the body are singularly distinct and well defined, and identical in the two specimens. All down the dorsal surface there runs a median broad reddish-brown or chestnut-coloured band, divided into a series of diamond-shaped patches by regular lateral indentations, one diamond corresponding to each pair of legs. In the middle of this band there is a thin, median, whitish line. On either side the chestnut-coloured band is edged by a narrow black line, which follows the indentations of its margin, and outside this comes a broad band of darker brown, and then, at the edge of the dorsal surface, a narrow band of light brown. The ventral surface is light yellowish-brown, speckled with spots of very dark pigment, especially abundant at the base of each leg. In the mid-ventral line there is a row of white spots, one between the two legs of each pair except the first (?) and the last (where, of course, the genital opening is situated). The antennæ are light brown, closely ringed all the way up with very dark brown or black.

This species, though small, is to my mind even more beautiful than any of those figured by Prof. Sedgwick, and I think there can be little doubt as to its distinctness. The anatomical features I hope to describe at a later date, and perhaps they will throw further light upon its relations to previously described forms. ARTHUR DENDY.

University of Melbourne, December 18, 1888.

Mass and Inertia.

PROF. WORTHINGTON is perfectly right in saying that in my little book on mechanics I did not carefully and solely use the term inertia in the precise sense I suggested for it in my last letter. The fact that *m* is really only the coefficient of inertia had not been seized by me when I wrote that book. The idea of calling mass-acceleration inertia simply, was suggested, I believe, by a discussion on Newton's third law of motion in the pages of the *Engineer* some few years back. It is a suggestion which has gradually commended itself to me, and I am calling the attention of the British Association Committee on Mechanical Units and Nomenclature to it.

With regard to the other matter referred to by Prof. Worthington, it scarcely strikes one as a satisfactory plan to have one system of units for teaching and another for actual use. Is it not better to get students to tackle difficulties rather than evade them?

OLIVER J. LODGE.

The Crystallization of Lake Ice.

THE percussion figures that Mr. Holland has discovered both are interesting in themselves and seem to be a very handy means of marking off one crystal from another in thin lake ice. Their symmetry about a vertical axis is evidence that the optic axes of the crystals were vertical. The small amount of snow here this winter has afforded unusual opportunities for examining the ice on the Davos lake, and I have found crystals, not indeed equal to those on the Welsh lakes, but still very large. A striking feature in the ice, about a week after it was strong enough to bear skaters, was the presence of a number of hexagonal disks, of all sizes up to a quarter of an inch diameter, with their planes apparently horizontal. Some were regular hexagons, but generally the sides were unequal, though the angles were always 120°. I concluded that within a single crystal all the hexagons would be similarly oriented, and that an interface of two crystals could be distinguished by a sudden twist in the direction of the sides. Judged by this test some of the crystals were at least a foot broad, and in depth no doubt equal to the thickness of the ice, at that time about a foot. To verify this conclusion Mr. Kidd hacked out a piece with the axe, and we prepared a rough plate six inches long and three thick, which we examined in the polariscope. The rings and cross were easily seen, and the plate proved to be all one crystal with the optic axis vertical *in situ*.

These hexagons are not identical with the figures observed by Prof. Tyndall in the path of a sunbeam through ice (described in "Forms of Water"), for at the time I saw them the ice was so cold that water froze rapidly in any hole that was made. A friend describes them as looking more like bits of cover-slip glass than anything else. They were formed, I was told, on a day when the warm Föhn wind was blowing, and the ice, no doubt, was at a thawing temperature. But the puzzle is, why they did not vanish when the temperature fell. They reflected light strongly, far more than Tyndall figures, and in some cases showed the colours of thin plates. I noticed that those that gleamed with reflected sunlight often lay considerably to right or left of the vertical plane through the sun. This showed that their planes were (allowing for refraction) inclined sometimes as much as 10° or 15° to the horizontal, and inferentially that the optic axes of the crystals were tilted an equal amount from the vertical. I hunted about all over the lake for signs of the columnar structure that I described in my article on "The Plasticity of Ice," but only succeeded in detecting it in one place close to the shore. We cut out a piece there and verified the existence of the columns with the polariscope. There were no hexagons in that part of the ice.

Of the St. Moritz lake last winter I can only give a very imperfect account. For at the time I began observations the great depth of snow had sunk the ice, and water had oozed into the snow and there frozen, so that the clear ice was covered with some eighteen inches of hard snow ice. The only part easy of access was where a supply of ice was being cut for the hotels. The process adopted was, after clearing the ice from a certain space, to leave that for a week or two, till the new ice had reached the thickness of a foot, and then cut it again. Both the new ice and the old ice in its neighbourhood was columnar. In one place, however, at some distance from the shore, where we got out a lump of clear ice, we found crystals with the optic axis vertical, and one, at least, three or four inches across.

Davos Platz, January 29. JAMES C. MCCONNEL.

Falls of Rock at Niagara.

THE following passages, which will interest geologists, I copy from the *Montreal Daily Star* of the dates given:—

"Niagara Falls, Ontario, January 7.—Last Friday evening, about 9 o'clock, a large mass of rock fell from the precipice of the Horse-shoe or Canadian Falls, and on Saturday night, at 10 o'clock, another mass broke away. In both cases the noise made alarmed the residents in the vicinity. In the Table Rock House, a stone building, doors were thrown open, and the occupants jumped out of bed greatly excited by the unusual noise and vibration, resembling severe shocks of an earthquake. The same sensation was experienced at the residence of the gatekeeper on Cedar Island, and also half a mile up the river. The effect of these falls on the contour of the cataract is quite marked, the change being from that of an angle at the vertex to the original horse-shoe shape."

"Niagara Falls, Ontario, January 15.—Another piece of rock broke away from the crest of the Horse-shoe on Sunday night. Although the jar was comparatively slight, the shock was distinctly felt at the Table Rock House. The cataract now presents the extraordinary shape of a double horse-shoe, the smaller one caused by the recent displacement being in advance and to the right of the great horse-shoe. Visitors familiar with the shape of the Canadian Falls during recent years will be able to appreciate the change at a glance.

"Thousands of people visited the Falls yesterday and to-day to view the relics of the bridge torn down by the late gale,—this is the upper suspension bridge, close to the Falls, destroyed by the storm of last week,—and also to enjoy the magnificent scenery which Niagara always presents when arrayed in her winter apparel. The contract for a new bridge to replace the one destroyed has already been let, and the work will be completed in ninety days."

Additional facts are here furnished in favour of the opinion that the recession of the great cataract is going on at a rate much more rapid than some have maintained, and more rapid than was estimated by Sir C. Lyell in 1842. Indeed, the rate given by Mr. Bakewell in his work on geology seems to have been nearer to the truth, 3 feet per annum instead of the 1 foot assumed by the author of the "Principles of Geology."

Akron, Ohio. E. W. CLAYPOLE.

Origin of the Radiolarian Earth of Barbados.

THE Barbados infusorial earth is well known for the beautiful specimens of Polycystina which it contains, but concerning the rock itself, its geological position, and probable mode of formation, little has been written.

Schomburgk, in his history of Barbados, gave a general description of it and indicated some of the localities where it had been found, but he did not separate it geologically from the group which he designated the "Scotland formation." One of us having resided in the island for some years has had opportunities of studying the lie of the deposit, and has found that it always overlies the rest of the Scotland beds, and that it generally, although not invariably, intervenes between them and the raised coral reefs which form the surface of the greater portion of the island. It has been found below the coral in certain borings recently made by the Barbados Water-supply Company, and there can be little doubt that it originally formed a sheet of considerable thickness extending beyond the present limits of the island.

The rock itself varies much in composition: in some places it is almost purely siliceous, consisting mainly of Radiolaria and Diatomaceæ, whilst in others it is largely calcareous (one sample having yielded as much as 79·9 per cent. of calcium carbonate), containing in places many Foraminifera. The more siliceous specimens agree closely with the descriptions given of those deep-sea oozes which contain Radiolaria and are more or less destitute of Foraminifera. We intend to pursue our investigation of the deposit, and to compare it, if possible, with samples of modern Radiolarian ooze, but the facts already known to us render it highly probable that the deposit is part of a raised ocean bed. If this conclusion be confirmed, it will correct the prevalent belief that oceanic deposits are not to be found amongst the rocks which form continents and continental islands, and will at the same time form a strong and well-nigh invincible argument against the theory of the permanence of oceans, a theory which has recently been discussed and rejected by one of us.

J. B. HARRISON.
A. J. JUKES BROWNE.

Natural History in the Field.

WILL you allow me to draw the attention of students of field botany, field naturalists, and those interested in encouraging natural history in the field, especially schoolmasters who may be initiating classes for the study of our native plants, to the high probability of the present year being quite an exceptionally prolific year for all our sun-loving vegetable flora.

The want of sunshine last year kept all our wild flowers back. Nothing had its full development: flowers were late, foliage was thin, colours were dull and undefined, fruit small and without flavour, seeds unripe.

But one season's loss is the next season's gain; in all probability the plants this year will be exceptionally fine, and many plants that are usually small and poor will flourish with unusual vigour, while, not improbably, many plants which seldom show themselves here will this year blossom and become visible.

On this account it might be well to advise the starting of classes for the study this year of field natural history, for students, particularly young students, are encouraged to go on with a pursuit that has been very successful at its commencement.

Chigwell. W. LINTON WILSON.

Detonating Meteor.

ACCORDING to the Jamaica Weather Report for November 1888, a very brilliant meteor was seen at Kingston, Jamaica, on the evening of November 10, at 8h. 52m. local mean time.

It appeared about 30° above the south-west horizon, crossed the heavens, and disappeared about 30° above the north-north-east horizon; and as Kingston is in lat. 18° N., we have for the point of appearance the celestial co-ordinates R.A. 21h. 24m., N.P.D. 113°, and for the point of disappearance, R.A. 3h. 45m., N.P.D. 25°.

Mr. R. Johnstone writes:—"It was by far the brightest meteor I have ever seen, and it so lit up the sky as to cause consternation among many of the negro population. Exactly four minutes afterwards I heard a sound as of a distant explosion, which was not quite so loud as the 9 o'clock gun at Port Royal, heard in due time about four minutes later. The sound was heard by other people in Kingston."

As Kingston is 5h. 7m. W. of Greenwich, the meteor appeared November 11, 1h. 59m. a.m. Greenwich civil time; and therefore the meteor falls within the period November 11–15, which is one of the large-meteor periods, according to the useful summary given in Whitaker's Almanac.

The interval of four minutes between the appearance of the meteor and the sound of its explosion corresponds to a distance of forty-eight miles. I am sorry that the details are at present incomplete in many respects, but inquiry will be made.

MAXWELL HALL.

12 Hartington Road, Ealing, February 2.

MEMORIAL TO G. S. OHM.

A MEETING was held on Thursday afternoon, January 31, in the meeting-room of the Royal Society, the Right Hon. Lord Rayleigh, Sec.R.S., in the chair, for the purpose of promoting the co-operation of English men of science and others in a project, set afoot in the first instance by some of the Professors and other leading men in Munich, of erecting in that city a statue of George Simon Ohm—a man who, although he discovered no new phenomena of very striking importance, yet by the accuracy of his thought, and the clearness of his insight into the true bearings of physical facts, was able to lay one of the principal and firmest parts of the foundation of the noble edifice of modern physics.

The occasion for the proposal at this particular time to erect a memorial to Ohm is the near approach of the hundredth anniversary of his birth, on March 16, 1789. There are, moreover, reasons why this proposal should be, and no doubt will be, taken up warmly in this country. English physicists may recall with satisfaction that the award of the Copley Medal by the Royal Society on November 30, 1841, was the first public or official recognition that Ohm received of the value of his work upon the laws of the electric circuit, and that this award contributed in a very great degree to obtain for his researches the attention and appreciation they deserved. It may not be without interest at the present time to refer to the words in which the Chairman, Sir J. W. Lubbock, Bart, V.P. and Treas., announced the award. The following is from the report of the proceedings at the anniversary meeting of 1841:—

"The Council has awarded the Copley Medal for the present year to Dr. G. S. Ohm, of Nuremberg, for his researches into the laws of electric currents, contained in various memoirs published in *Schweigger's Journal*, *Poggendorff's Annalen*, and also in a separate work, entitled 'Die galvanische Kette mathematisch bearbeitet,' published at Berlin in the year 1827. In these works, Dr. Ohm has established, for the first time, the laws of the electric circuit; a subject of vast importance, and hitherto involved in the greatest uncertainty. He has shown that the usual vague distinctions of intensity and quantity have no foundation, and that all the explanations derived from these considerations are utterly erroneous. He has demonstrated, both theoretically and experimentally, that the action of a circuit is equal to the sum of the electromotive forces divided by the sum of the resistances; and that whatever be the nature of the current, whether voltaic or thermo-electric, if this quotient be equal, the effect is the same. He has also shown the means of determining with accuracy the values of the separate resistances and electromotive forces in the circuit. The light which these investigations have thrown on the theory of current electricity is very considerable; and although the labours of Ohm were for more than ten years neglected (Fechner being the only author who, within that time, admitted and confirmed his views), within the last five years, Gauss, Lenz, Jacobi, Poggendorff, Henry, and many other eminent philosophers, have acknowledged the great value of his researches, and their obligations to him in conducting their own investigations. Had the works of Ohm been earlier known, and their value recognized, the industry of experimentalists would have been better rewarded. In this country those who have had most experience in researches in which voltaic agency is concerned, have borne the strongest testimony to the assistance they have derived from this source, and to the invariable accuracy with which the observed phenomena have corresponded with the theory of Ohm. This accordance it may be observed is altogether independent of the particular hypothesis which may be adopted as to the origin of electromotive force; and obtains equally, whether that force is regarded as being derived from the contact of dissimilar metals, or as referable to chemical agency."

Ohm's book, "Die galvanische Kette," referred to in the above extract, was translated into English by Dr. William Francis, and published in 1841, in the second volume of "Taylor's Scientific Memoirs." The publication of Wheatstone's paper (read to the Royal Society, June 15, 1843), entitled "An Account of several New Instruments and Processes for determining the Constants of a Voltaic Circuit," also contributed in an important degree to attract attention to Ohm's work and to cause its importance to be recognized. We may call to mind also that it was in this country that the necessity of expressing electrical quantities in absolute measure first came to be generally recognized, and that the term "ohmad" or "ohm," suggested by Sir Charles Bright and Mr. Latimer Clark at the meeting of the British Association in Manchester, in 1861, first came into use as the name of a decimal multiple of the absolute unit of resistance convenient for practical purposes. Twenty years later, at the Congress of Electricians in Paris, in 1881, the "ohm" was unanimously adopted as an international standard. The name of the modest German Professor has thus come to be an understood term in the language of every civilized community in connection with the conception which he was the first to define with perfect clearness, and to show the true bearing of in relation to the connected ideas of electromotive force and strength of current.

At the meeting on January 31, resolutions, moved by the President of the Royal Society and by Sir Frederick Abel, K.C.B., were adopted, expressing the concurrence of those present with the proposal to erect a statue to Ohm, and appointing a Committee to make the scheme known in this country and to collect subscriptions. Dr. Hugo Müller, F.R.S. (who, when a student at the University of Munich, was a pupil of Ohm's), was requested to act as Treasurer of the fund to be collected, and Profs. G. Carey Foster, F.R.S., and John Perry, F.R.S., were appointed Secretaries.

The following memoranda, taken from Lamont's *Denkrede* to the Munich Academy, 1855, may not be without interest at the present time:—Ohm was born in Erlangen, where his family had been settled for several generations. His father, who followed the hereditary trade of lock-smith, was a man of active intellect, and gained a very considerable acquaintance with mathematics and physics. It was in great measure owing to his example and encouragement that his two sons, George Simon and Martin (who afterwards attained great distinction as Professor of Mathematics in the University of Berlin), developed a love for similar studies. In 1805, G. S. Ohm became a student of the University of Erlangen, whither he returned in 1811, after some years spent as a private tutor in Switzerland, and then took his doctor's degree and established himself as *Privatdocent*. For a short time he was a teacher in the *Realschule* at Bamberg, and in 1817 obtained a more important post as teacher of mathematics in the Jesuits' Gymnasium at Cologne. It was while he held this appointment that his ideas as to the laws of the galvanic circuit took definite shape, and that his memorable book, "Die galvanische Kette mathematisch bearbeitet," was written. Soon after the publication of this book in 1827, Ohm presented himself at the Ministry of Education in Berlin, and there met with a reception so little appropriate to the whole-hearted and self-sacrificing devotion to science of which he was conscious, that he felt it impossible to remain any longer in the public service. He was thus driven to spend seven years in the prime of life in a state of deep mental dejection, and with very scanty means of subsistence. The end of this dismal period came in 1833, when he was appointed, by the Bavarian Government, Professor in the Polytechnic School at Nuremberg. The award of the Copley Medal, in 1841, already mentioned, cheered and encouraged him still further, and in grateful acknowledgment he dedicated to the Royal Society his "Molecular Physics." From this time he came to be recognized as one of the leading physicists of Germany, and "Ohm's law" soon found its way into every text-book of physics. In 1849, he was called to Munich as Curator of the Physical Cabinet, and in 1852 he became Professor of Experimental Physics in the University. On July 7, 1854, he died suddenly from apoplexy. For a great part of his life he had a hard fight with outward circumstances; but he seems to have remained throughout singularly simple-minded and unassuming, and at the same time thoroughly honest and conscientious in his work. G. C. F.

THE ROYAL SOCIETY OF EDINBURGH.[1]

AT the commencement of the session 1883–84, the Royal Society of Edinburgh entered upon the second century of its existence. Since its foundation it has had among its members men whose fame is national and often world-wide—Joseph Black, Henry Dundas, James Hutton, John Playfair, Adam Smith, Dugald Stewart, Adam Fergusson, James Gregory, Henry Mackenzie, John Leslie, William Wallace, Walter Scott, Maclaurin, Brewster, Forbes, and more recently Clerk Maxwell; and at present it has members whose names will rank as high as these. In the year 1886 the membership of the Society was 507, and was rapidly increasing. The number of papers communicated to it in the period 1883–87 was 317. We shall therefore select for special notice a few of these, which may be taken as typical of the work done by the Society; and it will be seen that its work, if large in quantity, is also high in quality. We agree with the opinion expressed to the Society by the Chairman in his opening address in December 1886, that, "if we include the extra volumes on the Ben Nevis observations, and on the botany of Socotra, . . . the Proceedings and Transactions of the Society during the past three years probably surpass in bulk and importance those of any other Society in the United Kingdom for the same period."

In the department of mathematics, these volumes include valuable contributions to the science of situation, or of those space-relations which are independent of *measure* though not necessarily of *number*, from the Rev. T. P. Kirkman and Prof. Tait. The former writer contributes papers "On the Enumeration, Description, and Construction of Knots of fewer than Ten Crossings," and "On the 364 Unifilar Knots of Ten Crossings;" a note "On the Twists of Listing and Tait," and "Examples upon the reading of a Circle or Circles of a Knot." Prof. Tait gives a "Census of 8-fold and 9-fold Knottiness," and a "Census of 10-fold Knottiness," with a special treatment of amphicheirals. There is also a paper, "Ueber algebraische Knoten," by Prof. Fr. Meyer, of Tübingen.

Dr. Thomas Muir treats of subjects connected with the theory of continued fractions and with the theory of determinants. Dr. Muir constantly aims at the attainment of simplicity through great generalization. An example of this is given in his paper "On the Researches of M. de Jonquières on Periodic Continued Fractions." He points out that many of the theorems given by M. de Jonquières are not new, and that the earlier ones are all special cases of a more general theorem previously published by Dr. Muir himself. He then proceeds to use this general theorem for the purpose of giving unity to M. de Jonquière's work.

Among other papers we note, "The Expansion of Functions in terms of Linear, Cylindric, Spherical, and Allied Functions," by Mr. P. Alexander; a quaternion investigation by Dr. G. Plarr of "The curve on one of the co-ordinate planes which forms the outer limit of the position of the point of contact of an ellipsoid which always touches the three planes of reference;" and a note "On the Hessian," by Prof. Chrystal. M. Hermite contributes a paper "Sur la Réduction des Intégrales Hyperelliptiques," and Prof. L. Cremona gives an "Esempio del metodo di dedurre una superficie da una figura piana."

In a remarkable paper "On the Law of Inertia; the Principle of Chronometry; and the Principle of Absolute Clinural Rest, and of Absolute Rotation," Prof. James Thomson treats of questions on the border-ground between pure mathematics and physics. He discusses "such motions of points in unmarked space, as can have a reference frame relatively to which these motions are rectilinear and are changeless in mutual rate." The problem of finding a reference frame for a known set of such points is worked out in another paper by the same author by a method of mechanical adaptations, and Prof. Tait has given a quaternion solution of it. Prof. Thomson's law of inertia is the equivalent of Newton's first and second laws of motion. The paper is one which merits the perusal of all students of dynamics, and it may be specially recommended for study to certain classes of metaphysicians.

[1] Proceedings, Sessions 1883–87. Transactions, Vol. xxx. Part 4; Vol. xxxii. Parts 2, 3, 4; Vol. xxxiii. Parts 1, 2.

The fact that, in the kinetic theory of gases, Boltzmann's extension of Clerk Maxwell's theorem regarding the distribution of energy in a system of colliding spheres has led to results which are inconsistent with either the observed value of the ratio of the specific heats of a gas, or the complexity of the radiation spectra of gases, has induced Prof. Tait to investigate the question afresh from the very commencement. His results are contained in papers "On the Foundations of the Kinetic Theory of Gases," published in the Transactions. His great aim is the simplification of the mathematical treatment of the subject, and he has "purposely gone into very minute detail in order that no step taken, however slight, might have the chance of escaping criticism, or might have the appearance of an attempt to gloss over a difficulty." Abstracts of the papers have appeared in the *Philosophical Magazine*. The subjects treated in the first two papers are as follows: one set of equal spheres; mean free path among equal spheres; number of collisions per particle per second; Clerk Maxwell's theorem; rate of equalization of average energy per particle in two mixed systems; mean path in a mixture of two systems; pressure in a system of colliding particles; effect of external potential; pressure in a mixture of two sets of spheres; viscosity; thermal conductivity; diffusion. On the suggestion of Prof. Tait, Prof. W. Burnside applied a method used by the former in his first paper to the problem—Given a very great number of smooth elastic spheres, equal and like in all respects, whose centres of figure and centres of inertia do not coincide, and the sum of whose volumes is but a small fraction of the space in which they move, it is required to find the ultimate distribution of energy among the various degrees of freedom when by collisions the system has attained a "special state." Prof. Burnside's result is given in a paper "On the Partition of Energy between the Translatory and Rotational Motions of a Set of Non-Homogeneous Elastic Spheres." The various steps of the investigation are given in detail, and the assumptions are clearly specified. The conclusion is that the average energies of rotation of a sphere about each of the three principal axes are equal, and the whole average energy of rotation of a sphere is twice the average energy of translation.

Sir W. Thomson communicated sixteen papers to the Royal Society during the period under consideration. These include a remarkable series of investigations of various cases of fluid motion. Most of the papers have already appeared in the *Philosophical Magazine* or elsewhere; only four are given in detail in the Proceedings. These are "On a New Form of Portable Spring Balance for the Measurement of Terrestrial Gravity," "On the Front and Rear of a Free Procession of Waves in Deep Water," "On the Equilibrum of a Gas under its own Gravitation only," and "On Stability of Fluid Motion: Rectilinear Motion of Viscous Fluid between two Parallel Planes." From results obtained in the latter paper, Sir William considers it probable "that the steady motion is stable for any viscosity, however small; and that the practical unsteadiness pointed out by Stokes forty years ago, and so admirably investigated experimentally five or six years ago by Osborne Reynolds, is to be explained by limits of stability becoming narrower and narrower the smaller is the viscosity."

The following extract will give an idea of the scope of a paper by Lord Rayleigh, "On the Colours of Thin Plates":—"The theory set forth so completely in our treatises tells us indeed how the composition of the light reflected depends upon the thickness of the plate, but what will be its colour cannot, in most cases, be foretold without information of an entirely different kind, dealing with the chromatic relations of the spectral colours themselves. This part of the subject belongs to physiological optics, as depending upon the special properties of the eye. The first attempt to deal with it is due to Newton, who invented the chromatic diagram, but his representation of the spectrum is arbitrary, and but a rough approximation to the truth. It is to Maxwell that we owe the first systematic examination of the chromatic relations of the spectrum, and his results give the means of predicting the colour of any mixed light of known composition. Almost from the time of first reading Maxwell's splendid memoir, I have had the wish to undertake the task of calculation from his data the entire series of colours of thin plates, and of exhibiting them on Newton's diagram. The results are here presented, and it is hoped may interest many who feel the fascination of the subject, and will be pleased to see a more complete theory of this celebrated series of colours."

A little note by the (then) Astronomer-Royal for Scotland on Brewster's line Y in the infra-red of the solar spectrum is illustrated by an exceedingly instructive plate. The line Y is one of three discovered by Brewster in a portion of the spectrum usually invisible. As the Astronomer-Royal well remarks, "It was Brewster's eye that looked; so no wonder that he saw with it more than any of his predecessors, and most of his successors as well." Prof. Smyth proves that Y is a true solar line, being more distinct with a high than with a low sun. In the Royal (London) Society's publications the opposite had been asserted; and ultimately, though perhaps unintentionally, the line was altogether omitted from the spectrum—or, rather, it was misnamed Z. It is to be hoped that Prof. Smyth's paper will have the effect of removing all the ambiguity, and the consequent confusion, on this point. In this note, short as it is, we have evidence of the unlooked-for rewards which often await the scientific observer. While seeking for direct confirmation of M. Henri Becquerel's discovery that the line Y is due to sodium, Prof. Smyth discovered three new air-lines much farther in the infra-red than any previously discovered.

Prof. Piazzi-Smyth has also a paper on "Micrometrical Measures of Gaseous Spectra under High Dispersion." The paper is accompanied by maps of the spectra investigated on the scale of 40 feet to the visible spectrum. The prism arrangement gave a dispersion of 60° from A to H, and the magnifying powers of the telescope varied from 12 to 36 with a further magnifying power of 5 in the recording apparatus. There was thus in effect a possible dispersion of 9000°. The gases dealt with are CH, CO, H, O, and N. The peculiar arrangement of the leading lines (usually two) and train of linelets in each of the five bands of the CH spectrum is fully shown in the diagram and described in the text. The low-temperature (simple spark) spectrum of hydrogen is given, over 1600 lines being recorded. Prof. Smyth has found that three of the four principal oxygen lines are triple, and he has discovered three other such triplets. The remarkably methodical spacing of the lines in these triplets and of the triplets themselves is noted; but a more striking example of regular spacing is furnished by the lines in the green CO band. The map of this band is given on the scale of 120 feet to the visible spectrum. Prof. A. S. Herschel has made out two series of lines (single and double respectively) following the same law of arithmetical progression. The full interpretation of such "natural writing" may possibly never be obtained until we know the nature of molecules and atoms; but, on the other hand, a further investigation of spectra such as we have here may throw some light on molecular and atomic structure. So magnificent are the maps that accompany Prof. Smyth's paper, that one is rather inclined to speak of his contribution to the Transactions as a series of maps of spectra with explanatory text. But besides explanations the paper contains a full record of the experiments, and also tells a tale of high war—the combatants being the author on the one hand, and the London Royal Society, the London Royal Astronomical Society, *et hoc genus omne*, on the other. Vacuum-tubes containing nominally CO, but also showing exceptionally strong CH bands, were "by a London maker." Prof. Smyth once admitted (though with great reserve), with "the English spectroscopists," that the CO spectrum might be that of pure carbon; he "begs now to apologize for that error;" and, long after he has come off victorious throughout the whole line, the rumble of distant thunder is heard in his "concluding notes."

Mr. John Aitken's investigations regarding the formation of small clear spaces in dusty air are already known to the scientific public, from the abstract published in NATURE, vol. xxix. p. 322 (January 1884). His paper on dew, a short abstract of which appeared in NATURE, vol. xxxiii. p. 256 (January 1886), is also contained in the Transactions. Some observations in addition to those indicated in NATURE are described. These refer to evaporation from extremely dry soils in Britain and France, and also, on the evidence of travellers, in Australia and South Africa. Additional evidence regarding the formation of the dewdrop is also given.

Mr. A. Crichton Mitchell has repeated Forbes's and Tait's experiments on the thermal conductivity of iron, copper, and German silver. His observations were conducted under improved experimental conditions, and the methods of calculation were different in some respects. These differences are pointed out and explained by Prof. Tait in an introduction to Mr. Mitchell's paper. On the whole, Mr. Mitchell's work confirms that of previous experimenters. One of the most important of his conclusions is that iron forms no exception to the rule that the thermal conductivity of ordinary metals increases with rise of temperature.

Prof. C. G. Knott, of Tokio University, Japan, gives a full experimental investigation of the thermo-electric peculiarities and the electrical resistance of hydrogenized palladium. In another paper he treats of the electrical resistance of nickel at high temperatures, and concludes from his results that "there is a strong presumption that the Thomson effect in metals has a close connection with the mutual relations of resistance and temperature."

From a series of observations made in atmospheric electricity at the top of Dodabetta, the highest hill in the Neilgherries, Prof. C. Michie Smith is led to the conclusion that on the edge of a dissolving mist the potential is lower than the normal, while in a condensing mist it is higher than the normal. He says: "If my results are confirmed by more extended observations, strong support will be given to the theory which looks on the condensation of a number of slightly charged particles into larger drops as the cause of the high potential indicated by disruptive discharges." In connection with this, results obtained by Mr. H. N. Dickson regarding the direction of earth-currents at Ben Nevis are worthy of note. When mist descends on the mountain, or rain (or snow) falls, a down current is observed in the telegraph cable when put to earth at both ends; but when the mist rises from the mountain-top the direction of the earth-current is upwards.

Von Helmholtz contributes an account of galvanic currents passing through a very thin stratum of an electrolyte.

Many of the facts brought out in a series of papers by Dr. H. R. Mill and others on various physical and chemical conditions of tidal estuaries should be of much use because of their evident bearing on the distribution of various forms of animal life, and on questions connected with meteorology.

A number of years ago Prof. Tait undertook the work of determining the pressure-errors of the *Challenger* thermometers. This investigtion gave rise to many others: such as the lowering of the maximum density-point of water by pressure; the variation of the compressibility of water with temperature, pressure, and amount of salt dissolved; and the question of the internal pressure in water. The various results obtained by Prof. Tait are contained in a series of notes scattered throughout the Proceedings.

The complete series of observations made at the Ben Nevis Observatory have been handed over to the Royal Society of Edinburgh for publication; and, from time to time, valuable meteorological information in connection with the Observatory is communicated to the Society and appears in their Proceedings. Dr. Murray remarks that "the refusal of assistance (to the Observatory) by the London Committees may be partly due to the fact that there are many claims on the funds which they administer, but it appears also to be very largely due to a want of proper knowledge of what has been done, and what may be reasonably expected to be done, by the Observatory, there being no Observatory in these islands that can compete with the Ben Nevis Observatory for the accuracy and intrinsic value of the hourly observations; and absolutely no pair of stations anywhere in the world that can be named alongside the Observatory and the station at Fort William as contributing data in furtherance of our knowledge of storms and the science of weather generally."

These volumes contain two or three papers in the department of engineering. Mr. A. C. Elliot gives a new formula for the pressure of earth against a retaining wall, which is an improvement on Rankine's formula. In a paper on "Cases of Instability in Open Structures," Dr. E. Sang discusses a class of theorems of which one previously enunciated by him—to the effect that any symmetric structure built on a rectangular basis, having no redundant parts, and depending on longitudinal strain alone, is necessarily unstable—was a particular example.

In thé department of chemistry we note an elaborate paper by Prof. Dittmar and Mr. John McArthur, entitled "Critical Experiments on the Chloro-platinate Method for the Determination of Potassium, Rubidium, and Ammonium; and a Redetermination of the Atomic Weight of Platinum." The paper consists of five parts—two detailing experiments on the composition of chloro-platinate of potassium, a part on Finkener's and Tatlock's methods of potash determination, a part descriptive of experiments on chloro-platinate of rubidium, and another describing experiments on chlôro-platinate of ammonium. The authors conclude that the atomic weight of platinum is very nearly 195·5.

Prof. Dittmar also gives, in conjuction with Mr. C. A. Fawsitt, a "Contribution to our Knowledge of the Physical Properties of Methyl-alcohol." The "vapour-tension" (why not *pressure* since it *is* pressure?) is investigated under varying conditions, and the specific gravity of aqueous methyl-alcohol for all the integral percentages is also tabulated at 0° C. and 15°·56 C.

Dr. John Waddell has determined the atomic weight of tungsten by an entirely new method, and has obtained results confirmatory of the commonly accepted value.

Comparatively few papers dealing with botanical questions were communicated to the Society during the period under consideration. A note "On the Structure of the Pitcher in the Seedling of *Nepenthes*, as compared with that in the Adult Plant," in which the late Prof. Alexander Dickson first called attention to the peculiar large marginal glands of *Nepenthes*, is of much interest. The Proceedings contain the fourth part of "Diagnoses Plantarum Novarum Phanerogamarum Socotrensium, &c.," by Prof. Bayley Balfour, and a note "On Degenerated Specimens of *Tulipa sylvestris*, by Mrs. A. B. Griffiths. Mr. John Rattray contributes a note on the marine plant *Ectocarpus*.

The number of papers in zoology and allied sciences is somewhat large.

In the summer of 1868, H.M.S. *Lightning* explored the region of the North Atlantic lying between the Hebrides and the Faroes. In 1869 H.M.S. *Porcupine* made three cruises, the first off the north-west and the west coasts of Ireland, the second off the south and south-west coasts of Ireland, and the third off the north of Scotland as far as the Faroes. In 1870, the *Porcupine* dredged down the west coasts of France and Spain and in the neighbourhood of Gibraltar Strait, and explored the African coast of the Mediterranean as far east as Sicily. Prof. W. A. Herdman contributes to the Transactions the Report upon the *Tunicata* dredged during the cruises of H.M.SS. *Porcupine* and *Lightning* in the summers of 1868, 1869, and 1870. The Simple Ascidians alone are treated of. The Report on the *Pennatulidæ* dredged by the *Porcupine*, is by Prof. Milnes Marshall and Dr. G. H. Fowler. One new genus and one new variety were obtained. Dr. P. H. Carpenter writes "On the *Crinoidea* of the North Atlantic between Gibraltar and the Faroe Islands," and some notes are added by Prof. L. von Graff on the *Myzostomida*. The Report on the *Ophiuroidea* of the Faroe Channel, mainly collected by H.M.S. *Triton* in 1882, is drawn up by Mr. W. E. Hoyle. Mr. Hoyle also gives the second part (on the *Decapoda*) of a preliminary Report on the Cephalopoda collected by H.M.S. *Challenger*.

Mr. J. T. Cunningham (then of the Scottish Marine Station) writes on the "Eggs and Larvæ of Teleosteans;" on the "Reproductive Organs of *Bdellostoma*, and a Teleostean Ovum from the West Coast of Africa;" on *Stichocotyle nephropis*, a new Trematode, found as a parasite in the Norway lobster; and, along with Mr. Rupert Vallentin, on the "Luminous Organs of *Nyctiphanes norvegica*." Mr. George Brook discusses "The Formation of the Germinal Layers in Teleostei." Mr. Harvey Gibson gives a detailed account of the anatomy of *Patella vulgata*, no systematic account having been previously given, though separate accounts of various organs have appeared. Mr. Frank E. Beddard writes "On the Minute Structure of the Eye in certain *Cymothoidæ*;" "On the Structural Characters of certain new or little known Earthworms," five apparently new species and possibly a new genus being described; and "On the Reproductive Organs of the Genus *Eudrilus*." Mr. J. Arthur Thomson describes the structure of *Suberites domuncula*, a sponge found covering the outside of a sea-snail shell inhabited by a hermit-crab.

In geology some important papers appear. Dr. Traquair contributes the first part of a Report on fossil fishes collected in Eskdale and Liddesdale (*Ganoidei*). Mr. R. Kidston gives the first two parts of an account of the fossil flora of the Radstock series of the Somerset and Bristol coal-field (Upper Coal Measures). A note is appended on the fossil flora of the Farrington, New Rock, and Vobster series, and a table is given comparing the flora of the Radstock series with that of other coal-fields. Mr. Kidston also discusses the fructification of some ferns from the Carboniferous formation. Prof. Geikie writes on the geology and petrology of St. Abb's Head. The final Report of the Boulder Committee of the Society is contained in the Proceedings.

The plates in Vol. xxx. accompanying a paper by Dr. Traquair on fossil fishes are of great artistic merit. Indeed, the illustrations which are contained in the Proceedings and Transactions are probably unsurpassed by those published by any other similar Society.

Observations by Dr. H. B. Guppy, of H.M.S. *Lark*, on coral reefs and calcareous formations of the Solomon Group, appear in both publications. He is led to the conclusions: (1) that these upraised reef-masses, whether atoll, barrier-reef, or fringing-reef, were formed in a region of elevation; (2) that such upraised reefs are of moderate thickness, their virtual measurement not exceeding the limit of the depth of the reef-coral zone; (3) that these upraised reef-masses in the majority of islands rest on a partially consolidated deposit which possesses characters of the "volcanic muds" which were found during the *Challenger* expedition, to be at present forming around volcanic islands; (4) that this deposit envelops anciently submerged volcanic peaks. The bearing of the two latter conclusions on Dr. Murray's theory of the formation of coral islands is important.

We conclude with another quotation from the address already referred to:—"With respect to Scotland, the only grant for scientific purposes in aid of learned Societies is £300 annually to the Royal Society of Edinburgh, which is repaid to a department of the Government in the form of rent. One might well ask what Scotland had done that her learned Societies and scientific men should be treated so niggardly as compared with those in England and Ireland. It cannot be because she does no scientific work. It is sometimes said, indeed, that in literary matters Scotland, and especially Edinburgh, is a mere shadow of her former self; but in science this is not the case, and it is towards scientific matters that the great ploughshare of human thought and activity is, in this age, directed. I question if any country in the world, taking into consideration its size, can show a better record of scientific work, or a more excellent volume of scientific literature than Scotland, during the past ten or twenty years."

TIME.

TIME is one of the very numerous subjects which seem to be perfectly simple until we begin to think about them; then difficulties crop up in all directions, and afford a favourite battle-ground to philosophers.

Newton, avoiding metaphysical difficulties, gave an account of time which suffices for all the purposes of the mathematician and experimentalist. "Absolute, true, and mathematical time of itself and from its own nature flows equably and without regard to anything external, and, by another name, is called duration; relative, apparent, and common time is some sensible and external measure of duration by means of motion."

The word time is here used to express two distinct ideas, for the former of which it would be better to reserve the term duration. This double meaning of the word has caused much controversy between idealists and materialists, which is still far from arriving at any definite result. Thus, Whewell writes ("Hist. Ind. Sci.," 131):—"Time is not a notion obtained by experience." "Time is a necessary condition in the presentation of all occurrences to our minds. We cannot conceive this condition to be taken away. We can conceive time to go on while nothing happens in it, but we cannot conceive anything to happen while time does not go on."

It has always seemed to me that philosophers are rather hard on the intellect of their fellow-mortals in laying down so absolutely, as they are fond of doing, what can and what cannot be conceived by the mind, when they are in reality arguing from a single instance—their own. Many persons would be tempted to say that the idea of the fourth dimension of space is inconceivable, did not men of more powerful intellect assure them that their crude ideas on the subject are quite erroneous. I can myself find no impossibility in the conception of a universe composed of a homogeneous mixture of gases, to which the ordinary conception of time does not apply. If I err, I I at least do so in good company. Lucretius writes (i. 460):—

> "Tempus item per se non est, sed rebus ab ipsis
> Consequitur sensus."

And, in 1690, Locke gave the following luminous exposition of this difficult matter ("Hum. Und.," xiv.):—"A man having, from reflection on the succession and number of his own thoughts, got the notion or idea of duration, he can apply that notion to things which exist while he does not think; as he that has got the idea of extension from bodies by his sight or touch can apply it to distances where no body is seen or felt." "Thus, a man when he is asleep, or when his mind is entirely occupied by one subject, has no notion of the passage of time." "This consideration of duration, as set out by certain periods and marked by certain measures or epochs, is that, I think, which most properly we call time."

According to Locke, then, duration is measured out, as it were, into time by changes, and as these changes are, so far as we know, due to motion, the ideas of time and motion are closely connected. These views have been further developed by Herbert Spencer ("First Principles," 163, 167, 171):—"The relation of sequence is given in every change of consciousness." "The abstract of all sequences is time. The abstract of all co-existences is space." "The conception of motion, as presented or represented in the developed consciousness, involves the conception of space, of time, of matter—a something that moves; a series of positions occupied in succession; and a group of co-existent positions united in thought with the successive ones." "These modes of cohesion, under which manifestations are invariably presented, and therefore invariably represented, we call, when contemplated apart, space and time; and when contemplated along with the manifestations themselves, matter and motion."

The abstract idea of duration without beginning or end is of the greatest value to the mathematician, but, so far as we know, it has no representative in Nature. It would, of course, be measured out by the equal spaces passed over by a body moving under the action of no forces, but no known body is in such a condition. As possible instruments for the accurate measurement of time, Thomson and Tait suggest a spring vibrating *in vacuo*, and Clerk Maxwell the period of vibration of light-waves of definite length. From this conception of duration or equable flow, Newton deduced his method of fluxions, which, owing to his delay in publishing the method, occasioned the lamentable controversy as to priority with Leibnitz. Though the manuscript of Newton's first paper on fluxions has been found with the date May 20, 1665, it was only communicated in a letter to Collins in 1672, used in some papers on motion read before the Royal Society in 1683, and printed in 1684. The method was first definitely published to the world in the "Principia," in 1687. According to Maclaurin: "In the doctrine of fluxions, magnitudes are conceived to be generated by motion, and the velocity of the generating motion is the fluxion of the magnitude." Suppose a movable point, starting from a fixed point, A, describes a line A B, of length x, Newton represented by $\dot{x}$ the velocity with which the line is described. Again, the velocity itself may not remain constant, but either increase, as when a stone falls, or decrease, as when a shot is fired. This change of velocity, now called acceleration, was expressed by $\ddot{x}$.

The conception of velocity is passing over a certain space in a certain time, as a mile in a minute or 88 feet in a second, and we may conceive both space and time to become infinitesimally small, so that the ratio of the one to the other becomes a fluxion. Acceleration is measured by the number of units of velocity gained or lost in the unit of time; thus, the acceleration due to gravity is a velocity of 32 feet per second gained or lost in a second.

The discussion of the connection between this conception of fluxions and the various methods of conceiving space as made up of infinitesimal portions, which were used more or less imperfectly by various mathematicians, until they were generalized and systematized by Leibnitz into the differential calculus (1675), would occupy too much space. A fluxion or differential, as was clearly pointed out by Newton, depends upon the philosophical conception of a limit, the foundation of so many of the higher branches of mathematics.

Important as are these theoretical questions deduced from the idea of duration, the practical questions of time and the means of measuring it with accuracy are far more so.

Since astronomers have been unable to find any truly equable motion by which to measure equal intervals of time, they make use of a fictitious sun, which apparently moves round the earth in the same period as the real sun does, alternately before and after it, but coinciding with it four times in the year—on April 15, June 14, August 31, and December 24.

The interval between two apparent passages of the fictitious sun over the meridian is a mean solar day, which is divided into 24 hours, 1440 minutes, or 86,400 seconds. The length of the tropical year, or the interval before the return of the sun to the same equinox, is 365·2422 mean solar days.

In the observatory, astronomers use as their unit the sidereal day, or the interval between two appearances of the same star on the meridian; owing to the apparent motion of the sun, there are 366·2422 sidereal days in the tropical year, or a mean solar day is equal to 1·0027379 sidereal days. About March 22 of each year, sidereal 0 hour coincides with mean noon, and for each day from that date the difference increases by 3 minutes 56 seconds. For purposes of calculation, astronomers make use of "the Julian period" of 7980 tropical years, of which 1889 is the 6602nd; and at mean noon on January 1, 2,411,004 mean solar days of the period had elapsed.

The oldest time-measurer, the sun-dial, dates from, at all events, 700 B.C. In its most simple form it consists of a style fixed parallel to the axis of the earth, and a graduated circle upon which the shadow falls. The clepsydra, or water-clock, in which time is measured by the equable flow of water, was introduced into Rome about 150 B.C.; and various methods of indicating the quantity of water which had flowed out by bells, hands, figures, &c., were subsequently added. A simple form of the instrument is still used in physical laboratories for measuring intervals of a few seconds. The replacement of water by sand furnished the hour-glass used by our ancestors for measuring out the eloquence of their preachers, as their more feeble descendants now use the three-minute glass for measuring the boiling of their eggs. A transit-instrument affords a ready means of correcting a clock; and mean-time signals are now sent from Greenwich to many places in England; hence in practice we individually measure only comparatively short intervals of time, correcting our private clocks and watches by public clocks regulated by time-signals.

Of all measures, those of time are most frequently and most accurately made. Public clocks are far more numerous than public standards of length or mass, and in 1880 the value of the clocks and watches imported amounted to £880,000. Few persons carry a foot-rule costing say 1*s*., but many a watch costing more than £2. Even among engineers but little attention is paid to lengths less than 1/64 of an inch; and few common balances indicate a difference of 1/100 of the load. But, according to Mr. Rigg (Cantor Lectures on Watch-making, 1881), a watch that does not vary more than half a second per diem, or 1/172800, is frequently met with, while an accuracy of two or three minutes per week, 3/10000, is attained even by cheap articles. It is no uncommon occurrence to meet with a chronometer which does not vary one-fifth of a second in twenty-four hours, or by about 1/432000 of the time measured out.

Almost all modern instruments for measuring time consist of three essential parts: (1) a motive-power, such as a falling weight, an uncoiling spring, an electric current; (2) a regulator, to render the motion steady, such as a pendulum, a balance-wheel, or a magnet; (3) some means of indicating the space passed over, such as hands, bells, or marks on paper.

About the eleventh century the motive-power of a stream of water or sand was replaced by a falling weight; and in the early part of the sixteenth century, Peter Hele, of Nürnberg, substituted a coiled-up spring for the weight. As is often noticed when a foreign clock is wound up, the motive-power of such a spring varies very much as it uncoils. This difficulty was overcome in 1525 by the invention of the fusee, the increased leverage of which compensates for the decreased power of the partly uncoiled spring. In modern going-barrel watches reliance is placed on the careful adjustment of the regulating machinery; while in chronometers a very long spring is wound up so frequently that it never uncoils beyond a very small extent. In 1840, Wheatstone proposed a method of conveying the motion of a standard clock to several others by a current of electricity, and the electric current has since been used both as a motive power and as a regulator.

But little is known about the early methods of regulating clocks and watches, but, according to Shakespeare, the result does not seem to have been satisfactory, though some may consider his testimony invalidated by the accompanying libel ("Love's Labour Lost," iii. 1, 191). Biron speaks:

> "What I, I love, I sue, I seek a wife!
> A woman, that is like a German clock,
> Still a-repairing, ever out of frame,
> And never going aright, being a watch,
> But being watched, that it may still go right."

The use of clocks in observatories (1500), and for finding longitudes at sea (1530), caused a demand for better instruments which was only slowly met.

Galileo is said to have discovered the isochronism of the pendulum before about 1590, by observing a lamp swinging in the Cathedral at Pisa, but the discovery, though used by him, was not published until 1639, and it is doubtful if he applied it to clocks. In 1673, Huyghens proved the isochronism of the cycloidal pendulum, and showed that a pendulum could be caused to vibrate in a cycloid by making the upper portion of the suspending arrangement of steel springs or silk fibres, which wrap round cycloidal cheeks. The cycloidal cheeks are not found to answer in practice, but many makers use one or two parallel steel springs, which causes the bob to describe a curve which falls within the circle, and adds a positive and negative accelerating force at the commencement and end of each swing.

The time, t, of one swing of a simple circular pendulum of length l, at a place where the acceleration due to gravity is g, is—

$$t = \pi \left\{ 1 + \left(\frac{1}{2}\right)^2 \frac{\text{vers } \theta}{2} + \left(\frac{1 \cdot 3}{2 \cdot 4}\right)^2 \left(\frac{\text{vers } \theta}{2}\right)^2 + \&c. \right\} \sqrt{\frac{l}{g}};$$

where θ is half the angle through which the swing passes. When θ is very small, vers θ vanishes, and the swing is isochronous. If $\theta = 2°$, the error is about 1/13333, or two seconds in three days. If $\theta = 8°$, vers $\theta = 0{\cdot}00973$, and the second and third terms become 0·00122 and 0·000003 respectively, or the time of oscillation is about 1/833 longer than it would be if the arc were indefinitely small.

Increase of temperature causes l to become longer, and therefore the clock to go more slowly. This cause of error is minimized by making the rod of some substance, such as varnished pine, which expands but little, or compensated for by some device, such as Graham's mercurial pendulum (1722), Harrison's gridiron pendulum (1725), or Baily's astronomical pendulum, in which expansion away from the axis of suspension is neutralized by an equal expansion towards it, so that the effective length of the pendulum remains unaltered.

The spring balance-wheel, which consists essentially of a heavy horizontal wheel, to which an oscillating motion is given by a long fine hair-spring, was invented by Hooke in 1660, and perfected by Huyghens in 1674. The difficulty of expansion is got over by dividing the wheel into two semicircles, each attached by one end only to the diameter, and made of two strips of metal of different coefficients of expansion, so that each curves inwards to compensate for the expansion of the radius which carries it.

Extremely short intervals of time have to be accurately measured in various scientific and practical researches, such as those connected with the science of astronomy and the art of gunnery. Many forms of the chronograph used for this purpose are extremely complicated, but the principle on which they all act is simple. A cylinder covered with paper is driven round by clockwork, at the rate, say, of a turn per minute, and a point connected with a pendulum beating half-seconds divides the circumference into 120 equal spaces. Suppose that by pressing a key an electric current causes a pen to press against the paper. So long as the key is down a line is traced, and the length of it, measured by the half-second pricks, determines how long the key has been down. Usually the cylinder is also caused to move along its axis, so as to throw the two circles of pricks and lines into spirals. It is said that 1/1000 of a second can be estimated by this method.

The need of accurate measures of time has had great effect upon, if it did not absolutely originate, the science of astronomy, and in many of the most important physical laws time is either directly or indirectly a most important factor. Thus, Sir William Thomson has found that, by a long-continued stress, the elastic resilience of a body may diminish, and has proposed for this curious fact the name of elastic fatigue; Harcourt and Esson and other chemists have investigated the circumstances which cause the rate at which certain chemical changes take place to vary; Berthelot and Dixon have measured the velocity of propagation of explosion waves; the time taken for sensation to pass through nerve-fibre and for other physiological phenomena has been carefully studied.

In 1830, Lyell, following up the work of Smith, Hutton, Murchison, and Sedgwick, showed that the history of the earth is continuous, and was governed by the same laws in the past as it is now, and hence that the rates at which changes are now going on are measures of the rates at which they have gone on in the past. Great doubt was thus thrown on the current view that the world has only existed for about 6000 years. For suppose chalk is now being formed at the bottom of the Atlantic at the rate of one-fifth of an inch per annum, and that the chalk formations in England, which are known to be more than 3500 feet thick, were formed in the same way at about the same rate; the time required for the mere formation of this series of beds would be, not 6000 years, but more nearly 3500 × 12 × 5, or 210,000 years! And we must reckon, in addition, the time required to form all the other beds below and above the chalk and to bring them all into their present positions and conditions.

Advanced geologists, then, convinced by the arguments of Lyell, postulated a world history of many millions of years, but their results were ignored or ridiculed by those who had not taken the trouble to investigate the proofs upon which the theory rested. In 1859, the publication of the "Origin of Species" brought this, among many other questions, prominently before the public. The admirable style and careful manner in which facts and theories, old and original, were shown by Darwin to point to the great law of evolution as opposed to the theory of special creations, threw what were previously the arcana of science open to all, and caused the acrimonious discussion of the duration, not only of each living or extinct type, but of the world itself. The fiercest conflict raged about the age of man, and evidence was gradually accumulated, which proved that for many thousand years the human type has been practically the same as it now is: the question then forced itself forward, How long would it take a simple cell to develop through various forms to the anthropoid apes and man? The answer was given in figures higher even than those required by the geologist.

On the other hand, the question of the possible age of the world in its present condition has been attacked by Sir William Thomson from the side of mathematical physics, and his results have been recalculated and extended by Profs. Tait and Darwin. Arguments based upon (1) the internal heat of the earth, (2) the retardation of the rotation of the earth due to tidal friction, (3) the temperature of the sun, seem to show that the earth has not continued under present conditions for more than from ten to a hundred millions of years; while the theory of evolution probably requires at least three hundred millions of years for even a comparatively brief portion of geological history. The two results, each supported by strong evidence, are at present in contradiction to each other.

Political economists have for some years past been gradually realizing the immense importance of time in all their theories and calculations. The various causes which accelerate and retard the rate of growth are most important questions, not only for agriculturists, but for the whole population, who are dependent for their subsistence upon the reproduction of plants and animals. As Malthus pointed out in 1798, the population of a civilized country increases in geometrical ratio, while the food-supply can only be increased by importation, by taking inferior land into cultivation, or by improved methods of production. The gradual advance of civilization tends to quicken the rate of increase of population, while it decreases the three palliatives; hence, at some time, a limit must be reached at which population will increase faster than the means of subsistence. The results of this condition of affairs have been most ably discussed by Mill, and will possibly, before long, be exemplified in England.

To an individual, all duration beyond comparatively few years is of no importance, but, to a country or corporation, the difference between a hundred years and perpetuity may be very great. Two instances of this distinction have recently caused some discussion. The services of a general or lawyer may be amply rewarded by the grant of an annuity for a hundred years or for three lives; while the burden of a "perpetual pension" is felt long after the services for which it is granted are forgotten, and too often after all who have any real claim upon, or connection with, the original recipient have passed away.

The old fiction of English law, that all the land of the country belongs to the Government, and that the holders of the land are in reality not owners, but tenants, has recently been brought into prominence by Mr. George and his followers. The tenure of land varies almost infinitely in different countries, and even in diffent parts of the same country, but two simple examples may serve to render the point at issue clear. In the United States the land in the Territories, speaking generally, belongs to the Government, and has been, and to some extent is being, sold to capitalists in large lots at "prairie value."

Suppose 1000 acres worth £1 an acre are sold outright, they would fetch £1000, but the present value of a lease for a hundred years, interest being reckoned at 4 per cent., is £980. So far as the capitalist is concerned, for all practical purposes, the land is as much his own in the second case as in the first, since any change would take place in the time of a descendant whom he has never seen, and a fair compensation might be arranged for any unexhausted improvements. But, from the point of view of the Government, the case is very different: they would receive for the lease only £20 less than the selling price, and at the end of the century the land, with its "unearned increment," would revert to them in the same or better condition than it originally was, with the exception of minerals, for which special arrangements by royalty or otherwise must be made, and the conditions of the tenancy could then be altered to meet any change of circumstances. Where, as is generally the case in England, the land has long ago passed out of the possession of the community, considerations of public faith rightly overpower all considerations of expediency, but even in this case the absolute sale of "Crown lands" or "commons" seems to be suicidal. That things are not perfect is no reason for making them worse.

SYDNEY LUPTON.

NOTES.

We print to-day an article on the proposal that English men of science and others should co-operate in the movement for the erection of a statue of Ohm in Munich. The Committee appointed by the meeting at the Royal Society to make the scheme known in England, and to collect subscriptions, consists of the following members:—Sir F. Abel, Prof. D. Atkinson, Mr. Vernon Boys, Mr. Conrad Cooke, Profs. Ewing, Fitzgerald, Fleming, G. Carey Foster, Mr. Glazebrook, Prof. D. E. Hughes, Mr. Norman Lockyer, Dr. Hugo Müller, Prof. John Perry, Mr. W. H. Preece, Lord Rayleigh, Profs. Reinold, Rücker, Stokes (President of the Royal Society), Mr. Swinburne, Sir William Thomson, and Prof. S. P. Thompson. Lord Rayleigh was elected President.

The manuscript of the Royal Society Catalogue of Scientific Papers for the decade 1874–83 is now ready for the press, but Her Majesty's Government have informed the President and Council that it is not their intention to undertake, as in the case of previous decades, the printing and publication of the work.

Those who knew Dr. O. J. Broch, either when he was Professor of Mathematics at Christiania, or when he was Minister of the Board of Trade in Norway, or more recently, when he acted as Director of the International Bureau of Weights and Measures at Paris, and all who had any opportunity of intercourse with him either in social or official life, will hear of his death with deep regret. Dr. Broch died at Sèvres on the 5th inst., at the age of seventy-one. It has been the especial duty of the Bureau, over which Dr. Broch presided from its creation after the Metric Convention of 1875, to construct new standards of the metre and kilogramme for the different countries, including Great Britain, which were parties to that Convention. At the time of his death all these standards had been constructed, after much patient investigation, and were only awaiting final approval at Sèvres, before their delivery this year to the several contracting States. Dr. Broch's work remains to us, not only in those standards of exact measurement which, with the assistance of the men of science attached to the Bureau, he so well designed and verified, but also in the various scientific contributions by which he advanced our knowledge, particularly those published annually by the Comité International des Poids et Mesures; and in the mathematical papers issued by the Academy of Sciences at Paris (Elliptic Functions, *Comptes rendus*, 1864, &c.). Dr. Broch was a corresponding member of the Paris Academy; he was also a member of the Academies of Sciences of Berlin and Copenhagen, and a high officer of the Legion of Honour of France, and of the Order of St. Olaf of Norway.

The death is announced of M. G. Meninghini, who had been Professor of Geology at Pisa from 1849. He died, on January 29, at the age of seventy-eight.

THE monument to be placed over the grave of the late General Prjevalsky on the shores of Lake Issik-kul has received the final approval of the Czar. It was designed by the traveller's companion and friend, M. Bilderling. The *Invalide Russe* gives the following description of it:—"The monument represents a picturesque rock 28 feet high, on the top of which is perched a large eagle, emblem of strength, intrepidity, and intelligence. The eagle grasps in its talons a map of Central Asia, the arena of the scientific exploits of the deceased, and in its beak an olive-branch, symbol of the peaceful scientific conquests which Russia owes to Prjevalsky. On one of the sides of the rock is a large bronze cross, beneath which is the inscription, 'Nicholas Mikhailovitch Prjevalsky, born 29th of March, 1839, died 20th of October, 1888.' In the interior of the rock is cut a spiral staircase crowned with an enlarged copy of the medal struck by the Academy of Sciences in 1887 in honour of Prjevalsky, and showing the original inscription, 'To the first explorer of Nature in Central Asia.'"

AT the last meeting of the Royal Swedish Geographical Society the *Vega* Gold Medal—the highest honour at the disposal of the Society—was conferred upon Dr. Nansen. There are only five other recipients, viz. Nordenskiöld, Palander, Stanley, Prjevalsky, and Junker.

THE eighth annual meeting of the Sanitary Assurance Association was held at 5 Argyll Place, W., on Monday, the President, Sir Joseph Fayrer, F.R.S., in the chair. After the reading of the Report, the following resolution was adopted: "That Dr. R. Farquharson, M.P., be ask to introduce the Sanitary Registration of Buildings Bill on the opening of Parliament, and to take the necessary steps to obtain as early a day as possible for the second reading; that Sir W. Guyer Hunter, M.D., M.P., Sir Henry Roscoe, M.P., F.R.S., and Dr. Cameron, M.P., be asked to again join Dr. Farquharson in introducing the Bill; and that as soon as the Bill is printed and in the hands of the members of the House of Commons, the President of the Local Government Board be asked to receive a deputation in support of the Bill."

THE Sanitary Institute has made arrangements for a series of lectures and demonstrations for sanitary officers, specially adapted for candidates preparing for the Institute's examination for Inspectors of Nuisances. The lectures will be delivered on Tuesdays and Fridays at 8 p.m., beginning with a lecture on the general history, principles, and methods of hygiene, to be given by Dr. Benjamin Ward Richardson, F.R.S., on March 5.

A MASTERLY paper on the scientific work of the German poet Adelbert von Chamisso was read by Emil du Bois-Reymond before the Berlin Academy of Sciences on June 28, 1888. This paper has now been issued separately. A most interesting account is given of Chamisso's voyage round the world in the *Rurik*—a voyage which in some respects resembled that of Darwin in the *Beagle*, fifteen years later. Among the many subjects which attracted Chamisso's attention during the voyage was the construction of coral islands. In connection with this question, curiously enough, he often receives credit for an observation with which he had in reality nothing to do. Darwin, for instance, was under the impression that it was Chamisso who had noticed that "the larger kinds of coral, which form rocks measuring several fathoms in thickness, prefer the most violent surf." M. du Bois-Reymond shows clearly that this observation was made, not by Chamisso, but by his companion in the *Rurik*, Dr. Eschscholtz.

AMONGST the memoirs recently published by the Société Philomathique of Paris in celebration of the hundredth anniversary of its foundation, is one by M. A. Milne-Edwards, describing a very singular new species of marsupial mammal of the genus *Dactylopsila* from New Guinea. *Dactylopsila palpator*, as it is proposed that this species shall be named, is remarkable for the enormous length of the fourth digit of the fore-limb, which surpasses in its proportions even that of the celebrated third finger of the Aye-aye, and is more than an inch longer than the two adjoining fingers. This new marsupial makes a second addition to the accurate catalogue of this order of mammals recently prepared by Mr. Oldfield Thomas, another important species (which will probably turn out to be the type of a new family) being the extraordinary fossorial form from South Australia, of which the discovery was announced in our issue of October 18, 1888 (see NATURE, vol. xxxviii. p. 588).

ON Sunday night, about 10.40, a shock of earthquake was felt in many parts of East Lancashire. At Great Harwood the vibration was so distinct that the occupants of a bedroom saw the wardrobe rocking and feared it would fall. "At Heapey, near Chorley, where there are many geological faults," says the *Times*, "a villa residence seemed to be struck three times, as if an attempt were being made to turn it round, and afterwards it oscillated to east and west five or six times, as if settling down after a violent shaking. But this effect was unique, and in most cases only a slight tremor was observed." At Bolton "there was first a heavy shock, and then for a few seconds a tremor. Doors were banged up; light articles danced in the houses; people were lifted in their beds, and one man in the out districts, who was sitting in front of a fire, was thrown into the grate, burning his hands and face. The electric bells at the fire brigade station were rung, and the central telephone office was besieged with inquiries. It was at first thought there had been a terrible colliery explosion." At Greenhaugh, near Kirkham, the shock was heralded by "a noise travelling in a westerly direction, which was followed by two or three oscillations."

AN earthquake occurred at Klagenfurt, on January 27, at 10.49 p.m., and on the same day a slight shock was felt at Ala, in the South Tyrol. At San José (Costa Rica), the National Capitol, the Cathedral, the President's palace, and many houses, were destroyed by the earthquake on December 29 and 30, 1888; and at Alejuela, several people were killed, and much damage was done.

A MANILA paper gives an account of an eruption of the Mayon volcano, in the Philippine Islands, on December 15, 1888. Vast columns of ashes were seen to ascend from the crater, and in a very short space of time the darkness became so intense that, though it was midday, lights had to be used in every house. The inhabitants of Legaspi, Camalig, Ligao, Libog, and other surrounding districts, were quite panic-stricken. At the time when the mail left, no loss of life had been reported. The lava, in vast streams, was then pouring down the mountain.

IN the Report of the Meteorological Council for the year ending March 31, 1888, recently published, the Council regret the loss they have sustained by the resignation of Prof. Stokes, consequent upon his election to Parliament. His place has been filled by the appointment of Dr. A. Buchan, who is well known by his various researches in meteorology. The work of the Office during the year in question is discussed under—(1) Ocean Meteorology. In this branch active intercourse is kept up with the Royal and Mercantile Navies, and an appendix shows that a large amount of valuable observations is being collected from all parts of the ocean. The investigations into the synchronous weather of the North Atlantic, the barometrical pressure charts for the Atlantic, Pacific, and Indian Oceans, and Part 5 of the contributions to Arctic meteorology have been completed, and noticed severally in our columns. Among the discussions now in hand may be mentioned those for the Red Sea, the Aden cyclone of June 1885, current charts for the principal oceans, and cyclone tracks in the Southern Indian Ocean for the years 1848–86 from materials supplied by Dr. Meldrum. It is intended that the discussion of the weather for the region lying between the

Cape of Good Hope and New Zealand shall also be taken up. (2) Weather Telegraphy. The work in this branch of the Office continues to increase. Forecasts are prepared three times a day, at 11 a.m., 3.30 p.m., and 8.30 p.m. A comparison of the results of the latter during the year shows an average success of 84 per cent. over the whole United Kingdom, being 3 per cent. more than for the previous year. Hay harvest forecasts were also issued, the results showing considerable success. Storm warning notices were issued to 146 coast stations. Under this head may be specially noticed a discussion of the severe storms which visited the British Isles between August 1, 1882, and September 3, 1883. From this investigation Mr. Scott concludes that it is extremely improbable that telegraphic reports from America can assist in the forecasting of the weather on our coasts, and this conclusion is supported by the actual results of the experiment made in dealing with the American reports during the year. (3) Land Meteorology. The records received from the Observatories and stations are classed under five heads; the methods employed are fully explained, and the Report shows that several important researches are being carried on in this branch.

A CORRESPONDENT writes to us from Adelaide:—"I am glad to be able to tell you that the drought, which has been so bad over nearly the whole of Australia during the past year, has at last broken up. We have had splendid rains right across the continent; the north-west monsoon, aided by a barometric trough across the interior, and a low-pressure area on the south coast, penetrating south of the tropics, and bringing a deluge of rain and heavy thunderstorms over the whole of South Australia, Victoria, and New South Wales."

IN consequence of the severity of the weather in Russia, wolves have made their appearance in East Prussia, where they have not been seen during the last six years.

THE hydrate of amidogen, or hydrazine, $N_2H_4 . H_2O$, has been prepared by Drs. Curtius and Jay, of the University of Erlangen. It may be remembered that a brief announcement of the isolation by Dr. Curtius of gaseous amidogen itself, $\begin{matrix} NH_2 \\ | \\ NH_2 \end{matrix}$, was made in NATURE (vol. xxxvi. p. 185) nearly two years ago. The free gas appears, however, to possess such an intense affinity for water, that its isolation in any quantity appears almost impracticable; for in all the reactions yet known in which it is liberated, water is also of necessity a secondary product, and combines with the amidogen at the moment of its liberation, forming this interesting hydrate, which is a liquid, and has been obtained pure in large quantities. Hydrazine hydrochloride, or hydrochloride of amidogen, as it is variously called, $\begin{matrix} NH_2 . HCl \\ | \\ NH_2 . HCl \end{matrix}$, a salt which may be obtained from its aqueous solution in fine regular octahedra, was distilled with caustic lime from a silver retort. The tube of the retort was inclined upwards for some distance and then bent into a U-shape, so as to prevent the possibility of any projection of particles from the contents of the retort. To the end of the silver U-tube was attached a horizontal tube, also of silver, containing fragments of quicklime; this in turn passed into a receiver of glass. The reaction between hydrazine hydrochloride and quicklime is exactly analogous to that so well known in the preparation of ammonia, amidogen water and calcium chloride being formed; but instead of obtaining the free hydride, its compound with water distils over. After the distillation had been in progress a few minutes, the horizontal tube was gently warmed, when liquid drops of the hydrate began to fall into the receiver. Barium oxide behaves just like lime, but by far the largest yield of the liquid is obtained by use of a strong solution of potash. Hydrazine hydrate is a fuming liquid, of very high refractive index, boiling unchanged at 119° C. Although boiling so near the boiling-point of water, it may be almost perfectly separated from that liquid by fractional distillation. It attacks glass energetically, and rapidly destroys cork or caoutchouc. It is strongly alkaline, as expected, tastes somewhat like ammonia, and leaves a burning sensation upon the tongue. It forms well-crystallized salts with most acids, which are found extremely poisonous, being fatal to the lower animals. It is probably the strongest reducing agent known. The most easily reducible metals are precipitated from solutions of their salts in the cold. Silver separates from cold strong solutions in fine compact crystalline masses; from very dilute solutions in the form of perfect mirrors of great beauty. On warming with a neutral solution of platinic chloride, metallic platinum separates, according to the degree of concentration, in silver-white particles or shining mirrors. In acid solutions it quantitatively reduces ferric to ferrous, cupric to cuprous, and platinic to platinous salts, with evolution of nitrogen gas. For instance, $N_2H_4 . 2HCl + 2PtCl_4 = N_2 + 6HCl + 2PtCl_2$. Finally, when dropped upon mercuric oxide, it violently explodes. From these facts it will be seen that hydrazine hydrate is one of the most remarkable liquids yet discovered, and appears likely to be of great use in chemical operations.

THE Haileybury Natural Science Society has published the first part of a list of the "Fauna and Flora of Haileybury." The volume is interleaved, and should be of considerable service to students of natural science in the neighbourhood.

MESSRS. ALLEN AND CO. have just issued a new edition of "Practical Microscopy," by George E. Davis. The work has been enlarged, and, as nearly as possible, brought down to the present time. The author has extended its scope, so as to include an account not only of English instruments, but of the apparatus in general use upon the Continent and in the United States of America.

MESSRS. LONGMANS, GREEN, AND CO. have published "The Student's Atlas," by the late Mr. R. A. Proctor. It consists of twelve circular maps, on a uniform projection and one scale, with two index maps, and is "intended as a *vade-mecum* for the student of history, travel, geography, geology, and political economy."

THE Royal University of Ireland has issued in a separate volume the examination papers of 1888. The volume forms a supplement to the University Calendar for 1889.

WE understand that the Trustees of the Australian Museum, Sydney, have decided to publish the manuscript and drawings relating to the life-histories of Australian Lepidoptera left by the late Alexander Walker Scott, and since acquired by them, and that the work of editing and revising this material has been intrusted to his daughter, Mrs. Edward Forde, and Mr. A. Sidney Olliff.

THE French Government, immediately after the recent outbreak of yellow fever at Jacksonville, despatched Dr. Paul Gibier, a French physician, to study the causes of the outbreak. Dr. Gibier now appeals to the American Government, on the ground that his own Government will not spend any more money on the task. He merely asks for the payment of incidental expenses, and for the moral support of the United States.

AT a recent meeting of the Scientific Society of Christiania, Prof. H. A. Getz exhibited the tusk of a mammoth found in Vaage, in Central Norway. This is the first discovery of remains of this animal in Norway.

THE Woman's Anthropological Society, Washington, has entered upon the fifth year of its existence; and, according to *Science*, it displays "undiminished enthusiasm and vigour." Mrs. Sybil A. Carter (wife of the Hawaiian Minister) and Miss Florence Spofford act respectively as President and Secretary.

WE learn from *Science* that Dr. Thomas Featherstonhaugh, a grandson of the famous pioneer geologist, has just returned from a visit to Florida, and has brought back an interesting collection of aboriginal remains. He thoroughly examined a mound of damp sand on the shore of Lake Apopka, about the geographical centre of the State, and farther south than any previous researches of the kind. The mound was 50 feet in diameter and 14 feet high, and was covered with a dense growth of palmetto and other trees. It was found to be full of fragmentary bones and pottery, so numerous that Dr. Featherstonhaugh estimates that there could have been no less than four hundred bodies deposited there. A few Venetian beads near the top indicated intrusive burials, but below 4 feet there were no evidences of any intercourse with whites. Four shapely hatchets were recovered, also a charm-stone, and numerous specimens of decorated pottery. The whole find was presented to Major Powell, and by him turned over to the National Museum.

ALL hope has now been abandoned of saving Prof. J. Mainwaring Brown, who occupied the Chairs of English Language and Literature and of Political Economy in the University of Otago, New Zealand. He was one of an exploring party, being accompanied by Mr. White and Major Goring, which set out on an expedition to the neighbourhood of Lake Manapouri. One morning, Mr. Brown left his tent for a stroll in the bush, and, shortly after, a terrific storm of snow, wind, and hail burst over the district, and lasted without intermission for three days. His companions made every effort to find him, but without avail. Large search-parties were formed, but no tidings were obtained of the unfortunate gentleman. An enterprising newspaper proprietor in Otago despatched a special search-party at his own cost, and the Government have sent a steamer to Smith Sound, in the hope of obtaining some intelligence.

AT the Royal Institution, Dr. Sidney Martin will, on Thursday next (February 21), begin a course of four lectures on the venom of serpents, and allied poisons, including those used in the Middle Ages; and Lord Rayleigh will, on Saturday (February 23), begin a course of eight lectures on experimental optics (polarization, fluorescence, wave-theory, &c.). Mr. Harold Crichton-Browne will give a discourse on Friday evening (February 22), entitled, "In the Heart of the Atlas."

A CORRESPONDENT writes to point out that the planet Venus is now visible before sunset even in London. A few days ago he saw it at 4.30 p.m., thirty minutes before sunset, and as it was then very distinct he has no doubt that he could have seen it earlier if he had looked for it.

MR. HAROLD P. BROWN AND MR. GEORGE WESTINGHOUSE, Jun., have had a public discussion on the respective merits of alternating and continuous electrical currents. Mr. Brown, apparently not having satisfied Mr. Westinghouse, issues the following challenge, which we take from one of the electrical papers:—"I challenge Mr. Westinghouse to meet me in the presence of competent electrical experts, and take through his body the alternating current, while I take through mine a continuous current. The alternating current must not have less than 300 alternations per second (as recommended by the Medico-Legal Society). We will begin with 100 volts, and will gradually increase the pressure 50 volts at a time, I leading with each increase, each contact to be made for five seconds, until either one or the other has cried enough, and publicly admits his error. I will warn Mr. Westinghouse, however, that 160 volts alternating current for five seconds has proved fatal in my experiments, and that several men have been killed by the low-tension Jablochkoff alternating current." In other words, says Mr. Harold Brown, "I invite you to have a current passed through your body which I know (though you do not) will kill you, and I invite competent electrical experts to be present at the death which is sure to ensue." Mr. Brown and his experts will make preparations for what they all know to be an experiment highly dangerous to life, and which some of them believe must be fatal to Mr. Westinghouse, and if the latter is oolish enough to agree to his opponent's idiotic proposition, and the result is what Mr. Brown says is certain, then Mr. Brown and his experts will find themselves lodged in gaol awaiting their trial for murder, and being accessories to murder. If Mr. Brown knew a pistol was loaded which Mr. Westinghouse declared was not,' and then induced the latter to fire it into his head to test which was right, Mr. Brown and the gallows would run the risk of being acquainted, while the experts who aided and abetted him would have an opportunity of trying the effects of some years' penal servitude. This fustian "challenge" does not make Mr. Brown any more accurate than he was before, but it must make every man of common-sense pretty certain that he can be an excessively foolish person, and that the chances are, when Mr. Brown is particularly positive about anything, he is wrong.

THE additions to the Zoological Society's Gardens during the past week include a Tropical Squirrel (*Sciurus æstuans*) from Bolivia, presented by Mr. Peter Suarez; four Marbled Polecats (*Putorius sarmaticus*) from India, presented by Colonel Sir Oliver B. C. St. John, K.C.S.I., R.E.; eight Indian Gerbilles (*Gerbillus indicus* 2 ♂ 6 ♀) from India, presented by Dr. J. Gilbert; a Jackdaw (*Corvus monedula*), British, presented by Mr. Basil Carter; an Areolated Tortoise (*Homopus areolatus*), seven Tuberculated Tortoises (*Homopus femoralis*), two well-marked Tortoises (*Homopus signatus*), a Robben Island Snake (*Coronella phocarum*), two Infernal Snakes (*Boodon infernalis*), two Aurora Snakes (*Lamprophis aurora*), a Many-spotted Snake (*Coronella multimaculatus*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; an Adorned Ceratophrys (*Ceratophrys ornata*) from Buenos Ayres, presented by Captain Hairley.

OUR ASTRONOMICAL COLUMN.

NEW MINOR PLANET.—M. Charlois discovered a new minor planet, No. 284, on February 8, at the Nice Observatory. M. Charlois has named No. 277 Elvira.

OBSERVATIONS OF VARIABLE STARS.—Mr. Paul Yendall publishes in *Gould's Astronomical Journal* the results of his observations of a few variable stars in 1888. The observations compare as follows with the ephemerides given week by week in NATURE:

Star.	Observed.		Calculated.
R Ursæ Majoris...	Oct. 22 *M*	...	Nov. 7 *M*
R Scuti	Aug. 6 *m*	...	Aug. 15 *m*
η Aquilæ	June 12·98 *M*	...	June 12·88 *M*
	July 25·76 *M*	...	July 25·96 *M*
	Sept. 6·50 *M*	...	Sept. 7·00 *M*
S Sagittæ	Sept. 27·9 *m*	...	Sept. 27·9 *m*
	Sept. 30·5 *M*	...	Sept. 30·9 *M*

WINNECKE'S PERIODICAL COMET.—An exceedingly valuable memoir on the motion of this comet has recently been published by Dr. von Haerdtl, *Privatdocent* for Astronomy in the University of Innspruck. The most interesting point of this memoir, which was communicated to the Imperial Academy of Sciences of Vienna, lies in the evidence it supplies that an increase is necessary in the accepted value for the mass of Jupiter. After referring to the early history of the comet, its probable identity with Comet 1766 II., and with that discovered by Pons on February 6, 1808, and its rediscovery by the same observer on July 18, 1819, Dr. von Haerdtl commences the detailed treatment of the observations made during the four last periods when it was seen—viz. 1858, 1869, 1875, and 1886, discussing the individual observations, some 462 in all, with great thoroughness, and forming normal places and computing the resulting elements for each of the four periods of observation. Then follow the computations of the perturbations exercised by the different planets from Venus to Uranus, Mercury having no appreciable disturbing effect, for the comet at perihelion does not come far within the orbit of the earth, and remains well without that of Venus, its perihelion distance being 0·831. The perturbations exercised by Jupiter, however, are most important, for the aphelion of the comet does not lie far outside the orbit of that planet, and the two tend to come into proximity every eleven years, their aphelion distances being, respectively, 5·57 and 5·20, and their periods 2076·79 and 4332·59 days, so that the comet was only 0·87 distant from the planet in December 1870, and eleven years later, in November 1881, was only half as far from it. These perturbations were computed for intervals of twenty days through the whole period covered by the observations, including thus five revolutions; and where it seemed desirable, for every ten or even every five days. The reciprocal of the mass assumed for Jupiter was $\frac{1}{m}$ = 1047·54, and with this value, so far from finding an acceleration of the mean motion of the comet, as with Encke's comet, a retardation was displayed—a retardation which, however, disappeared when a somewhat higher value viz. 1047·1752, was substituted. It appears that this latter value satisfies the observations not only of the comet in question, but also those of Faye's and Encke's. The value obtained by Dr. Schur from the four satellites of Jupiter does not greatly differ from that now found by Dr. von Haerdtl, and the latter considers that the simple mean of the two, $\frac{1}{m}$ = 1047·204, may be adopted as the nearest approach to the true mass of Jupiter, *i.e.* of the Jovian system, the satellites being included.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1889 *FEBRUARY* 17–23.

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

At Greenwich on February 17

Sun rises, 7h. 11m.; souths, 12h. 14m. 12·0s.; sets, 17h. 17m.: right asc. on meridian, 22h. 4·9m.; decl. 11° 48′ S. Sidereal Time at Sunset, 3h. 8m.

Moon (at Last Quarter on February 23, 0h.) rises, 17h. 59m.*; souths, 1h. 12m.; sets, 8h. 10m.: right asc. on meridian, 11h. 0·9m.; decl. 10° 42′ N.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. on meridian. h. m.	Declination on meridian. ° ′
Mercury..	6 37	11 49	17 1	21 39·7	10 6 S.
Venus.....	8 22	15 4	21 46	0 55·6	7 42 N.
Mars.....	8 9	14 11	20 13	0 1·6	0 26 S.
Jupiter....	4 24	8 19	12 14	18 8·8	23 6 S.
Saturn....	15 47	23 22	6 57*	9 14·9	17 11 N.
Uranus...	22 8*	3 32	8 56	13 21·4	7 53 S.
Neptune..	10 16	17 59	1 42*	3 50·9	18 26 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Feb.	h.	
18	4	Venus at greatest elongation from the Sun, 47° east.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·5	81 17 N.	Feb. 17,	19 9	*m*
			,, 22,	18 49	*m*
R Ceti	2 20·4	0 41 S.	,, 17,		*M*
λ Tauri...	3 54·6	12 11 N.	,, 17,	18 32	*m*
R Canis Majoris...	7 14·5	16 11 S.	,, 17,	2 39	*m*
			and at intervals of	27 16	
U Monocerotis ...	7 25·5	9 33 S.	Feb. 20,		*M*
S Canis Minoris ...	7 26·7	8 33 N.	,, 22,		*m*
S Cancri	8 37·6	19 26 N.	,, 20,	19 22	*m*
U Hydræ	10 32·1	12 48 S.	,, 22,		*M*
R Hydræ	13 23·7	22 42 S.	,, 17,		*M*
R Lyræ	18 52·0	43 48 N.	,, 18,		*m*
U Cygni	20 16·2	47 33 N.	,, 20,		*M*
X Cygni	20 39·0	35 11 N.	,, 18,	2 0	*M*
δ Cephei	22 25·0	57 51 N.	,, 19,	0 0	*M*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A. °	Decl. °		
From Canes Venatici ...	181	34 N.	February 20.	Very swift; white.
Near τ Herculis	238	46 N.	February 17.	
,, ρ Herculis	260	36 N.	February 20.	Swift.

GEOGRAPHICAL NOTES.

A PAPER of more than usual interest was read at Monday's meeting of the Royal Geographical Society, by the Rev. W. Spotswood Green, on his explorations in the glacier regions of the Selkirk Range, British Columbia, in the summer of 1888. This range is generally included in the Rocky Mountains, although, as Mr. Green showed, it is in many respects distinct from them. After crossing the Rockies by the Canadian Pacific Railway, and plunging into the valley of the Columbia River, the Selkirk Range lies before the traveller. It has been but little explored, and some of its glaciers were probably visited for the first time by Mr. Green. The Selkirk Range is entirely bounded by the great bend of the Columbia and its tributary, the Kootenie, and the drainage of all its glaciers finds its way into the Columbia in some part or other of its course. Under many difficulties, owing to the densely forest-clad nature of the ground, the want of guides and porters, the necessity of opening up new routes, and other causes, Mr. Green visited some of the higher parts of the range, and explored, and in some cases named, its previously unvisited glaciers. After crossing the Rockies proper, curiously ridged prairie hills have to be passed, and all the ranges between these and the Columbia have a smooth rounded outline, forming a strong contrast to the ranges on the other side of the watershed. These latter form a complexity of glacier-clad ranges, many peaks rising quite as high as those on the watershed. Among the higher ranges an immense number of small glaciers lie in the hollows, and two extensive snow-fields are to be found within the limits of Mr. Green's map. One of these, being the source of the best-known glacier in the whole region, on account of its being so clearly visible from the railway, Mr. Green has called the great Illecellewaet firn, after the river of which it is the true source. This ice-field, probably 500 feet thick, to the southward extends down into a valley as the Geikie Glacier, and to the eastward, having been joined by ice-streams coming from the Dawson Range, it pours into Beaver Creek Valley as the Deville Glacier. All these glaciers show evidence of shrinking. An immense moraine exists in the valley below the Illecellewaet Glacier. Some of the blocks of quartzite in the moraine are of huge dimensions, one being 50 feet long, 24 feet thick, and 33 feet high. Mr. Green set up some poles at a little distance from the end of the glacier, and found that after thirteen days the ice had melted a vertical foot over its whole surface, and the centre of the glacier had moved 20 feet. The Geikie Glacier, about 4 miles long and 1000 yards wide, is a much more interesting ice-stream. Sheltered from the sun's rays by high cliffs, it flows along a level valley, so that one can walk across its lower portion in various directions without trouble. As it descends from the firn, it is much broken; then its surface becomes level, but with numerous transverse crevasses. Flowing round a bend, longitudinal fissures are set up, crossing the others, and forming such a multitude of *séracs* that the surface presents an appearance more like some basaltic formation with the columns pulled asunder than anything else I can think of. This beautiful structure gives place to the frozen waves of a *mer de glace*, and the glacier terminates in longitudinal and slightly radiating depressions and crevasses. The level of perpetual snow in these mountains may be put down at 7000 feet, and the upper limit of the forest at 6000 feet. Red snow, caused by the presence of *Protococcus nivalis*, is of frequent occurrence. Like most of the rest of British Columbia, the Selkirks are covered with forests, all the trees attaining huge dimensions. These forests are being devastated by fires, often caused by sparks from the engines on the new railway. Beneath the living trees, thousands of prostrate trunks lie piled in every conceivable position, and in every stage of decay. Exploration and mountaineering under such circumstances are attended with enormous difficulties. Above the forest region, the slopes of the mountains are as profusely covered with flowers as the "Alp" region of the Swiss mountains; the most conspicuous plant being the *Castilleia miniata*. The heaps of boulders above the forest region form a refuge for a great variety of small animals. With regard to the geology of the Selkirks, earlier than the Glacial formation, no rocks later than the Palæozoic seem to be met with in the central range. In the higher ranges, greenish quartzites and micaceous schists are the commonest rocks. The summit of Mount Bonney and the southern and south-western *arêtes* of Mount Sir Donald consist of a beautiful white, smooth quartzite, speckled in the former case with deep brown spots, "probably iron or manganese oxides." Associated with these harder rocks are a number of remarkable silky-looking schists (*phylites* of Prof. Bonney), the result of great squeezing in the movements which upheaved the ranges. Roughly speaking, then, the configuration of this district, with its complexity of valleys, is due to the disintegration and denudation of the softer schists and the permanence of the harder quartzites in mountain-ridges. With regard to age, the rocks range from true Archæan to late Palæozoic, possibly a little later. The presence of very old schists and gneisses would seem, then, to show that though the range called the Rockies, on the Canadian Pacific Railway route, is the water-parting, the Selkirks are geologically the true continuation of the Rocky Mountains of Montana, and the backbone of the continent.

THE Russian Geographical Society has received the following news from Captain Grombchevski, who was sent out to explore the Khanate of Kunjut in the highlands between India and Afghanistan, and for a time was supposed to have been lost. After having left Marghelan in Russian Turkistan, M. Grombchevski crossed the highlands of Alai, and, *viâ* the Pamir lakes, Great Kara-kul, and Rang-kul, he reached the sources of the Amu-daria (the Murghab). Thence he proceeded to the Ak-baital River, and on August 16 he crossed the high ridge on the frontier of Afghanistan. On the southern slope of this ridge the Expedition was overtaken by a violent snow-storm, during which M. Grombchevski's Cossacks succeeded in getting hold of two inhabitants of Turm, from whom they learned that the Expedition was surrounded by Afghan troops, who had been sent out to take them prisoners. In consequence, M. Grombchevski, notwithstanding the snow-storm which was still raging, crossed the mountains again and returned to the Pamir, whence he immediately went across the Hindu-kush through a mountain pass which leads to Kunjut. The journey was so difficult that the Expedition lost one-half of its horses and part of its luggage. Circumstances did not permit M. Grombchevski to stay at Kunjut. He re-crossed the Hindu-kush, and entered East Turkistan at the sources of the Raskem-daria, one of the affluents of the Yarkand River. He followed its course, hoping to reach Karakorum, but was soon compelled to abandon his scheme, and only explored the nephrite mines on the banks of the river. After having surveyed part of the Raskem and Yarkand Rivers, the Expedition returned to Little Kara-kul Lake on the Pamir, and reached Kashgar on November 13. Three weeks later they were at Osh, bringing in a mass of interesting information and numbers of photographic views of the explored region.

THE last volume of the *Izvestia* of the Caucasus branch of the Russian Geographical Society contains a variety of interesting short articles and notes. V. Massalsky's sketches of the regions of Kars and Batum are especially valuable to botanists. M. Konshin gives a most interesting geological and geographical sketch of the Transcaspian region; and two obituary articles (with portraits) devoted to Abich and Von Koschkul contain excellent reviews of their work in the Caucasus. The appendix contains a note on the study of the Caucasian languages, and various papers relating to Persia, Asia Minor, and Afghanistan. The most important of the latter is a report on the work done by the Russian Commissioners of the Afghan Boundary Commission, with a map of the region (13 miles to the inch) brought up to date in 1888. A short paper on the economic conditions of the Russian Transcaspian dominions, and a condensed translation from a "Guide to Armenia," by Bishop Srvandziantz, are also worthy of notice.

ELECTRICAL NOTES.

HALLWACHS (*Ann. Wied.*, vol. xxxiv. p. 731, 1888) is continuing his researches on the connection between light and electricity. He has found that if the light of an arc lamp falls on clean plates of zinc, brass, and aluminium, they are always charged positively, the zinc to a potential of over 1 volt, the brass to 1 volt, and the aluminium to 0·5 volt. The plates become fatigued by constant illumination.

SIR WILLIAM THOMSON gave the Friday evening lecture on February 8 at the Royal Institution, on "Electrostatic Measurement," and described voltmeters and their functions; but the most interesting part of his discourse was his approving and eulogistic reference to Hertz's work, his own measurement of "v," which brings it very close to 3×10^{10} centimetres per second, and his long-deferred conversion to Maxwell's electromagnetic theory of light, which he thought had sprung from Maxwell's inner consciousness.

HIMSTEDT (*Ann. Wied.*, vol. xxxv. p. 126), using a condenser, has determined the value of v to be $3·0093 \times 10^{10}$.

NAHRWOLD (*Ann. Wied.*, vol. xxxv. p. 107) has shown that platinum rendered incandescent in a closed space is electrified negatively, the air being positive, but the same effect is not to be obtained with hydrogen, or any other pure gas.

MAGNETIC ELEMENTS, Parc Saint-Maur, Paris:—

	January 1, 1889.	1888.
Declination	15° 47′·4	− 4′·7
Dip	65° 15′·7	− 1′·0
H	0·19508	+ 0·00028
V	0·42275	+ 0·0003
T	0·46559	+ 0·00039

E. G. ACHESON in New York (*Electrical World*, January 19) has repeated many of Prof. Oliver Lodge's experiments on the "alternative" path in discharging Leyden jars, but has deduced from them different conclusions. He has avoided the errors due to charging which vitiated Prof. Lodge's early experiments. This is done by using one jar instead of two, and separating the charging system entirely from the discharging. He shows that the effects are due entirely to "extra currents" in the alternative wire dependent on the geometrical form of the current, and modified a little by the electro-magnetic inertia of iron. He has photographed the sparks, and obtains clear traces of oscillation when self-induction is present. His results have little or no bearing on the form of lightning protectors.

WESENDONCK (*Ann. Wied.* vol. xxxv. p. 450) has made the curious observation that if in a long vacuum tube the distance between the electrodes be increased, the resistance is not affected. This does not agree with Varley's conclusions (Proc. R.S. vol. xix. p. 236, 1871), who showed that after the polarization of the electrodes is overcome gases obey Ohm's law.

MEBIUS (*Beiblatter der Physik*, vol. xii. p. 678, 1888) has tried to verify the statement that an electric current diminishes the coefficient of elasticity of metals, and he has come to the conclusion that it has no action on elasticity.

ON THE INTENSITY OF EARTHQUAKES, WITH APPROXIMATE CALCULATIONS OF THE ENERGY INVOLVED.[1]

AS an exact science, seismology is in its infancy. Although great progress has been made during the past ten years, and especially in the development of instruments and methods for a more precise study of seismic phenomena, the results thus far have served rather to reveal the complicated nature of the problems involved; and while encouraging the seismologist to renewed effort, they warn him that his efforts are not to be light. The recent advances of the science have been, and properly, toward the study of the phenomena at hand, the nature and extent of the motion of the earth particle together with the rate at which the disturbance is propagated, in the expectation and hope that in time the location and character of the original cause may be revealed through these.

In the early growth of an exact science one of the obstacles met with is the absence of an exact nomenclature, and seismology furnishes no exception to this rule. Whenever it becomes desirable or necessary to incorporate the meaning of a word in a mathematical expression, it is imperative that the necessary restrictions be placed upon its use. It has long been customary to speak of the *intensity* of an earthquake without any special effort to give the word an exact meaning. Generally it is applied to the destructiveness of the disturbance on the earth's surface, and sometimes to the magnitude of the subter-

[1] By Prof. T. C. Mendenhall, President of the Rose Polytechnic Institute, Terre Haute, Indiana. (From the Proceedings of the American Association for the Advancement of Science, 1888.)

ranean cause of the same. But modern seismology proposes to measure the intensity of an earthquake and to express its value numerically. It is worth while, therefore, to inquire in what sense the term may be used with precision, and what may be accepted as its mathematical equivalent. Evidently it may mean, and in fact it has been made by different writers to mean, the measure of the surface destruction; the energy per unit area of wave-front of a single earthquake wave; the rate at which energy is transmitted across unit area of a plane parallel to the wave-front; and the total energy expended in the production of the original disturbance. The use of well-constructed seismographs has furnished us, within a few years, a good deal of fairly trustworthy information relating to certain elements of earthquake motion, notably the amplitude and period of vibration and the velocity of transmission, by means of which, and aided by a few not very violent assumptions, some of the above quantities may be calculated. They are not identical, numerically or otherwise, and it is manifestly improper to apply the word *intensity* to all of them.

An earthquake wave is generally assumed to be the result of an harmonic vibration. While this supposition is not strictly correct, it is probably not so far erroneous as to materially vitiate the results which follow.

If then—

a = maximum displacement,
t = periodic time,
v_1 = maximum velocity of particle,
V = velocity of wave transmission,
d = density of material through which transmission occurs,

the following are easily obtained:—

(1) Maximum velocity, $v_1 = \frac{2\pi a}{t}$.

(2) Maximum acceleration, $\frac{v_1^2}{a} = \frac{4\pi^2 a}{t^2}$.

(3) Energy of unit volume with velocity, $v_1 = \frac{1}{2}dv_1^2 = \frac{2\pi^2 a^2 d}{t^2}$.

(4) Energy of wave per unit area of wave-front $= \frac{2\pi^2 a^2 d V}{t^2}$.

(5) Energy per second across unit area of plane parallel to wave-front (rate of transmission) $= \frac{2\pi^2 a^2 d V}{t^2}$.

It is well known that Mallett and others of the earlier seismologists attempted to find a mathematical expression which should represent the so-called "intensity" of the shock, by means of the velocity of projection of loose bodies as determined by their range, and also through the dimensions of bodies which would be overturned by the shock. The maximum velocity of the earth might be ascertained by the first method with fair accuracy; the second method is nearly, if not quite, worthless in practice, and both are decidedly inferior in design and operation to the modern seismograph, which gives the principal elements of the motion directly.

In a paper by Profs. Milne and Gray, *Philosophical Magazine*, November 1881, the following occurs:—"The intensity of a shock is evidently best estimated from the maximum velocity of translation produced in a body during an earthquake. This is evidently the element according to which the destructive power is to be measured, it being proportional to the maximum kinetic energy of the bodies on the earth's surface relative to that surface during the shock." Now this statement is inconsistent with that which immediately follows, and with their mathematical expression, which is $I \propto \frac{A}{T^2}$, equivalent to the second expression given above. This inconsistency was doubtless quickly and first detected by the authors, and in a copy of the paper received from them I find interlinear corrections in the paragraph quoted above in virtue of which the words "rate of change of" are substituted for the word "maximum" where it first occurs, and "acceleration" for the words "kinetic energy," thus bringing it into agreement with the remainder of the discussion, and at the same time unquestionably better representing the opinion of the authors, who in all subsequent publications have used the maximum acceleration to represent the intensity as shown in the overturning, shattering, and projecting power of the shock.

The same expression, $\frac{v_1^2}{a}$, is used as a measure of intensity by Prof. Holden in his paper on "Earthquake Intensities in San Francisco" (*American Journal of Science*, vol. xxv. p. 427) where he defines it as "intensity of shock defined mechanically = destructive effect = the maximum acceleration due to the impulse." He asserts that "the researches of the Japanese seismologists have abundantly shown that the destruction of buildings, &c., is proportional to the acceleration produced by the earthquake shock itself, in a mass connected with the earth's surface." This statement is hardly justifiable, at least up to the present time. In the Report of the British Association for 1885, the Committee appointed by the Association for the purpose of investigating the earthquake phenomena of Japan, consisting of Messrs. Etheridge, Gray, and Milne, describe among other seismic experiments one which consisted in determining the quantity to be calculated from an earthquake diagram which would give a measure of the overturning or shattering power of a disturbance. The result of this investigation seemed to show that the acceleration, which by calculation from the dimensions of the columns was necessary for overturning, was something between the mean acceleration, represented by $\frac{4v_1}{t}$, and the maximum acceleration, $\frac{v_1^2}{a}$.

The actual destruction caused by an earthquake wave is undoubtedly a function of many variables, but it seems tolerably certain that maximum acceleration is the leading factor, and at the present time no better measure can be found. It appears to me, however, that it is unwise to apply the term "intensity" or "intensity of shock" to this quantity, which might be called the "destructiveness" of the wave, or perhaps its "destructivity," as indicating a little more clearly the power to destroy.

Dutton and Hayden, in their "Abstract of the Results of the Investigation of the Charleston Earthquake," presented to the National Academy of Sciences on April 19, 1887, define intensity as the "amount of energy per unit area of wave-front," but, in the subsequent discussion, use it almost continually as a measure of surface destruction. Upon the first definition they have based a very interesting and novel method for determining the depth of the focus; but in the application of the method to the Charleston earthquake they have used the word in its other and very different sense. A reference to the formulæ given above will show that one of these quantities is inversely as the square of the distance from the origin, as assumed by them in the development of their method, while the other, used in its application, is not so proportional, and this must be admitted to be fatal to their deductions.

In the discussion of a somewhat analogous case, Lord Rayleigh says ("Theory of Sound," vol. ii. p. 16), "The rate at which energy is transmitted across unit of area of a plane parallel to the front of a progressive wave may be regarded as the mechanical measure of the intensity of the radiation." The algebraic expression for this quality, as shown above, is, of course, similar to that of the quantity last considered, differing from it only in the power of "t" in the denominator. Both are very important expressions; neither is very closely related to "surface destruction," and the latter is unquestionably a suitable measure of the "intensity of an earthquake" in the most important sense.

It thus appears that at least four measures for earthquake intensities are and have been in use, which are expressed mathematically in terms of amplitude, period, velocity of transmission, and density of medium in formulæ (1) (2) (4) (5) above. To show more forcibly the necessity of placing some restrictions upon the use of the word, I have compared the "intensities" of two earthquakes, using each of the four expressions. The disturbances compared are those of May 6 and May 11, 1884, at Tokio, Japan, the observations being made by Prof. Milne (Trans. Seis. Soc. Japan, vol. x. p. 27). The same instrument, located in the same place, was used in both, and the interval of time between the two is so small as to forbid any important change in the conditions. That of May 6 is called "A," and that of May 11, "B." The results are as follows:—

$\frac{B}{A}$	...	(1) 1·1	(2) 1·7	(4) 0·9	(5) 1·3

from which it is evident that much depends on the measure of intensity adopted.

As stated at the beginning of this paper, the more recent work of seismologists has been in the study of individual disturbances for the purpose of determining the principal elements of motion, amplitude, period, direction, and speed of transmission. In this study much has been learned. From the nature of the case we are almost absolutely restricted to an investigation of surface phenomena, and we are soon forced to admit that what goes on at the surface cannot accurately represent what is going on below. Among other reasons for this conclusion we have, notably, the greatly varying results obtained from the same disturbance at points comparatively very near to each other. The amplitude at one point may be two or three times that at another a few hundred feet away, and not only this, but the periodic times do not agree, and when the maximum acceleration is applied to the disturbance, its so-called intensity or destructiveness will vary greatly within a small area. As a matter of fact, it has long been known that such variations in destructive power do occur in nearly all earthquakes. Not only do the above elements vary, but the speed of transmission, when once the surface is reached, is undoubtedly not constant, although we have no reason to believe that it is not approximately so in the rocks through which it is, in the main, transmitted. Most of these irregularities are doubtless due to the non-elastic character of the materials lying near the surface and to their lack of homogeneity. In spite of their appearance in the phenomena of the surface, it is difficult, if not impossible, to believe that they exist in the rocks below. It is more reasonable to assume that during an earthquake the waves of transmission are, in the main, and until the surface is reached, somewhat regular in their form and approximately constant in certain of their elements. It may also be assumed that in amplitude and periodic time the subterranean wave, although doubtless much less than the surface-wave, cannot differ from it enormously, so that elements of motion obtained by seismometric observations upon the surface may be applied within certain limits to the investigation of the energy involved, the results being considered as rough approximations.

On these assumptions the following calculations have been made:—

Let A be the area of a portion of a wave-front, and l a length measured at right angles to A. Then formula (5) above, which shows the energy per second across unit area, multiplied by $\frac{Al}{V}$ will evidently express the energy required to generate the waves existing at any moment in the volume lA. That is

$$\frac{2\pi^2 a^2 d V}{t^2} \cdot \frac{Al}{V}$$

$$= \frac{2\pi^2 a^2 d A l}{t^2}$$

$$= \frac{2\pi^2 a^2}{t^2} \cdot m \; (m = \text{mass of volume } lA)$$

$$= \tfrac{1}{2} m v_1^2.$$

That is to say, the work consumed in generating waves of harmonic type is the same as would be required to give the maximum velocity to the whole mass through which the waves extend.[1] Sir William Thomson, who was probably the first to apply this principle, in his calculation of the mechanical value of a cubic mile of sunlight, concludes that in the case of a complex radiation this value is more likely to reach twice that of the above expression.

On the assumption that the maximum velocity of the particle is known, we may now apply this formula to the calculation of the energy involved in an earthquake. For this purpose I have selected, first, the Japanese earthquake of January 15, 1887, which disturbed over 30,000 square miles of territory, and the elements of which were well recorded on the Tokio seismographs. Assuming a mass of 150 pounds per cubic foot, and taking a cubic mile as the volume to be considered, I find that to put it in vibration required the expenditure of 2,500,000,000 foot-pounds of energy, and this might be called the "mechanical value of a cubic mile of earthquake." Assuming that an area of 100 miles square, with a mean depth of one mile, was thus in vibration at any one instant of time, which is not improbable considering the known rate of transmission and the long duration of the earthquake, the amount of energy thus represented would be 25×10^{12} foot-pounds. This energy might be generated by the fall, under the action of gravity, of a cube of rock 1000 feet on each edge, the mass of which would be 75,000,000 tons, through a vertical distance of about 166 feet.

It would be interesting to apply this method to the Charleston earthquake of August 31, 1886. Unfortunately no seismographic records were made, and the elements of motion are largely matters of conjecture. Messrs. Dutton and Hayden, in the report already referred to, express the opinion that in some localities the displacement must have been as much as 10 inches or 1 foot. This seems to me improbable, but it may be safe to say that over a considerable area it was as much as 1 inch. Nothing is known with certainty as to the period of the oscillations, but as it generally increases with the magnitude of the disturbance, it would probably not be grossly incorrect to call it two seconds. Assuming these magnitudes, I find the energy of a cubic mile of the Charleston earthquake, taken near enough to the epicentrum to be disturbed as above, to be equal to 24,000,000,000 foot-pounds. The speed of transmission of this disturbance has been pretty well determined, by Newcomb and Dutton, to be approximately three miles per second, so that a cubic mile would be disturbed in one-third of a second. To do this would require 130,000,000 horse-power. Assuming as before that an area about the epicentrum 100 miles square was thus disturbed, the energy involved would be 24×10^{13} foot-pounds, and the rate of its expenditure would be that of 1,300,000,000,000 horse-power.

All of these numbers can only be regarded as gross approximations. They probably indicate the order of magnitudes involved, and may be useful until more trustworthy data are furnished.

[1] Lord Rayleigh, "Theory of Sound," vol. ii. p. 17. Sir William Thomson on "The Possible Density of the Luminous Medium."

THE ROYAL HORTICULTURAL SOCIETY.

THE annual general meeting of the Royal Horticultural Society was held on Tuesday, February 12, at the offices, 117 Victoria Street, S.W. The Society is to be heartily congratulated on the great improvement which has taken place in its affairs since it quitted the Gardens at South Kensington this time last year. From the Report of the Council, and the speech of Sir Trevor Lawrence, Bart., M.P., President, in moving its adoption, we glean the following particulars. During the past year 657 Fellows have joined the Society, 81 have resigned, and 48 died, the total number of Fellows on the books being now 1636. The total income from all sources, independent of the "Donation" account (£1125 5*s.*), was £3617 8*s.* 6*d.*; the total expenditure, £3412 14*s.* 4*d.*, showing a surplus of £204 14*s.* 2*d.* On January 1, 1888, there was a debit balance of £1152, which has been cleared off by the transfer of of £755 7*s.* 6*d.* from the "Donation" account, and £396 12*s.* 6*d.* from current revenue. The total expenditure on the maintenance of the Society's Gardens at Chiswick was £1501 6*s.* 8*d.*, the receipts from the sale of produce, £737 7*s.* 6*d.*, brought up by minor items to £810 4*s.* 3*d.*, making the net cost of the Gardens to the Society £691 2*s.* 5*d.* The income for 1889 is estimated at £3000, and the expenditure at £2950. The President referred to the great value to the Society of the services of Mr. Dyer, F.R.S., Director of the Royal Gardens, Kew, and Mr. H. Veitch, who were retiring from the Council owing to the pressure of other engagements, and of Mr. Wilson, F.R.S., and Dr. Hogg, who were retiring after having served the Society well and faithfully during very many years. He also paid a well-deserved tribute to the energy, ability, judgment, and devotion to their duties, of the Honorary Secretary, the Rev. W. Wilks, and the Treasurer, Mr. D. Morris, Assistant-Director of the Royal Gardens, Kew. During the past year numerous very interesting exhibitions have been held in connection with the fortnightly meetings of the Society in the Drill Hall of the London Scottish Volunteers, James's Street, Buckingham Gate. A magnificent show was held on May 17 and 18, in the Gardens of the Inner Temple, by the permission of the Treasurer and Benchers, in which, for the first time in the history of such displays, attention was drawn to the excellent horticultural work being done by the market growers of the London district. A conference on apples and pears, held at Chiswick from October 16 to 20, attracted great attention, and the papers read and the discussions raised as to the circumstances and conditions requisite for the successful cultivation of these fruits in the British Isles were of great value. The Society propose to hold this year, in addition to a great show in the Temple Gardens on May 30 and 31, and its usual bi-monthly exhibitions, a national rose conference and show on July 2 and 3, a great vegetable conference on September 24, 25, and 26, and a chrysanthemum centenary conference on November 5 and 6, —all at Chiswick. There will be at the bi-monthly meetings a short lecture and discussion on the plants exhibited, such as was in former years very popular under the guidance of Dr. Lindley. The Society will revive the publication of its periodical Journal and Proceedings, and carry on at Chiswick extensive trials of various classes of flowering plants, ferns, vegetables, and artificial manures.

Altogether it is gratifying to find that, the unfortunate and costly connection of the Society with South Kensington having been severed, there is a great revival of vigour and vitality and of interest in a Society which has been in existence for nearly a century, is the parent of a vast progeny of kindred institutions throughout the Empire, and has rendered to horticulture services the value of which it is impossible to over-estimate.

SOCIETIES AND ACADEMIES.

London.

Royal Society, January 31.—"On *Isoëtes lacustris*, Linn." By J. Bretland Farmer, B.A., F.L.S. Communicated by Prof. S. H. Vines, F.R.S.

Many points connected with the development of Isoëtes still remain to be cleared up, and this is especially true of the germination of the macrospore. This structure consists of a mass of protoplasm, which, in perfectly mature spores, is inclosed in a thick envelope, and this envelope is differentiated into six layers, of which the outermost belongs to the episporium, the three within this to the exosporium, and the two innermost to the endosporium. The protoplasm contains very large quantities both of oil and starch, and is provided with a large nucleus, in which are embedded certain bodies which appear yellowish-brown in preparations stained with hæmatoxylin, but as to whose nature it is not at present possible to speak definitely. During germination, hæmatoxylin fails to reveal the presence of a nucleus, and the cytoplasm at this period stains so rapidly and deeply that it is possible that the nuclear substance may be diffused through it. It is when the protoplasm stains thus deeply that the first indication of cell-formation is visible. Its mass is seen to be traversed by "cracks," which divide it into a few large isolated portions, and it is in the direction of these cracks that the cell-walls first appear. The splitting of the protoplasm is doubtless called forth by the methods necessarily used in embedding the spores, but the conclusion that may be drawn from its presence probably is, that the substance destined eventually to form the cell-wall, is present before the appearance of this structure, and is arranged in a plate-like manner, in such a way as to determine the direction of the cracks referred to. The cells thus formed probably owe their existence to a process similar to that obtaining in the endosperm of many plants, except that, at least so far, I have been unable to detect free nuclei in the first stages. Very soon after cell-formation has begun, these bodies are again very easily seen, especially in the upper part of the young prothallium. Division proceeds with great rapidity in this portion, and the rudiments of the archegonia are laid down. Their origin is similar to that in the Marattiaceæ; superficial cells divide at first once, periclinally, and of the two cells thus formed, the upper gives rise to the neck by further division into four stories, each story being divided crosswise in the usual way; the lower cell forms the central series consisting of oosphere, one neck, and one ventral-canal cell.

Division in the lower part of the prothallium takes place with extreme slowness, and here at least the appearance of free nuclei precedes that of the cell-walls. The cells which arise in this region are readily distinguishable, on account of their large size, from those which owe their origin to the primitive cells in the upper portion of the prothallium, but although further cell-division takes place throughout the spore, I am not in a position at present to state exactly how it occurs, or in what relation it stands with regard to the nucleus in these later stages.

Mineralogical Society, January 22.—Mr. R. H. Scott, F.R.S., President, in the chair.—The following papers were read:—On connellite from a new locality, by G. T. Prior.—On pseudomorphs of hæmatite after iron pyrites, by R. H. Solly.—On crystals of percylite, caracolite, and an oxychloride of lead (daviesite), from Sierra Gorda, Bolivia, by L. Fletcher.—On the distribution and origin of the hydro-carbons of Ross and Cromarty, by Hugh Miller.

Edinburgh.

Royal Society, January 21.—Prof. Sir Douglas Maclagan, Vice-President, in the chair.—Mr. J. Arthur Thomson discussed the history and theory of heredity.—Prof. Haycraft communicated a note, written by himself in conjunction with Dr. E. W. Carlier, on the conversion, by means of friction, of ciliated into stratified squamous epithelium. Specimens in illustration were shown under the microscope.—Prof. Tait read a paper on the virial equation, as applied to the kinetic theory of gases, especially as regards the form of isothermals in the neighbourhood of the critical point. The curves obtained from the new formula, with suitable values of the constants, represent with accuracy the isothermals of carbonic acid gas as obtained experimentally by Andrews. But the chief point of interest in the paper is connected with the question, What portion of the whole kinetic energy of a substance is, in each of its molecular states (*i.e.* as gas, vapour, liquid, and solid), to be regarded as proportional to the absolute temperature? Prof. Tait gave reasons for believing that it is incorrect to assume, with Van der Waals and Clausius, that the *whole* kinetic energy determines the absolute temperature. The part which is directly due to inter-molecular forces is at least mainly incommunicable to other bodies, and can thus have little to do with the temperature.—A note, by Mr. R. T. Omond, on a remarkable fog-bow seen from Ben Nevis on December 4, 1888, was communicated.—Mr. George Brook described a new type of dimorphism found in certain *Antipatharia.*—Prof. Crum Brown communicated a paper, by Dr. A. B. Griffiths, on a primitive kidney, or the beginning of a renal system.

Sydney.

Royal Society of New South Wales, October 3, 1888.—Sir Alfred Roberts, President, in the chair.—The following papers were read:—Considerations of photographic expressions and arrangements, by Baron Ferd. von Mueller, K.C.M.G., F.R.S.—Census of the fauna of the older Tertiary of Australia, by Prof. Ralph Tate.—Notes on the storm of September 21, 1888, by H. C. Russell, F.R.S. Mr. Russell pointed out that, although such cyclonic disturbances seldom visited the coast of New South Wales, experience had proved that they were not unknown, and another such storm of greater dimensions would probably cause considerable havoc in the city of Sydney if the unstable class of buildings so much in vogue were adhered to.—Some New South Wales tan substances, Part 5, by J. H. Maiden.

November 7.—Mr. H. C. Russell, F.R.S., Vice-President, in the chair.—The following papers were read:—Results of observations of Comets I. and II. 1888, at Windsor, N.S.W., by John Tebbutt.—Desert sandstone, by the Rev. J. E. Tenison Woods.—On a new self-recording thermometer; and notes on the thunderstorm of October 26, 1888, by H. C. Russell, F.R.S. Three meteorites were exhibited: the first, weighing 35½ pounds, found near Hay, was shown by the Chairman; the second, weighing 137 pounds, found at Thunda, in Queensland, had been received by Prof. Liversidge that afternoon. A preliminary note upon the qualitative analysis of a portion of this meteorite was read before the Society in 1886, which showed that it consists essentially of iron and nickel with a little cobalt, sulphur, and phosphorus. The third was exhibited by Mr. C. S. Wilkinson: it weighed 12½ pounds, and was composed chiefly of iron, of an irregular pear-shape, and was discovered firmly embedded in slate rock on the highest peak of a mountain near the junction of the Burrowa and Lachlan Rivers.

December 5.—Sir Alfred Roberts, President, in the chair. —The Chairman announced that the Council had awarded the Clarke Memorial Medal for 1889 to R. L. J. Ellery, F.R.S., Government Astronomer of Victoria.—The following paper was read:—The Latin verb *jubere*—a linguistic study, by Dr. John Fraser.—Prof. Liversidge exhibited and described a large collection of New South Wales minerals.

Paris.

Academy of Sciences, February 4.—M. Des Cloizeaux, President, in the chair.—On the loss of nitrogen during the decay of organic substances, by M. Th. Schlœsing. The fact that, during decomposition, nitrified organic matter liberates free nitrogen, was demonstrated for the first time by M. Reiset in 1856, and confirmed by the subsequent experiments of Messrs. Lawes and Gilbert, and others. Here, M. Schlœsing describes the process by which he has endeavoured to determine the quantity of nitrogen dissipated during decomposition under the *natural* conditions of temperature and the general environment. The results of these researches will be communicated in a future paper.—The Buitenzorg Botanic Garden and Laboratory, by Dr. Treub. From this interesting description of the Buitenzorg institution near Batavia, Java, it appears that it comprises three distinct branches: (1) the Botanic Garden, properly so called, where are cultivated from 8000 to 9000 tropical and sub-tropical plants; (2) the Tjibodas Garden, situated at an altitude of 1500 metres in one of the hilliest districts of the Preang residency; (3) the Experimental Garden, in the Tjikeumeuh quarter of Buitenzorg, where are grown all the economic plants of the tropical zone. The first comprises a museum, an herbarium, a large library, a phytochemical laboratory, a photographic *atelier*, and a laboratory for botanic research. This last was established four years ago for the purpose of enabling botanists from Europe to study tropical vegetation on the spot, and is thus somewhat analogous to the Zoological Station at Naples. Buitenzorg is supported by an annual grant of £6000 from the Dutch East Indian Government.—Observations of Barnard's Comet, 1888 *e*, made with the west equatorial of the Paris Observatory, by M. D. Eginitis. These observations, covering the period from December 7 to January 8, give the positions of the comparison stars, and the apparent positions of the comet.—Observations of the new planet discovered on January 28, at the Observatory of Nice, by M. Charlois. The observations were taken on January 28 and 29, when the planet was of the thirteenth magnitude.—On the personal equation in astronomical calculations, by M. J. J. Landerer. The object of this communication is to show that within somewhat wide limits the personal equation depends on an effect of diplopy which may be easily measured.—Euler's problem on the equation $ds^2 = dz^2 + dy^2$, by M. G. Kœnigs. In this note the problem in question is extended to the case of any surface.—On homography in mechanics, by M. Appell. It is shown that the method of transforming figures by central projection, which plays such an important part in geometry, may also be employed in mechanics. These remarks may be extended to the movement of a point in space, and even to the movement of several points, on the condition in the latter case of making a general homographic transformation, which shall simultaneously contain the co-ordinates of all the points.—On the compressibility of mercury and the elasticity of glass, by M. E. H. Amagat. In his communication of October 15, 1888, the author gave the results of his studies on the elasticity of the crystal in the cylindrical piezometers of this substance charged with mercury. By simultaneous inward and outward pressure of these cylinders, he obtains the coefficient of apparent compressibility, and ultimately that of the absolute compressibility of the liquid metal. The whole series of experiments are now repeated, and the results here tabulated, showing for mercury a mean general coefficient of 0·000003918 under pressures not exceeding 50 atmospheres. Although slightly higher, this may be regarded as in accordance with the coefficient 0·0000036, obtained by Prof. Tait, who worked up to a pressure of 450 atmospheres, and who considered his result as somewhat too low, even according to the method adopted by him ("Voyage of the *Challenger*," Part 4).—On the heat of formation of the bichromate of aniline, by MM. Ch. Girard and L. L'Hote. In a previous note (*Comptes rendus*, June 13, 1887) the authors showed that the bichromate of aniline might be easily prepared by causing the bichromate of potassa to react on the hydrochlorate of aniline under conditions there specified. In order to complete these researches they here study the thermic conditions of the formation of this salt.—Alcoholic combinations of the glycolalcoholate of soda, by M. de Forcrand. The author finds that the monatomic alcohols combine with the glycolalcoh olate of soda, forming with it crystallized compounds analogous to the alcoholic glycerinates of soda. He has prepared and analyzed the following products:—

$$C_4H_5NaO_4,\ C_2H_4O_2,$$
$$C_4H_5NaO_4,\ C_4H_6O_2,$$
$$C_4H_5NaO_4,\ C_6H_8O_2.$$

—On the quantitative analysis of organic nitrogen by the Kjeldahl method, by MM. E. Aubin and Alla. In reply to M. L'Hôte's objections to this method, experiments are here described showing that it is both trustworthy and accurate, yielding results fully equal, if not superior, to those of MM. Will and Warrentrapp. During the process the organic matter is completely transformed, and in the end all the nitrogen appears under an ammoniacal form; the sulphuric liquids obtained are always limpid and colourless, nor is there any loss of ammonia during the operations.—On the cockroaches of the Carboniferous age, by M. Charles Brongniart. Mr. S. H. Scudder, author of the best monograph on these Palæozoic forms, divides them into the two families of Blattinariæ and Mylacridæ, the former common to both hemispheres, the latter, as he supposed, confined to the United States coal-fields. But it is here shown that this is a mistake, and that the Mylacridæ are as common as the Blattinariæ in the Commentry formations, France.—M. de Malarce contributes a paper on the extension of the metrical system, on the development of uniform monetary systems and of the credit system (cheques, bills, &c.), throughout the civilized world.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

The Scientific Papers of the late Thomas Andrews, M.D., F.R.S., with a Memoir by P. G. Tait and A. Crum Brown (Macmillan).—The Physician as Naturalist: W. T. Gairdner (MacLehose, Glasgow).—Report on the Proceedings of the U.S. Expedition to Lady Franklin Bay, Grinnell Land, vol. i.: A. W. Greely (Washington).—Popular Lectures and Addresses, vol. i., Constitution of Matter: Sir Wm. Thomson (Macmillan).—The Philosophy of Mysticism, 2 vols.: C. du Prel, translated by C. C. Massey (Redway).—Dr. H. G. Bronn's Klassen und Ordnungen des Thier-Reichs, Erster Band, Protozoa, 53, 54, 55, Liefg.: Dr. O. Bütschli (Williams and Norgate).—Bird Life of the Borders: A. Chapman (Gurney and Jackson).—Report on the Cost and Efficiency of the Heating and Ventilation of Schools: T. Carnelley (Dundee).—Yield Tables for the Scotch Pine: W. Weise; converted into English measure and arranged by Dr. W. Schlich (Allen).—Volkaner i det Nordöstlige Island: Th. Thoroddsen (Stockholm).—Journal of the Chemical Society, February (Gurney and Jackson).—Observaciones Magnéticas y Meteorológicas del Real Colegio de Belen en la Habana, 4°. Trim. 1886 (Habana).—Bulletin de l'Académie Royale des Sciences de Belgique, No. 12 (Bruxelles).—Annalen der Physik und Chemie, 1889, No. 2 (Leipzig, Barth).—Beiblätter zu den Physik und Chemie, 1889, No. 1 (Leipzig, Barth).

CONTENTS.

PAGE