THURSDAY, SEPTEMBER 16, 1886

EARTHQUAKE DISTRIBUTION

Alphabetical Catalogue of the Earthquakes recorded as having occurred in Europe and adjacent Countries arranged to serve as a basis for an Earthquake Map of Europe. By Joseph P. O'Reilly, C.E., Professor of Mining and Mineralogy, Royal College of Science, Dublin. *Transactions* of the Royal Irish Academy, Vol. XXVIII. "*Science.*" (Dublin, 1886.)

THE distribution of earthquakes may be studied either geographically or topographically—either along its broad lines in connection with the general physics of the globe, or in its smaller details with immediate and minute reference to local peculiarities. The field of inquiry is in both directions vast and comparatively unexplored. As regards what we may call circumstantial seismography, little has been done in the particular application of general principles to explain the apparent caprices of disturbances. These are innumerable and fantastic; yet, by patient observation, they can to a certain extent be brought within the range of strict physical reasoning. The laws of wave-motion, taken in connection with the facts of geological formation, will account for a good deal. Not, however, for all. Subterranean agencies introduce an element of uncertainty into the calculation which no diligence or ingenuity avails wholly to eliminate. Thus, in South America certain districts are observed to remain year after year, perhaps century after century, unscathed amid surrounding devastation. They are hence called "bridges," the disturbance seeming, as it were, to flow beneath them, like a river under a bridge. Prof. Milne suggests that their immunity may be due to the total reflection of earth-vibrations which would otherwise reach them ("Earthquakes," p. 141). An obstacle to the propagation of such is besides often interposed by faults and fissures. The partial repose of Quito is attributed to the frequency of cañons in its vicinity; as, similarly, the Capitol of Rome and the citadel of Capua were said to be protected by numerous deep wells or springs sunk round them.

"Bridges," however, cannot invariably be depended upon. Their privilege of safety is liable at any moment to be withdrawn. The peninsula of Caraya, for instance, forming the northern shore of the Gulf of Cariaco, was never known to be shaken until December 14, 1797; yet it has since had its full share of disturbance. The interior arrangement of strata was here doubtless subverted, and the barrier to the extension of shocks from the chalk-hills of the mainland to the slate-rocks of the opposite peninsula overthrown, by the violence of the blow which destroyed Cumana. Centres of disturbance, too, shift and travel in a way to defy anticipation; and the effects of the interference of earth-waves, to which some terrific catastrophes, as well as many apparent anomalies of rest or commotion, are ascribed, can rarely be calculated beforehand. Nevertheless, much knowledge of high value, both practical and theoretical, might be acquired by the continuous topographical study of earthquakes in countries exposed to their ravages. Prof. Milne states that in Japan (where, through his initiative, more has been done in this branch than in any other part of the world), although earthquakes occur there at the average rate of two a day, yet with proper care a building site may be chosen as free from shocks as if it were situated in Great Britain.

The publication now under review is, however, directed to a different and a wider purpose. Prof. O'Reilly had already compiled a "Catalogue of Earthquakes" for these islands (see NATURE, vol. xxxi. p. 351); he has now accomplished a similar task for the whole of Europe with the outlying districts along the Mediterranean and Black Sea shores, designed to form the basis of a map showing the larger geognostic relations of these phenomena. Without some such picture, he rightly observes, no geological map should be regarded as complete. The latter displays results; the former represents the forces at work to produce them. The importance of earthquakes in geological history is great and far-reaching. Their connection with the physical structure of a country is most intimate. Every one of its leading features is related to them, either causally or consequentially. The main lines of jointing and fissuring, with the inseparably associated strike of coast-lines, are, according to a view originated by our author, directly conditioned by the prevailing direction of earthquake shocks. Its correctness can be tested only by statistical inquiries such as those of which he here gives us a laborious example. Other questions of interest awaiting similar elucidation relate to seismic action with reference to coal-fields and to the progress of elevation or subsidence.

Fuchs gives many instances of shocks limited to or originating in carboniferous districts ("Vulkane und Erdbeben," p. 196), and explains them by the progressive decomposition of organic matters quickened by the admission of air in working the shafts. The resulting escape of fire-damp diminishes the volume of the beds; they give way with a concussion, and an earthquake ensues. Extremely curious, in this connection, is the close agreement between the curves denoting the monthly frequency of earthquakes and of colliery explosions pointed out by Prof. O'Reilly (*Trans.* R. Irish Academy, vol. xxviii. p. 297). Each shows a strong and precisely coincident maximum in March, while the earthquake maximum in November is less perfectly matched by a conspicuous increase, one month later, in the number of explosions. The analogy of the equinoctial maxima of auroræ and magnetic disturbances cannot fail to suggest itself; and there are other indications that seismic and magnetic perturbations are not wholly extraneous to each other. Both auroræ and earthquakes, for instance, distinctly gain in frequency during the half-year which includes our winter season and the perihelion passage of the earth; and there have been too many and too close coincidences between their occurrences to be purely accidental.

Sudden changes of level, especially depressions, are an ordinary concomitant of earthquakes. An internal collapse of the strata in some cases produces the shock; in others the shock ruptures supports or overturns foundations long unsound. Degradation by water has perhaps undermined them; contractions have taken place through cooling, through chemical action, possibly through slow evaporation. At last a crash comes, and a tract of land,

deprived all at once of its insecure props, settles down to a lower level, a forest perhaps subsiding into a lake, or the sea over-washing a stretch of shore.

Slower processes of change, however, are probably far more general and effective, and with these seismic relations are still in part obscure. Such changes depend, there is little doubt, upon variations of equilibrium between internal forces of expansion and external forces of repression. Where these are accurately balanced, the bounding surface of the earth remains unaltered; where subterranean heat gets the better of gravity, as through the denudation of large tracts, elevation ensues; where the weight of the superincumbent strata is augmented by deposition, there is slow subsidence. The effects of the earth's secular cooling must evidently, in the long run, be thrown wholly into the scale for contraction; and yet it is to them indirectly that the upthrusting of mountain-ranges is due. These might be compared to the folds and creases of a garment grown too ample for the shrunken body it covers. The terrestrial crust, indeed, is less easily adaptable than an old coat; not a wrinkle in it but represents a series of paroxysms, every one implying a greater or less amount of earth-shaking, past and present. The snap after prolonged strain, the shifting and twisting of rocks, the fissuring and faulting, the slipping and wrenching and grinding of tormented strata in the effort to satisfy the stresses put upon them, all result in earthquake action of the mechanical kind. Thus, mountain-making is essentially a seismic operation, not only while in progress, but in its effects during long subsequent millenniums. This is one chief reason why the lines of earthquake distribution follow so faithfully the general direction of mountain-ranges.

But besides those commotions which result from the catastrophic restoration of disturbed equilibrium, there are earthquakes of the volcanic or explosive class. This species has been defined as an "uncompleted effort to establish a volcano." Such abortive eruptions are occasioned, there is much reason to suppose, by the sudden formation of steam at great depths beneath the earth's surface. They arise where broken and disjointed strata facilitate the percolation of water to volcanic foci. A fractured crust and a plentiful aqueous store are their developing conditions. Hence their frequentation of sea-coasts. Prof. Milne remarks that most Japanese earthquakes originate in the Pacific, and that the steepest coasts are, on the whole, the most severely shaken; as is easily intelligible when we consider the violence of the dislocations necessary to produce them.

Earthquakes may then be broadly distributed, according to their kind, into two systems, now coalescing, now independent of each other. The explosive species follow volcanoes along sea-coasts, the mechanical sort are associated with mountain-ranges; all attend lines of weakness, and are more or less closely connected with the shrinkage by cooling of the terrestrial crust. Thus, every volcanic region is liable to earthquakes; though there are earth-shaken districts which are not volcanic.

The tendency to alignment in volcanoes has often been noticed: Prof. O'Reilly indicates a similar peculiarity in earthquakes, adding that the lines along which they range commonly approximate to great circles. This inference, or suspicion, can be verified only by detailed charting. There are great difficulties, however, in getting a true graphical representation of seismic activity. Not only deficiencies in records have to be contended with, but grave perplexities as to their treatment. They are fully admitted by our author. The number of shocks felt in a given spot is the criterion inevitably adopted; but these may vary to any extent in intensity, or may be the mere sympathetic reverberation of some distant catastrophe. The Lisbon earthquake of 1755, for instance, may quite possibly have shaken every square foot of the globe. The ideal seismic map would be one of earthquake origins, with their attendant areas of disturbance; but this is at present far from being attainable; and we can only acknowledge the indebtedness of science to those indefatigable workers who, like Prof. O'Reilly, promote knowledge by the best *present* means open to them.

OUR BOOK SHELF

Department of Agriculture, Washington: Third Report on the Chemical Composition and Physical Properties of American Cereals, Wheat, Oats, Barley, and Rye. By Clifford Richardson. (Washington, 1886.)

THIS Report is an important continuation of a most valuable work. The object in view is to obtain accurate information respecting the composition of the cereal grains produced in the various States. The grain analysed is in some cases the produce of seed issued by the Agricultural Department, but generally represents the ordinary crops of the district. A complete physical and chemical examination has been made of each sample of grain: the results are tabulated under the head of the State in which the grain was reared. The Report contains 77 analyses of different varieties of wheat grown in Colorado; 179 analyses of the kernel of oats, and 100 analyses of the husk; 57 analyses of rye, and 72 of barley. The extent of variation in composition, the relation of physical characters to chemical composition, and the influence of climate, are discussed. The results are further compared with those obtained by investigations in Europe. At the close of the Report are given some detailed analyses of cereal grains in which sugar, starch, and the albuminoids soluble and insoluble in alcohol, are separately determined. Analyses are also given of the very various products obtained from wheat by roller-milling. The whole is a magnificent contribution to the history of cereals. We now know far more of the characteristics of cereals grown on the American continent than we do of those produced in the United Kingdom. When will an English Agricultural Department inaugurate a similar study?

As we have no space for the details of the results, it is perhaps hardly fair to criticise. We would merely remark that dextrin is not reckoned by the best modern chemists among the constituents of barley, or of other cereal grains that have been thoroughly investigated. The method used for determining starch is apparently one yielding too high results, while the "fibre" shown in the analyses is far below the total cellulose and incrusting matter really present. We call attention to these errors of method, as they are very generally met with, and it is high time that they were remedied. R. W.

Longmans' School Geography. By George G. Chisholm, M.A., B.Sc. (London: Longmans, Green, and Co., 1886.)

ONE point which the recent discussions with regard to geographical education in this country has brought out

beyond dispute is that our teachers have wretched text-books in geography, and Germany has been held up to us as the model to follow in this as in many other respects in regard to geographical teaching. The Germans (as Mr. Chisholm points out in his interesting preface) have had long experience in working out an advanced system of education; they know that a limited period must be turned to account for the thorough teaching of a great variety of subjects, and accordingly they have learned to distinguish between what is indispensable as a ground-work and what must be omitted. In this country the study of geography is mainly a work of memory—the names of towns, rivers, mountains, with their populations, lengths, and heights. This and similar details are precisely those on which the Germans lay least stress, and as Mr. Chisholm has "earnestly endeavoured to guide himself by German examples," he anticipates that his book will appear more remarkable for what it omits than what it contains. Stated in his own words his object has been, in the first place, to draw a mental picture of the different countries and regions of the world, giving due relief to what is most distinctive in each region, and, secondly, to give special prominence to the relation of cause and effect, so as to enable pupils to realise that in geography there is something to understand as well as to commit to memory, in other words, to make geography a mental discipline as well as a body of instruction. Of course there is important work for the memory in geography as in every other branch of education, and this the author recognises, and provides for in his tables and printing. He insists, too, on the vital necessity of maps, without which there can be no adequate knowledge of geography. A text-book is supplementary to an atlas, and does not supersede it. These are high ideals which Mr. Chisholm sets before him; let us see how he fulfils them.

The whole volume contains 320 pages. The first 60 are devoted to an introduction dealing with mathematical and physical geography, which, as explained in the preface, is designed primarily for teachers, and is not intended to form part of the course for the pupils until they have gone through the whole body of the book.

The introduction is followed by a description of continents and countries. Of the 260 pages which remain for this purpose, Europe fills 150 pages, Asia 45, Africa 16, and America 32. The proportions are based on the degree of knowledge which an educated English boy or man should have of the respective countries and continents. Some of the divisions are original. Thus English counties are divided into corn and grazing, the countries of Asia into monsoon and non-monsoon countries. We have specially examined the sections devoted to the countries of Eastern Asia, for the sins of ordinary British school geographies are more apparent here than elsewhere—the sins, namely, of stereotyped inaccuracy, and of strings of names and numbers. Mr. Chisholm has not a superfluous line in any of these sections, the information is of the latest kind, and all the knowledge that the average boy requires of the countries is put in a short space.

As an instance of the care with which the work is done it may be mentioned that the puzzling variations of some Japanese names (*e.g.* Fujinoyama, Fujisan) are given and explained. On the whole, we are convinced that there is at present no school geography in the English language more calculated to give adequate and intelligent instruction in that subject than this, and can therefore strongly recommend it to those teachers who have lamented the absence of a sound text-book. It is to be hoped that Mr. Chisholm may see his way to producing a smaller work about half the size and price of this book for lower classes.

LETTERS TO THE EDITOR

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

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

Physiological Selection and the Origin of Species

As Mr. Romanes has referred to my article in the current number of the *Fortnightly Review*, and stated that he is prepared to answer what he terms "the very obvious exceptions" which I have taken to his theory, I shall be glad to be allowed to state, very briefly, what those exceptions are, and to give an illustration of one of the more important of them.

(1) Mr. Romanes makes a great deal of the alleged "inutility of specific characters," and founds upon it his extraordinary statement that, during his whole life, Darwin was mistaken in supposing his theory to be "a theory of the origin of species," and that all Darwinians who have believed it to be so have blindly fallen into the same error. I allege, on the contrary, that there is no proof worthy of the name that specific characters are frequently useless, and I adduce a considerable series of facts tending to prove their general utility.

(2) In support of his view as to the swamping effects of intercrossing, Mr. Romanes objects to the assumption of Darwin, "that the same variation occurs simultaneously in a number of individuals," adding: "Of course, if this assumption were granted, there would be an end of the present difficulty"; and his whole argument on this branch of the question rests on the assumption being false. I adduce evidence—copious evidence—that the supposed assumption represents a fact, which is now one of the best-established facts of natural history.

(3) Mr. Romanes states, as the special feature of his physiological varieties, that "they cannot escape the preserving agency of physiological selection." He gives no particle of proof of this, while I show that, on the contrary, it is hardly possible for them to survive to a second or third generation. It is on this point that I wish to give an illustration. Mr. Romanes speaks of his supposed variations as "showing some degree of sterility with the parent form," while continuing to be fertile "within the limits of the varietal form"; but I hold that any such variety (beyond single individuals) can hardly exist, while he has adduced no proof whatever of their existence. To show the improbability of their existence, let us suppose a definite case.

In a given species there is born an individual, A, which is infertile with the bulk of the species, but fertile with some few individuals of the opposite sex, *a*, *b*, *c*. Let there be a second individual, E, born from other parents in another part of the area occupied by the species, and fertile only with *e*, *f*, *g*. Other individuals, K, P, R, &c., may have similar relations, each infertile with the bulk of the species, fertile only with a few individuals which may be termed their physiological complements. Now each of these, separately, is a physiological variety, but the whole set, A, E, K, P, R, do not form one, but five distinct varieties. To form one variety all of them must be fertile with the same identical set of individuals of the opposite sex, and this seems to me to be so highly improbable that it must not be assumed till rigidly proved. Yet there is not one passage in Mr. Romanes' paper to show that he recognised this difficulty; on the contrary, he always speaks as if any number of separate physiological variations within one species must necessarily form one variety. It will easily be seen that the chances against any single variety of this nature being preserved are overwhelmingly great. For, first, at least two of the complementary individuals must survive to the breeding-season, and the chances against this are measured by the fertility of the species. If it produces ten young each year, the chances are between nine and ten to one against any one of them surviving. The chances against the *two* complements surviving will be about ninety to one; and then there remains the chances against the two meeting at the breeding-season, for, by the assumption, there is nothing whatever to bring them together but chance, and this may be any number of thousands to one.

There are, no doubt, other possible cases in which the physiological variety might be continued, but, as I have shown in my

paper, the chances against it are always very great. Here, then, are three objections to Mr. Romanes' theory which seem to me to be weighty and fundamental; yet he says, in effect, that he anticipated, and is prepared to answer, them. This, I must say, puzzles me; because in the whole of his lengthy paper, occupying seventy-five pages, I cannot find any adequate recognition of their existence, or any attempt whatever to answer them.

My apology for writing this is that I am shortly leaving England, and wish the readers of NATURE, who may not have seen the *Fortnightly*, to be aware of the character of the objections which Mr. Romanes declares that he anticipated, but apparently thought of too little importance to require any discussion in his paper. ALFRED R. WALLACE

I AM sorry that I have not succeeded in making my meaning clear to Mr. Romanes. I had hoped that my former letter (NATURE, September 2, p. 407) would have given some indication as to my father's views. With regard to the sentence quoted from the "Origin of Species," our views seem to differ so much that it seems useless to prolong the discussion.

FRANCIS DARWIN

Golf Club, Felixstowe, September 13

I HAVE read the numerous notes and letters in recent numbers of NATURE upon the origin of species and varieties with great interest. It seems to me that all your correspondents are raising an imaginary difficulty.

"If it is to the advantage of some particular variety not to resemble the parent form," then that variation must have been produced by some efficient cause acting upon the parent form alone. Is it not obvious that that cause still acting will be still more potent in producing that particular variation when the parent form intercrosses with the variety? This is, of course, supposing that the new variety is suitable to its environment; if it is not so, no amount of "propping up," whether by "amixia" or otherwise, would perpetuate it.

If, as is probably the fact, varieties or incipient species have arisen from individual divergences, amixia would tend to immediately suppress them in the case of animals and dioecious plants, as a new generation could not possibly arise without intercrossing with the parent stock. J. H. A. JENNER

4, East Street, Lewes

I SHOULD be glad to call Mr. Romanes' attention to a letter by Mr. Edmund Catchpool, published in NATURE, November 6, 1884 (vol. xxxi. p. 4), where he will find his theory of physiological selection very clearly put forward.

FRANK EVERSHED

113, Darenth Road, Stamford Hill, N.

Solution Discussion at the British Association

IT was a pity there was no discussion on solution in British Association, Section B, on Thursday last. More than the whole day was taken up with reading a great many papers, some of them having very little to do with the subject, so no time was left for discussion. I was indeed, by the courtesy of the Vice-President and the patience of the few remaining listeners, allowed to make a few remarks, but of course it was only possible for me to indicate that I had something to say.

In the papers referred to a good deal was said of solution being due to purely physical causes. Now this is either a truism or a veil to hide ignorance, and I am sure no one was a bit the wiser. What we want to get at is THE physical cause of solution. Again, a great deal was made of the part of the heat of solution that might be accounted for by the contraction in volume of the solution. This looks very learned and scientific, and no doubt is interesting from some points of view, but even if all the heat could thus be accounted for, it would not advance our knowledge of the cause of solution; it is merely surrounding the subject with cobwebs. The question would still remain, What is THE physical cause of this contraction?, and I maintain it is due to the affinity of all the elements for one another acting as pointed out in my papers on chemical affinity and solution published in NATURE, April 29 and July 22 of this year. The truth is, chemists, for convenience of study, drew a circle and called all within this "chemical affinity," and then forgot that the circle was their own making, and imagined it was Nature's work. This restriction has served its day, and must now be obliterated if we would understand the plainest teaching of the laboratory and make continued progress.

Portobello, September 9 WM. DURHAM

Actinotrocha of the British Coasts

IN NATURE of August 19 (p. 361), which I have only seen to-day, my friend, Mr. J. T. Cunningham, records as a novelty the finding in 1883 of *Actinotrocha* off Cromarty Firth. Without giving an exhaustive note of its occurrence off our shores since the discovery in 1856 of *Phoronis* by the late able and accomplished Dr. Strethill Wright, viz. one species from Ilfracombe, and another on an oyster-shell from the neighbourhood of Inchkeith in the Firth of Forth, the following remarks may be of interest. So long ago as 1858 the late Dr. Spencer Cobbold found *Actinotrocha* near Portobello, as was likely after Dr. Wright's discovery, and I have also since met with it in and off the Forth. Moreover, at the meeting of the Microscopical Society at which Dr. Cobbold read his paper, the lamented Dr. Carpenter mentioned that he had found *Actinotrocha* in abundance off the Island of Arran, probably when working at *Tomopteris* and other surface-forms with his friend, the enthusiastic E. Claparède, of Geneva. Besides these localities, Prof. Kölliker ("Kurzer Bericht an der westküste von Schottland," *Zeitsch. f. w. Zool.*, Bd. v. 1864) describes the occurrence of a *Phoronis* apparently identical with Dr. Wright's *P. hippocrepia* from Millport on the larger Cumbrae in the Clyde, a region in which the steam-yacht *Medusa* from Granton has lately been at work. It is probable, indeed, that *Phoronis* and its larval form (*Actinotrocha*) are more generally distributed round our shores than the scanty notices of them would lead one to suppose. Old shells in and off the mouth of the Forth, off the western shores, and these and other structures in the littoral region on the southern coast of England, as well as the shores of the Channel Islands, will probably produce many examples of *Phoronis*, while the careful scrutiny of the contents of the tow-net in similar localities will yield corresponding results as regards *Actinotrocha*. W. C. MCINTOSH

St. Andrews Marine Laboratory, August 25

The Manatee

I NOTICE in the review of Dr. C. Hartlaub's work on the Manatees, which appears in your issue of July 8 (p. 214), that the geographical range ascribed to that animal on the West Coast of Africa has its southern limit at the Quanza. A reference to earlier writers would, I think, justify us in believing that the manatee was once to be found as far south as the Cape of Good Hope, or else that it has been confounded with the hippopotamus.

Dapper, in his description of the Cape Settlement, speaks both of sea-cows—"zee-koeien of zee duivels, zoo groot als koeien, die bij wijlen te lande gaen weiden"—and of sea-horses—"zee-paerden, een zeer groot en wonderijgelyk zee-gedrocht" ("Naukenge Beschrijonige der Afrikaensche gewesten," p. 266; Amsterdam, 1676).

Here the hippopotamus is evidently the *zee-koe* or sea-cow, which occasionally feeds on dry land. May not the *zee-gedrocht*, the sea-monster, have been the manatee?

For Valentyn, also writing of the Cape of Good Hope, refers very explicitly to the manatee:—

"Onder de zee dieren telt men de zee koejen, de hier zeer veel en ongemeen swaar vallen, alzoo men er zommige van 4 of 5000 ponden gezien heeft. In West Indien *noemt men dit dier Manati* bij de Indianen, en anderen noemen het wel een Lamantine; hoewel er zijn die beide deze dieren nog eenigzins onderscheiden.

"Diergelijk zwaar zee paarden heeft men er ook, hoewel wat verder van de Kaap af, gezien. Zij vallen doorgans kastaniebruin" ("Beschrijung van Kaap de Goede Hoop," p. 115; Dordrecht and Amsterdam, 1726. Eighth volume of "Oud en Nieuw Oost Indien").

But here the manatee is called the sea-cow. What is the sea-horse (*zee-paarden*)? Can it be what Leguat saw at sea on his voyage from Amsterdam to the Cape—which he reached twelve days after the *rencontre*?

"Le premier jour de l'an 1691 nous eûmes le plaisir de voir assez distinctement une vache marine de couleur roussâtre (cf. the "kastaniebruin" of Valentyn) "qui faisoit voir la tête entière,

et quelquefois de la moitié du corps hors de l'eau. Elle était ronde et épaisse et paraissoit plus massive que nos plus grandes vaches. . . . Un de nos matelots nous assura que ces animaux avoient les pieds, comme vous pouvez voir dans la figure que voici."

This figure, however, except for the toes, which resemble fins or webbed feet, is unmistakably the hippopotamus! (See "Voyage et Avantures de François Leguat," vol. i. p. 35; Londres, 1708.) Leguat did not apparently consider it a manatee, for on p. 93 he gives a full description, with plate, of the lamentin or manati, which "se trouve en grande abondance dans les mers de cette Isle" (Rodriguez). The skin is "noirâtre."

Père Tachard plainly calls the hippopotamus the *vache marine*—he is speaking of the Cape: "on voit dans les grandes Rivières un animal monstrieux, qu'on appelle Vache Marine, et qui égale le Rhinocéros en grandeur" ("Voyage de Siam," vol. i. p. 78; Amsterdam, 1688). The plate accompanying is the hippopotamus, and we know that the Dutch colonists have always called this pachyderm the "zee-koe."

Kolbe ("Caput bonae spei hodiernum," p. 167, Nürnberg, 1719) speaks of the "zee kuh," the "meer kuh," the "zee pferd," and the "kuh fisch," all of which he appears to consider different names for the hippopotamus, notwithstanding that "in dem Tartarisch meere grosse Küh-Fische schwemmern, die grosser als unsere Kühe in Europa waren, aber weder Schuppen noch Hörner hatten." This must be the dugong, surely.

Bogaerts ("Asia," p. 105; Amsterdam, 1711) distinguishes between "zee-paarden" and "zee-koien."

Dampier's mention of the manatee is probably well known:—"While we lay here (Blewfield River, between the Nicaragua and Veragua Rivers) our Moskito men went in their canoa and struck us some manatee or sea cow. Besides this Blewfield River I have seen of the manatee in the Bay of Campeachy, on the coast of Bocca del Drago and Bocco del Toro, in the River of Darien, and among the South Keys or little Islands of Cuba. . . . I have seen them also at Mindanea, one of the Philippine Islands, and on the coast of New Holland." Then follows a full description (see Dampier's "Voyage Round the World," vol. i. p. 33 *et seq.*, also pp. 2, 9, 41, 381, 463, and 547; London, 1729). Dampier also points out that the so-called manatee of St. Helena is really a "sea-lion."

Cape Town, August 4 W. HAMMOND TOOKE

Time Reform in Japan

THE following communication may perhaps interest your readers.

On my return home from America and Europe, I presented a report on the resolutions of the International Meridian and Time Congress, held at Washington last year, to which I was sent as a delegate. A Committee was appointed to discuss the matter contained in my report, and reported favourably. The following decree was issued on July 12, 1886, under the Imperial seal:—

(1) The meridian passing through the centre of the transit instrument at the Observatory of Greenwich shall be the initial meridian for longitude.

(2) Longitude shall be counted from this initial meridian in two directions up to 180°, east longitude being + and west longitude −.

(3) On and after the first day of the first month of the twenty-first year of Meiji (January 1, 1888), the time of the meridian of 135° E. shall be used as the standard time throughout the empire. D. KIKUCHI

Science College, Imperial University, Tokio, Japan

Tremblement de Terre du 5 Septembre

L'ÉBRANLEMENT des couches terrestres, qui peut être considéré comme la suite du trembleterre du 27 août, a eu son centre dans le Piémont, dans les environs de Suse, au pied du Mont-Cenis. Le phénomène a été composé des secousses suivantes, qui ont toutes été très-faibles dans la Suisse.

Secousses préparatoires. 4 septembre, 11h. 35m. soir (heure de Berne) Colombier (Neuchâtel); 5 septembre, 8h. 16m. soir, Briançon (Hautes-Alpes, France).

Grande secousse. 5 septembre, 8h. 55m. soir. Nous en avons des observations de Bienne, Berne, Lausanne, Morges, Genève, Vevey, Aigle, Villars-sur-Ollon, Bex, Mouthey, Troistorrents, Sion, Saviese.

Secousses consécutives. 5 septembre, 11h. 55m. soir, Genève; 6 septembre, 4h. 10m. matin, Mouthey (Valais); 7 septembre, 0h. 43m. matin, Genève. F.-A. FOREL

Morges, 12 septembre

Lunar Rainbow

A BEAUTIFUL lunar rainbow was plainly visible here for a few moments last evening. The eastern sky being clear, the moon looked fully out from behind dark clouds in the west at a moment when rain was falling lightly. Turning quickly away from her light, in the hope of seeing a bow, I was not disappointed. A semicircle of pale, whitish light, was projected against the eastern sky, much smaller in diameter, apparently, than a sun-bow, and without any traces of colour.

Reflecting on the circumstance that repeated efforts have never, previously, enabled me to see a lunar bow, although the conditions necessary for its formation are common enough, I am tempted to think that the phenomenon can only be seen when the atmosphere is unusually clear. The light issuing from the bow is so faint that the slightest mistiness of the air intervening between itself and the spectator is probably sufficient to, practically, extinguish it. Last night the air here and over the Channel was extraordinarily pellucid, lights on the French coast which are hardly ever seen being plainly visible, while others, nearer neighbours, flashed with most unusual brilliancy.

D. PIDGEON

Arthur Villa, Hythe, Kent, September 6

Aurora

THE aurora seen in Ireland on July 27, and described in NATURE, August 5, p. 312, was visible in this vicinity. It was the finest observed thus far this year, with the exception of that of May 8. Other dates on which the aurora has been seen in this locality recently are as follows: June 29, June 4, and April 14. It has been noted that these appearances of the aurora have been coincident with the return of the disturbed area on one side of the sun (see NATURE, July 22, p. 278), and likewise with widespread and violent storms.

Lyons, New York, August 25 M. A. VEEDER

THE SOLAR ECLIPSE OF AUGUST 29

THE following communication, dated Grenada, September 5, is published by the *Times* from its correspondent with the Eclipse Expedition. It should be compared with the communication made by Prof. MacAlister to Section A at the Birmingham meeting of the British Association (NATURE, September 9, p. 441), and with the article in the same number (p. 437), describing the arrangements for observation.

"The observations of the corona during the last two eclipses, including that observed in Egypt, have been confirmed by the present. Capt. Darwin's observations with the coronagraph seem disappointing, the glare of irradiation from the body of the sun, and not the true corona, being visible on his plates. The bright lines seen in the spectra of the prominences are displaced in such a direction as to prove that there is in them a downrush of gas towards the sun.

"The curious prolongation of the corona observed on several previous occasions to occupy the sun's equatorial plane, does not appear in any of the photographs taken, though it was visible at all the stations except Mr. Lockyer's."

PHOTOGRAPHY OF THE SOLAR CORONA

UNDER the above title we have received the following communication with reference to the results of the recent eclipse observations:—

Accounts have appeared in your journal of my attempts to photograph the corona of the sun without an eclipse. Many of the plates obtained presented appearances which seemed not to myself only, but to several scientific men who must certainly be con-

sidered to be amongst those who are exceptionally competent to give an opinion on this point, to be most probably due to the corona. Plates taken in England about the time of the eclipse of May 6, 1883, and drawn by Mr. Wesley before any information reached this country of the observations of the eclipse, presented not only a general resemblance to those taken during the eclipse, but showed the remarkably-formed rift on the east of the sun's north pole which is the main feature of the corona, as photographed at Caroline Island. It is true that since the summer of 1883 I have not been able to obtain in England photographs which show satisfactory indications of the corona; but the abnormally large amount of air-glare from finely-divided matter of some sort, which has been present in the higher regions of the air since the autumn of 1883, might well be considered a sufficient cause of the want of success. This well-known state of the sky rendered the plates taken by Mr. Ray Woods in Switzerland in the summer of 1884 inconclusive as to the success of the method. During the past year photographs of the sun have been taken at the Cape of Good Hope, and are under discussion by Dr. Gill.

Such was the state of things before the eclipse of August 29. The partial phases of this eclipse furnished conditions which would put the success of the method beyond doubt if the plates showed the corona cut off partially by the moon during its approach to and passage over the sun. As the telegrams received from Grenada and a telegram I have this day received from Dr. Gill at the Cape of Good Hope state that this partial cutting off of the corona by the moon is not shown upon the plates, I wish to be the first to make known this untoward result. I regret greatly that a method which seemed to promise so much new knowledge of the corona, which under ordinary circumstances of observation shows itself only during total eclipses, would seem to have failed. At the same time, I am not able to offer any sufficient explanation of the early favourable results to which I have referred briefly in the opening sentences of this letter.

WILLIAM HUGGINS

Upper Tulse Hill, S.W., September 11

In reply to a similar communication which appeared in the *Times*, Mr. A. A. Common writes to that journal as follows:—

"Dr. Huggins, in his letter in to-day's issue, seems to consider that the failure to get a picture of the moon projected on the corona of the sun during the partial phases of the last eclipse is fatal to his method of photographing the corona; but it is quite possible, and, indeed, probable, that this is due entirely to the state of the sky, for against such unfavourable negative as this we have the positive evidence that the moon has been seen so projected in various solar eclipses, and in one case it has been so photographed. This was by Liais, at Paranagua, in 1858, under conditions that were not, as far as concerns the processes employed, nearly so favourable as those now in use. This single piece of positive evidence, if correct, is of vital importance in showing that the present failure is probably due only to such temporary causes as have prevented Dr. Huggins getting lately such promising plates as those he obtained in 1883.

"Ealing, September 13 "A. A. COMMON"

THE RECENT AMERICAN EARTHQUAKE[1]

THE author gave a brief account of the earthquakes in Eastern Europe of August 27, which seem to have travelled eastwards from Malta to the south of Italy. It is a curious coincidence that the first important indications of earthquake disturbance in the United States took place on that date, when the geyser of the Yellowstone spouted forth and when the first moderately severe shock at Charleston occurred. The principal shock was on Tuesday night, August 31. This is the one which has done most damage, and which was felt over a wider area than any previously recorded in North America. It has, however, been succeeded by shocks, fortunately of less intensity, which have been felt over a still wider area. The later shocks of Thursday and Friday were felt in Nevada and California.

The author gave a description of the earthquake, founded upon the newspaper telegrams and upon a telegraphic despatch which Major Powell had kindly forwarded at the author's request. The latter is as follows:—

"The earthquake is the most severe on record in the United States, and affected the greatest area. Origin along line of post-Quaternary dislocation on the eastern flanks of the Appalachian, especially where it crosses central North Carolina. There were slight premonitory shocks in the Carolinas for several days, moderately severe shocks occurring near Charleston on August 27 and 28. The principal shock, causing great destruction in Charleston, originated in central North Carolina on August 31, 7.50 p.m., 75th meridian time. Thence the shocks spread with great rapidity in all directions, with velocity varying from 25 to 65 miles a minute, over an area of 900,000 square miles, or one quarter of the United States—from the Gulf of Mexico to the Great Lakes and Southern New England, and from the Atlantic seaboard to the Central Mississippi Valley. In the Carolinas it was accompanied by landslides, crevasses, and great destruction of property. Half of Charleston is in ruins; about 40 lives were lost. No sea-wave has yet been reported. A second moderately severe shock occurred at Charleston at 8.25 a.m. September 1. Minor shocks followed at increasing intervals. The principal shock was felt over this vast area in intervals of 15 minutes, and recorded at some principal points on a scale of intensity of 5 as follows:—Raleigh, 4, 9.50 p.m.; Charleston, 5, 9.54; Cedar Keys, Florida, 2, 10.05; Knoxville, 3, 9.55; Memphis, 4, 9.55; St. Louis, 1·2, 10.00; Milwaukee, 3, 10.06; Pittsburg, 4, 10.00; Albany, 2, 10.00; Springfield, Mass., 1, 10.00; New York, 2, 9.53."

Prof. Carvill Lewis has studied a previous earthquake in the North-Eastern States. This ranged along the north-eastern flanks of the Appalachian Chain. The author described the structure of Eastern North America, and the lines of old earth-movements therein to which both earthquakes seem to be related.

The local phenomena of the recent earthquake may be summarised as follows:—Fissures were formed, some running north to south, some east to west, out of which mud and sand were ejected. Several telegrams speak of stones falling from the air, which (if true) must previously have been ejected from such fissures. No tidal wave has been recorded, nor has any alteration of level of land or depth of sea occurred, although the earthquake was noticed at sea off Charleston; but some passing disturbance of the water seems to have occurred at Sullivan's Island near Charleston, for the high water spoken of could not be a spring tide, as the tides then were the neap tides. The accounts agree in the earthquake being accompanied by rumbling noises. Accounts differ as to the direction of the vibratory movement, but it was probably from the south or south-south-west to north or north-north-east, both at Charleston and New York. As usual in earthquakes, wells and springs have been affected; some dried up, whilst water has appeared where before there was none. The natural gas wells of Pennsylvania have been affected, and the supply much diminished. Perhaps the most interesting phenomenon is the

[1] "Notes on the Recent Earthquake in the United States; including a Telegraphic Despatch from Major Powell, Director of the United States Geological Survey." Read at the British Association by W. Topley, F.G.S., Geological Survey of England, President of the Geologists' Association.

outburst in the Yellowstone Park of a geyser which has been quiescent for four years.

All the evidence so far published tends to show that the earthquake was a true seismic disturbance, which was probably transmitted along certain lines of great rock-masses, or along lines of weakness; but details to enable us to determine these points are not yet to hand.

DR. KLEIN'S REPORT ON MILK SCARLATINA

IN a recent Report to the Local Government Board, "On Certain Observed Relations between Scarlatina in various Districts of London and Milk supplied from a Dairy Farm at Hendon," Mr. Power has related the circumstances (NATURE, vol. xxxiv. p. 393) under which I became associated in inquiry at the farm in question; and, while briefly indicating certain provisional inferences of my own as to the nature of the malady discovered among the cows there, Mr. Power goes on to promise an account by me of the special features and pathology of the disease. This I now proceed to give.

The cows (I. and II.) which were the first subjects of my investigations had on the teats and udder several flat irregular ulcers, varying in diameter from ¼ to ¾ of an inch; some ulcers were more or less circular, others extended in a longitudinal direction on the teat. The ulcers were covered with a brownish or reddish-brown scab, which, when scraped away, left exposed a granulating slightly indurated base. The margin of such ulcer was not raised, nor was there any perceptible redness of the skin around. But where I afterwards got the opportunity of watching the earlier stages (especially in animal IV.) it was noticed that a small vesicle made its appearance on a greatly swollen and red teat, in the course of a couple of days assuming the character of the above ulcers. In another cow, an ulcer about ½ inch in diameter, was becoming covered in its central part with a scab, while at its margin vesiculation was still distinctly visible.

As a rule, *i.e.* in most animals, the disease affected the teats, but in some there was also on the lower part of the udder here and there an ulcer. In such animals, patches denuded of hair were noticed on various parts of the skin, the tail and back particularly. In these patches the epidermis was scaly, and the cutis more or less thickened. The animals looked thin, but not strikingly so, except in one or two cases of animals that had only a few weeks ago been admitted to the place, and which therefore had calved comparatively recently (see Mr. Power's Report). As regards the feeding capacity of affected animals, their milking power, and their body temperature, nothing abnormal could be detected.

Two animals (to be referred to as cow III. and cow IV.) became the special subjects of study after they had been removed from the farm to the stables of the Brown Institution.

The temperatures (Centigrade degrees) of cow III. were as follows:—

	Morning temperature	Evening temperature
January 4	38·8° ...	38·7°
,, 5	38·9 ...	38·9
,, 6	38·8 ...	38·3
,, 7	38·9 ...	—
,, 8	39 ...	39
,, 9	38·8 ...	38·7

The temperature afterwards remained as above without alteration.

The temperatures of cow IV. were:—

January 6	38·4° ...	38·3°
,, 7	38·7 ...	—
,, 8	38·4 ...	38 8
,, 9	38·6 ...	38·5

In animal III. the ulcers were present, and on January 4 were at their full development and covered with crusts. They gradually died away, and subsequently healed up by January 10, leaving, however, a whitish indistinct flat scar.

When this animal was received there were noticed on its coat several patches where the hair was gone, and the epidermis was rough and scaly.

Animal IV. when received showed several scabs in the skin of the back; it had also muco-sanguineous discharge from the vagina (the animal was in the third month of pregnancy) and redness and excoriation of the mucous membrane of the vagina. One teat, which was much swollen and inflamed, presented in several places brownish crusts. These when taken off left an infiltrated firm sore, from which, when squeezed, a thickish lymph oozed out. Similar crusts were found on other teats and on the udder. The greatest development of the sores in this cow was on January 7. On January 9 the sores were decreasing; the animal was then killed.

On opening the chest it was found that both lungs exhibited in the upper posterior lobes numerous petechiæ under the pulmonary pleura, the peripheral lobules of these parts being much congested. There were numerous adhesions by recent soft lymph between the lower lobes of the lung and the costal pleura, particularly laterally. In the liver there were several reddish streaks and patches, reaching from the surface of the organ to a depth of about a quarter of an inch. In these patches the liver tissue was much softened. The spleen and kidneys, with exception of slight congestion, appeared normal. In the placenta there were numerous petechiæ.

Cow III. was killed on March 12. For some days previously the animal had been getting very thin, notwithstanding its ravenous and excessive eating. On post-mortem examination the following appearances were found:—

In the lungs there were numerous lobules, especially in the peripheral parts, which showed great congestion; there were in addition pleural adhesions; the cortex of the kidney was congested, but its medulla was pale.

Experiments were now made with the matter of the ulcers, with a view of ascertaining whether or not the disease was transmissible to other animals.

On January 7, when the ulcers of cow IV. had reached their maximum development, I took scrapings from some of the ulcers on the udder and teats, having first removed the crust, and inoculated in several places the skin of groin and inside of ear of two calves (1 and 2). For inoculation a superficial small incision (not longer than about a quarter of an inch) was made, passing in an oblique direction through the superficial part of the corium, and into this pouch a particle of the scraping was rubbed.

On January 9, with scraping of ulcers of the cow before she was killed, I inoculated two calves (3, 4), introducing the matter as before into the corium of the groin and of the inside of ear.

Calves 1 and 2 showed during the first three days after insertion of the matter no change at the seat of inoculation.

Four days after inoculation:—There was in calf 1 one place in the groin which promised to become an ulcer. Calf 2 showed on the ear one promising place, the other places of inoculation having nearly healed.—At the same distance of time after inoculation calf 3 showed two promising places on the ear, and calf 4 showed two promising places in both groin and ear. Calf 3 also showed a kind of vesiculation at the margin of the spot inoculated and commencing formation of a crust in the centre. What I call promising places of inoculation were spots that had become swollen and tender, the other and not promising places were spots that seemed healing or were already healed and dry.

On the sixth day:—Calf 1 showed four successful places in the groin; the places had become swollen and enlarged with imperfect vesiculation at the margin and formation of crust in the centre. Calf 3 had four successful places on the ear, and calf 4 had the same number in the groin.

On the seventh day:—In calf 1 all places except one in the groin had nearly disappeared. This place was now a distinct ulcer covered with a crust, on removing which a granulating infiltrated base was exposed. In calf 2 all places of inoculation were decreasing, covered with small scabs, easily detached. In calf 3 the sores on the ear had enlarged to about half an inch in breadth, each of them covered in their whole extent by a brownish crust. In calf 4 all except one place on ear were healing.

On the eleventh day:—Calf 1 had still one ulcer in groin not yet healing. Calf 2 had one ulcer on ear not quite healed up. Calf 3 had four big ulcers still progressing; crusts thick, and corium much indurated. Calf 4 had one ulcer on ear much diminished in size.

By the eighteenth day:—The ulcerations in calf 3 (one ulcer had been cut out for microscopic examination) had all healed up and become converted into flat scars. In the other animals the healing was completed at an earlier date.

Simultaneously with the above experiments several inoculations with materials of the ulcer of cow No. IV. had been made into the skin of the groin of ten guinea-pigs and of three dogs. In the guinea-pigs no result was obtained; but in one of the dogs one place of inoculation appeared swollen and inflamed on the third day. On the fifth day this place was an oblong ulcer of about a quarter of an inch in diameter; the margin was red and swollen, but the centre was without crust (the animal had been frequently seen to lick it). On the seventh day the ulcer was much smaller, and it had nearly healed up by the tenth day.

From these experiments there can be no doubt whatever that by inoculating a particle of matter from the sores of an affected cow a positive result has been obtained in all four calves. In calf 3 this result was best and most striking. After an incubation of about three days the places of inoculation became swollen, tender, and spreading; on the fifth to the sixth day the change was distinct, the suceessful places having become sores; in the marginal part showing vesiculation, and in the centre formation of crusts. The sore enlarged during the next few days, and on removing the crust a raw surface was exposed, the corium itself being found infiltrated. According to the intensity of the process the retrogressive change sets in later or sooner; in slight cases the healing begins about the ninth or tenth day, in severe cases (calf 3) not before the end of the second week.

Having thus demonstrated this disease of the cow to be directly communicable from animal to animal, I set to work to study its minute anatomy.

The microscopic examination of fine sections through the ulcer of the cow shows the following conditions:—

The corium throughout the whole extent of the ulcer is infiltrated with round cells. This infiltration, though densest in the central portions of the ulcer, is sufficiently pronounced even in the peripheral parts, but it gradually fades away on passing from the ulcer to the normal skin. The infiltration in the deeper parts of the corium is limited to the vascular branches, but in the superficial parts is more diffuse, the papillæ becoming at the same time thicker. This thickening of the papillæ fades off towards the periphery of the ulcer. The most noteworthy changes are, however, present in the epithelium. In the peripheral portions of the diseased part there are present in the superficial layers of the stratum Malpighii close to the stratum lucidum, as also in the stratum lucidum itself, numerous cavities of different sizes. These cavities lie closely side by side; the most superficial ones are either covered by the stratum lucidum or extend between the layers of this stratum. The former cavities descend into the depth of the epithelium; at the very margin of the diseased part they are smallest, and they do not in depth comprise more than the superficial third of the stratum Malpighii. They enlarge in depth gradually as we pass from the periphery of the ulcer towards its centre; at its very centre they involve the whole thickness of the stratum Malpighii. At the same time it is to be noticed that, at the marginal parts, the cavities, although closely placed side by side, are well separated from one another by thicker or thinner trabeculæ composed of epithelium; while at or near the centre the ulcer these trabeculæ get destroyed, and the cavities become confluent, and the covering layers of the cuticle having here also given way, their contents extend on to the free surface of the ulcer. These contents, which go to form what has been above mentioned as the crust, spread thus gradually over the surface, not only of the centre, where the stratum lucidum has become lost, but also over the rest of the ulcer. In the marginal positions, *i.e.* where the superficial layers of the cuticle are still present as cover of the above cavities, this layer (*i.e.* the stratum lucidum) separates the contents of the cavities from the crust. The contents of these cavities consist (*a*) of an albuminous fluid looking, in hardened sections, uniformly granular or containing also fibrinous threads; (*b*) of a few red blood corpuscles; and (*c*) chiefly of round cells or pus cells, the nuclei of which, near to and on the surface, gradually break up into amorphous granular matter.

In the central parts of the ulcer the whole exudation undergoes degeneration into debris, and not only in its superficial, but also in its deeper portions. While some cavities contain very few cells and are filled chiefly with albuminous fluid (granular or fibrinous), others are almost entirely filled with pus cells closely packed together. In the papillæ near the cavities the blood-vessels are engorged and there is also escape of red blood disks.

On a careful examination it is evident that the origin of these cavities is in enlargement of and exudation into the tissue of the papillæ, but only of those portions nearest to the stratum lucidum, and from hence arises formation of cavities in the cuticle. The whole anatomical details of the distribution and arrangement of these cavities recall vividly the conditions observed in the vesicles of cow pock and of sheep pock, and on comparing under a low power of the microscope a section through a sheep pock with a section through the ulcer of the cow now under consideration, the similarity is very striking indeed.

There are, however, anatomical differences between the two diseases. The infiltration of the corium is slighter in the cow ulcer than in the sheep pock, and in the cow ulcer the cavities form in a more superficial stratum of the epidermis.

There is in the disease we are now considering a good deal of infiltration of the epithelium by round cells derived from the cavities, not only into the stratum Malpighii, but also, and particularly in the marginal parts, into the cuticle; the round cells burrowing in great numbers between the scales of this stratum, and ultimately reaching the free surface to join those of the crust.

Fine sections made through the ulcer artificially induced by inoculation in the ear of calf 3, proved its complete identity in anatomical respects with the ulcer in the cow. The infiltration of the superficial corium; the formation of cavities, filled with exudation cells and fluid, in the superficial layers of the epithelium, particularly between the layers of the cuticle; the final destruction in the centre of the ulcer of the covering cuticle; and the extension of the exudation over the free surface to form here the crust, are the same in both instances.

Microscopic examination of the internal organs of cow IV. revealed facts as follows:—

In the lung.—Sections made through the portions above mentioned as containing much congested lobules, show not only great congestion of the blood vessels, large and small, but a large amount of hæmorrhage; blood in substance being present in the air vesicles and infundibula, in the lymph spaces of the interlobular septa, and in the tissue and lymphatics of the pleura. In the latter membrane numerous diplococci are to be met with. Here and there the same diplococci occur in the alveolar wall and in the tissue of the interlobular septa.

Sections through *the liver* show a great deal of change. Under the capsule, as well as in the substance of the liver, there occur, in connection with the interlobular branches of the portal vein, larger and smaller foci of inflammation, consisting in the presence of numerous round cells. Some of these foci are several millimetres in diameter, others are very small. From the interlobular tissue the inflammation extends into the lobules between the liver cells. The liver cells of these lobules involved in the inflammatory process are swollen up, and many of them are undergoing disintegration. In some of these foci, particularly those situated in the vicinity of the capsule, the round cells are so much crowded that given foci look almost like miliary abscesses. The blood vessels are much distended and filled with blood.

Numerous diplococci and short coccus chains occur in the parts surrounding the inflammatory foci. These are particularly numerous near the capsule in the vicinity of inflamed parts.

Sections through the *kidney* showed well-marked glomerulo-nephritis; infiltration of the sheath of the cortical arterioles with numerous round cells; the epithelium of the convoluted tubules swollen, opaque, and in many places disintegrating.

The lungs and kidney of cow III. showed on microscopic examination the same appearance as in cow IV.; in addition there was a good deal of round-cell infiltration in the wall of the infundibula and bronchi in the lung, and around the cortical arterioles in the kidney. In the blood-clots filling the alveoli and small bronchi of the lung there were present larger and smaller clumps of micrococci.

Search was now made for micro-organisms inhabiting the tissues of the ulcer of the cow, with a view of ascertaining what were present, and afterwards whether any single kind of those found had the power, when dissociated from the diseased tissues and inoculated into healthy animals, of transferring the disease.

Removing the crust, scraping off the most superficial layer, then squeezing the ulcer so as to collect a droplet of lymph, I spread it in thin films on cover-glasses, and dried, stained, and mounted the several specimens in the usual manner. Such a specimen, examined under the microscope, revealed a number of red blood disks, mixed up with large numbers of pus cells, each of which contained two, three, or four small nuclei and remnants of epi-

thelial cells. Amongst the pus cells numerous dumb-bells of micrococci (or diplococci), and a few short chains of the same, were met with. In size these micro-organisms do not differ from those described in connection with foot-and-mouth disease. In many sections—stained in fuchsin, or in methyl blue, or in gentian violet—through the diseased tissue of the cow, as well as that of calf 3, there were found the same diplococci and chains in the contents of the superficial cavities, as well as in the depth of the epithelium. In the latter stratum they were met with abundantly throughout the whole extent of the marginal portion of the ulcer, but not beyond it. In the superficial parts, namely, in the contents of the cavities in the stratum lucidum, the same chains were to be found, provided the pus cells were not too closely packed. They were very numerous in the tissue of the crust, and also in the superficial central portions of the ulcer that had undergone degenerate change. There occurred also in the crust and in the necrotic parts of the ulcer numerous clumps of zooglea of micrococci; but these micrococci are not to be confounded with the chains of streptococci to be presently described, nor yet with those streptococci which are found occurring singly.

From the deeper parts of an ulcer of cow IV. material was obtained with which tubes containing either solid nutritive gelatine, or Agar-Agar mixture, were inoculated. After some days, and in both media, a micrococcus appeared, the growth of which was extremely characteristic. These are its characteristics, in the nutritive gelatine: after 3 to 6 days' incubation at 20° C., the growth made its appearance at the point or line of inoculation, in the form of small points or granules, whitish in colour and tolerably closely placed. During the next few days their number and size increased. At the end of a fortnight the line of inoculation was visible as a streak of whitish granules or droplets, some large, others small, more or less closely placed. On the surface of the gelatine the growth, like a film of granules, spreads slowly in breadth, but even after months remains small. When inoculated into the depth of the gelatine, the channel of inoculation becomes visible as a whitish streak, made up of smaller and larger droplets. The gelatine is not liquefied by the growth. The same characters are assumed by the growth in Agar-Agar mixture and in solid serum. The general aspect of the growth in gelatine, in Agar-Agar, and in serum, is very similar to that presented by the *streptococcus* of foot and mouth disease (see my report of this year upon that malady [1]), but with this difference, namely, that in gelatine tubes the streptococcus of foot-and-mouth disease is a little faster in its growth, and its component granules are a little more distant. Nevertheless, I have tubes of both kinds of organisms in gelatine and in Agar-Agar—tubes which cannot be from their general appearance easily distinguished. In faintly alkaline broth, or in broth and peptone, the micrococcus of the cow ulcers grows readily, and in the same manner as that of foot-and-mouth disease. But there is one test by which the two kinds of organism can be very readily distinguished: the streptococcus of foot-and-mouth disease, when grown in milk, does not affect the fluid character of the milk, whereas milk inoculated with the organism obtained from the cow's ulcer will, if kept for two days in the incubator at 35° C., have been turned completely solid. This difference is a very striking difference, and a few days' growth in milk suffices for distinguishing without fail between the two.

The microscopic examination of a culture in broth peptone, in gelatine, or in Agar-Agar mixture shows that the growth consists of spherical micrococci, arranged as diplococci, and as shorter and longer straight, wavy, or curved chains—streptococcus,—these latter sometimes of great length. As regards the shape of the micrococci, the mode of their division, the branchings of the chains, the presence here and there in the chain of a large element amongst the smaller ones, the organisms of the ulcers hardly differ from the description which I am preparing of the streptococcus of foot-and-mouth disease. The elements of a coccus chain of the foot and mouth micro-organism are, however, smaller than those of the disease under consideration.

The streptococcus chains of a growth in broth are short during the first few days; but later on, when the growth settles down more into the deeper parts of the broth, the chains become of great length. So also in Agar-Agar tubes of one to two or more weeks' incubation.

A curious fact, to which importance must provisionally attach, is this: In a cow having several of the ulcers on the teats, the fingers of the milker pressing over the ulcers would constantly rub off from the latter particles of matter, and the fingers and the teat being kept moist, this matter would easily mix with the milk as it passes from the teat. To learn whether the milk *while in the udder* contained the streptococci, the following experiment was made: A teat free of any ulcer was milked so as to obtain a few ounces of milk, and from this milk a large number of gelatine and Agar-Agar tubes were inoculated; a second teat of the same cow, affected by an extensive ulcer, was milked to the same extent, and from the milk thus obtained a large number of other gelatine and Agar-Agar tubes were inoculated. In the first series no single tube showed the growth of the above-described streptococcus, whereas in the second series one gelatine tube and one Agar-Agar tube were found to develop the typical growth of the streptococcus.

We cannot draw any certain inference from this one observation, but evidently the experiment deserves repetition.

With a cultivation (a third sub-culture) in Agar-Agar mixture of this streptococcus, I, on February 1, inoculated subcutaneously in the groin two calves (5 and 6) On February 27 calf 6 was found dead. The subcutaneous tissue at, and for some distance around, the seat of inoculation showed much effusion, and the inguinal glands were swollen and red. There was peritonitis, with sanguineous exudation, congestion, and hæmorrhagic spots in omentum and in the serous coat of the stomach. The spleen appeared small and its capsule thickened. The liver was greatly congested. Kidneys were large and much congested. The ileum was much congested in its mucous membrane, and the epithelium detached in flakes. The mesenteric glands belonging to the ileum were greatly enlarged and hyperæmic. Both lungs were congested, the superficial lobules showed so much congestion that they looked almost solid, and were of a deep red colour. A few petechiæ under the pleura. Bronchial glands enlarged and congested. There was pericarditis, and the heart was distended by, and filled with coagulated blood. The organs of the throat were found much congested. The hairy parts of the skin were not examined.

Calf 5 showed on March 7, around the nostrils and lips of the mouth, and on hard palate and gums, numerous irregularly outlined patches not raised above the level of the skin. These patches had a discoloured, brownish, very slightly raised margin, and a paler centre; they were round or irregular, some as small as ⅛ of an inch, others four to six times larger. The animal was killed on March 8. On post-mortem examination the following appearances were noted: Congestion of some of the peripheral lobules in both lungs; the pleura pulmonalis slightly opaque, numerous soft lymph adhesions between it and the costal pleura; in the spleen several hæmorrhagic patches under the capsule in the shape of bullæ filled with semi-congealed blood; spleen pulp softened and very congested; kidney congested; organs of the throat congested.

There can then be no doubt that a definite disease has been produced in both animals, of which the affection of the lungs is a conspicuous feature, and coincides with, though more pronounced than, the lung disease noticed in cow IV.

In calf 5 there was, in addition, the disease of the skin and in the mouth, which, as the microscopic examination proved, is in a certain degree similar to the disease in cow IV. and calf 3. More in detail, this is what is found as regards the skin: The tissue of the papillæ and of the superficial corium is infiltrated with round cells, and the blood-vessels of the papillæ are distended and filled with blood. In their peripheral portions, their most superficial parts, the papillæ are very much distended by extravasated blood and round cells;—in fact the first rudiments of cavities are forming in them. The same condition, but more pronounced, obtains in the cuticle, where between its layers there are present small cavities filled with blood and round cells, or only fluid and a few round cells. There is, in addition to this, a general infiltration with round cells of the layers of the cuticle. The brownish-reddish colour of the marginal parts is due to this condition. In the central part the cuticle is loosened by the formation of such cavities containing fluid and a few round cells; by this its layers were separated and ultimately detached. In the cavities of the cuticle occur very fine diplococci and chains. So also in the infiltrated and enlarged papillæ, and in the deeper layers of the epithelium in the whole extent of the diseased skin, diplococci and short chains are present.

In neither of these cases of subcutaneous inoculation was there found any rent or breakage of the stratum Malpighii, *i.e.* no real ulcer. The anatomical features here described in many respects

[1] To appear in the Supplement to the fifteenth volume of the Board's Reports.—G. B.

resemble the lesion of the skin in human scarlatina (see my report for 1876). I did not, unfortunately, look at other (the hairy) parts of the skin to see whether there were any such patches in this calf. (Some observations on the kidney of calf 5 are noted in the sequel.)

Examination of the organs of calf 6:

(*a*) *The lung.*—Congestion of all blood vessels, large and small. Transudation of fluid and hæmorrhage into the alveolar cavities of part of some lobules of the lung, while the rest of the alveolar cavities are collapsed, the capillaries around them very much congested; infiltration with leucocytes of the interlobular septa, extending also into the inter-alveolar septa. In some of the lobules next to the pleura the engorgement of the capillaries is extremely great, blood *en masse* filling the alveoli to the extent of producing a state of red hepatisation. The pleura itself is thickened by exudation of fluid and leucocytes. The bronchi do not show any distinct alteration. Numerous diplococci and a few chains are met with in the pleura and in the congested parts of the lobules, in the alveolar wall, and in those alveolar cavities which contain exudation and blood. The bronchial glands show great changes: the capsule and septa being much thickened by exudation and leucocytes; the lymph vessels everywhere filled with round cells; the tissue of the follicles and medulla much swollen.

(*b*) *The liver* shows extreme congestion of all vessels in all parts, inter- and intralobular. The liver-cells are opaque, granular, and atrophic.

(*c*) *The ileum.*—The epithelium of the surface detached and gone; the epithelium of the Lieberkühn follicles loosened, and in most places detached; the mucosa shows great congestion and infiltration; in the superficial layers the villi show hæmorrhage, the tissue being filled with blood corpuscles, fibrin, and leucocytes; and in many spots the superficial layers of the mucosa are necrotic.

The Peyer's glands are much swollen and inflamed; the central portions of their follicles are breaking down.

Micrococci and bacilli pervade everywhere the tissue of the mucosa. The mesenteric glands in relation with the ileum have their capsules, septa, follicles, and medullary cylinders much congested and inflamed.

(*d*) *The kidney.*—The changes in this organ are highly interesting, since they completely coincide with those in acute scarlatina nephritis in man: great congestion of the cortex, leading in some parts to hæmorrhage into the parenchyma; glomerulo-nephritis with exudation of albuminous fluid and blood into the cavities of the Malpighian corpuscles; granular or opaque swelling of the epithelium of the uriniferous (convoluted) tubules, with degeneration into granular debris of many of the epithelial cells; miliary foci of aggregations of round cells around small bloodvessels; congestion of the medulla.

[The kidney of calf 5 was also examined microscopically, and the changes were exactly the same as those found in the kidney of calf 6, viz. congestion of the glomeruli, glomerulo-nephritis, transudation of albuminous fluid and red blood corpuscles into the cavity of Bowman's capsule; opaque swelling of the epithelium of the convoluted tubules; granular disintegration of the epithelium in many places; infiltration with round cells around some arterioles of the cortex; and congestion of the medulla.]

(*e*) *The heart's blood* was examined for organisms, and in it, by the staining with Weigert's gentian violet, a few diplococci and a few chains could be distinctly detected.

Cultivations were made with this blood in tubes containing Agar-Agar mixture, and a growth of the streptococcus was obtained in all respects identical with the streptococcus that had been employed for inoculation of this animal.

In view of the whole of this evidence, I consider it conclusively established that this streptococcus is identical with the virus of the cow disease.

We have, then, inoculated subcutaneously with sub-cultures of the streptococcus these two animals, calves 5 and 6, with the result of producing a general disease, which in many respects bears a close resemblance to human scarlatina. The minute anatomical characters of the eruption on the skin around the nostrils and mouth in calf 5 is of much significance in this connection, as also is the disease in the liver in both animals, and above all, the disease in the kidney. This latter organ corresponds so closely with a kidney of an acute case of human scarlatina that sections made of the one and compared with those of the other, of which I preserved a large collection from my former investigation into the anatomy of human scarlatina (see Medical Officer's Report for 1876), show no difference whatever.[1]

The outcome of the investigation thus far, and it is of importance until further differentiated observations shall have been made, may be stated thus:—By inoculating the virus directly taken from the local disease (the ulcer on the teats) of the cow into the corium of the calf the same local disease is produced, namely, a change in the skin, which commences as a congestion of the papillæ and corium, and an exudation of fluid and leucocytes. This leads, in the superficial parts of the epidermis, to the formation of cavities, which, enlarging, and extending, and opening on to the surface, and extending into the depth, ultimately lead to the formation of an ulcer. But the virus, in the form of an artificial cultivation of the streptococcus derived from the above ulcer of the cow, when inoculated into the subcutaneous tissue, that is, when introduced almost directly into the vascular system (for all matter injected subcutaneously is easily absorbed by the lymphatics and carried into the blood system) sets up a general disease resembling to a considerable degree in its anatomical features human scarlatina.

Furthermore, as respects the concern that cow's milk may have in the communication of disease—the consideration which led to the present investigations—we have some facts which appear to me to afford very suggestive indications for further pathological study. As I have pointed out on a previous page, it would seem that the milk pure does not contain the organism, but (whether or not this observation be confirmed) the milk during the act of milking is pretty sure to become contaminated by the fingers of the milker bringing down into the milk particles from the ulceration on the teat. The organism contained in these particles would find in the milk a good medium in which to multiply. Such milk would then practically correspond to an artificial culture of the streptococcus, such as we have found capable of setting up a general disease, when inoculated subcutaneously into calves. It is true we have as yet no experience of the inoculation of a known milk sub-culture into the human subject, but in the case of calves we have learnt that the general disease resulting from inoculation of an Agar-Agar sub-culture had characters closely allied to, if not identical with, human scarlatina. Then, feeding of animals with the cultures has not yet been tried, so that at present we are without information as to the characters of any disease that may be produced in calves by that means; whether or not calves fed with milk sub-culture of our streptococci exhibit the same pathological states as we have found to be produced by inoculation of calves with an artificial culture—states that bear so marked a resemblance to those of scarlatina in the human subject. In order completely to understand these and other relations, more experiments are required, and these I hope soon to have an opportunity of making.

Until I am in a position to state at greater length the peculiarities of the infective phenomena of the disease under consideration, I refrain from further comment on its various interesting and promising aspects.

THE BRITISH ASSOCIATION

SECTION E

GEOGRAPHY

Opening Address by Major-General Sir F. J. Goldsmid, K.C.S.I., C.B., F.R.G.S., President of the Section

However diffident I may feel in undertaking the duties of President of the very important Section of Geography at this anniversary, I have no right to take shelter under that diffidence for any shortcoming in the fulfilment of my task. All I would seek at your hands is indulgence for one whose training and antecedents have scarcely fitted him for appearing before you in a quasi-professorial capacity, and whose brief tenure of a Presidential chair at a meeting such as this must be regarded as rather an incidental passage in the annals of the British Association than a fair illustration of its *modus operandi*, or principle of selection in respect to its officers.

As to the subject of my opening address, I know none more befitting the occasion than the means of popularising the branch

[1] Referring to the commencement made in 1882 of investigation of the results producible in the cow by inoculation with the material of human scarlatina, see p. 67 of report of that year, I would propose that this study be extended without loss of time.

of science to which the meetings in this Section will be devoted, and thus attracting towards it that attention which it merits—nay which, in this our country if anywhere, it demands and necessitates.

The question is a wide one, but I will endeavour to narrow the field of its discussion to suit our purpose of to day, and keep within reasonable limits. A few words will suffice to lay before you the programme. It embraces: first, the uses of geography, an exposition of which should prove, and a due apprehension of which should admit, the necessity of its inclusion among the special studies of public schools; secondly, the mode of imparting a knowledge of geography so as to render it at once practical and engaging; and finally, such illustrations of modern travel and research as may serve to demonstrate how urgent is the study of geography to all classes in this country.

Before closing the subject, I shall endeavour to draw your attention directly, if somewhat cursorily, to the progress made by travellers and geographers in furthering what I may for the nonce describe as the objects of their profession during the past year, or since the last annual meeting of the British Association, at Aberdeen. But I shall only dwell upon such instances of geographical progress as from their character and locality come within the range of my personal experience, and serve to illustrate the main argument of this address.

To begin then with the uses of geography. There are doubtless many who will say demonstration here is superfluous, and that if its use was not admitted it would find no place in school studies, which is contrary to fact in many instances; there would be no primers or elementary works on the subject, whereas they may be reckoned by the score; books of travel would be rather entertaining than instructive, a charge which many recently published volumes would disprove; and so forth.

Some again will argue that its uses, such as they are, must be restricted to the few specialists who aspire to be geographers, and that for the million it is enough to carry about a rough idea of the four quarters of the globe, the principal countries and capitals in them, and a sufficient amount of preliminary instruction to understand Bradshaw and Baedeker. A third, and perhaps the largest category among educated people, consists of those who are indifferent to the whole question, and are content to find in geography either an honoured branch of science, or a mere nominal study, according to the views of the latest speaker, or most plausible reasoner. If it be allowable to apply things holy to things profane, no truer illustration of this class can be given than the Scriptural definition of men who receive seed "in stony places."

To the first of the above I would say that the place which geography holds among school studies is not that which it ought to hold if its uses were understood and appreciated. Primers and elementary books already published are good enough in their way, but the instruction they contain is not seriously imparted; and it may be that something fitter and more attractive to the beginner could be produced. At present all school-books on geography may be said, as a rule, to be consigned to the shelf of secondary subjects; and this is not the treatment which should be reserved for a study of such real magnitude. By and by it will be my endeavour to establish by argument and example the indisputable character of its importance.

For those who look upon geography as a profession which needs rather separate training than general education, and would prefer to leave its acquirement to travellers aiming at distinction, specialists in Government employ, and the more zealous and scientific Fellows of the Royal or any other Geographical Society, I can only express my regret that the delusion under which they lie unfits them so thoroughly to understand and much less satisfy the wants of a rising generation. By denying the universal character of the study they clearly misapprehend its true scope, and are dwarfing it to within the narrow limits of a conventional school task.

As a matter of State or public school education the science of geography should in truth be elevated, not degraded. In my humble opinion it should be placed on a par with classics, mathematics, and history, with each and all of which it has affinity. Undoubtedly there are accomplishments which come, as it were, of themselves, or are the outcome of lightly-sown seeds in the home. These for the most part are rather mechanical than mental, though some may have advocates to claim for them intellectual honour. But a knowledge of geography is not to be so acquired: it will not come like handwriting with incidental practice, nor is it to be gained by mere travelling. To move from place to place, whether across seas or continents, or both, to go round the globe itself and visit every important country and capital in the track chosen, even to prefer byways to railways, and search into obscure and hidden spots rather than those which are more generally frequented—all this process affords admirable matter for the note-book of the man of the world and observer, but will not educate in geography, unless the student himself has a serious purpose to turn his wanderings to the account of science. The cursory description which would apply to men and women, cattle and conveyances, hotels and caravansaries, restaurants, coffee-houses, and the like, in a moving panorama, is not always suited to bring out in bold relief the physical aspects of a country.

To the indifferent and wavering, to those who would wish to promote the study of geography if they could feel persuaded that it needs promotion, but who would leave to the better judgment and experience of others the decision on the whole question; to those who are content to accept the institution of a professorial chair in honour to the science, or to leave geographical study to the primitive teaching of their own childhood, whichever course be most in accordance with the temper or fashion of the times—I can perhaps do no better than appeal on the grounds of urgency—in other words, of the real importance of the cause for which, in common with abler and worthier advocates, I would now most earnestly plead. . . .

. . . I almost seem to be treading upon the threshold of platitudes when seeking to explain why geography should be useful to young men of ordinary culture, for whatever career they may be destined. In some cases it is naturally more urgent as a study than in others. The military man, for example, should be more or less a scientific geographer. His profession may require him to survey and describe new regions; and a campaign over a beaten track should find him acquainted with the minute topography and physical aspect of places, at least the names of which are familiar household words. The sailor should in like manner bear in mind the configuration and character of sea-coasts, and carry about the landmarks of his own observations as well as those to which he may refer in books. To both must geography be eminently a professional study. But, considering the enormous extent of our Indian Empire and colonies, and the many foreign States with which we must have intimate relations, is any Englishman, I would ask, competent to discuss, much less to serve, the interests of his country who knows nothing of the physical features, resources, products, population, and statistics of these? It seems to me to be the duty of every loyal subject and citizen, high or low, rich or poor, to seek information on these heads wherever it may be obtained.

But of all men who should realise geography in its broad, comprehensive sense—both as an aid to history, and as a science to which history may be subordinate—first in order is the statesman, in whose province falls the disposal and partition of countries or regions. What should we say of the judge—we may be thankful there are none such on the English bench—who not only gave his decision without mastering the merits of the case before him, but who was also ignorant of the law and precedents which should guide him in the treatment of those merits? The argument might apply with equal force to other callings from the members of which professional opinions or decrees are required by their fellow men. Why, the evil would be so great and so palpable that its existence would not be tolerated for a single day: and the only reason why it *is* allowed to prevail in matters geographical is that though equally great in respect of these it is not equally palpable. The statesman may not know the situation of this or that particular palce, nor its products and resources, but neither does the public. One is not taught geography any more than the other; so that while ignorance and error are brought to bear on a spurious judgment, the critic is not in a position to point out the real flaw, and the blunderer escapes the scathing condemnation which would otherwise await him in the columns of the morning paper.

Let us suppose a case by way of illustration—a case which conveys no exaggerated idea of what happens, or may happen in the course of a year—a case which without being an actual occurrence has in it the flavour of actual occurrences. There is a large tract of land in the far West or far East, it matters not which. All that is known about it is that it is called Laputa or Barataria, and that it is situated in the central part of a region or continent so vast that it might be reasonably called the largest quarter of the globe. Well: it is encroached upon by a powerful neighbour, and England requires the preservation of that land's integrity

and independence. Her best instructors on the matter have told her that such is her interest, and she believes them. Intervention, therefore, becomes necessary; negotiations ensue; and the whole question revolves itself into a partition of territory and demarcation of boundary—in other words, the question becomes one of geography—what I should call, for reasons to be explained hereafter—Political Geography. Who, if not the ruling statesman, should know the true principle on which to deal with a large settlement of this nature—one, it may be, involving ethnological, commercial, humanitarian, quite as much as territorial, considerations? Who, if not the agent on the spot, should know the details to regulate the application of the principle? But the statesman should be in full possession of his agent's details, and be capable of appreciating them not only from the latest reports supplied, but from a certain insight into the matter obtained from early study. He should have been coached in that comprehensive kind of geography which would have embraced the particular information required. Under present arrangements it is not so. The geography taught at schools is too simple or too scientific—too complex or too superficial; in any case it is not the geography which would benefit the Cabinet Minister in solving a territorial difficulty any more than would those "ingenuæ artes" which have so strong a civilising influence on the natural man. Experience in classics may forestall the faulty quotation and false quantity, but fail to suspend the false move on the political board. And it need not be said that, while the first, in point of fact, affects the speaker only, the last concerns the happiness of the million.

We now reach the second consideration: the mode of imparting a knowledge of geography so as to render it at once practical and engaging; and I may be pardoned if I dwell upon this somewhat lengthily, for it involves the gist of the whole question before us. It is always easier to detect a flaw than to find a remedy, and in the present case the flaw is generally admitted by experts. There may be differences of opinion on its character and extent, but apparently there are none on its existence. I shall have to recur to the first, but would ask leave to dismiss the last as established. We are told on excellent authority that in our own country the elements of success in geography are wanting, and the conclusion has been practically accepted by the representative Society of this branch of knowledge. The remedy has been suggested, and in a certain sense partially applied, but a great deal more remains to be done, and the many views entertained and expressed by competent men on the claims and requirements of geography in England render necessary a short review of what may be called the "situation," including notice of work achieved in the direction of reform. . . .

Of late years the Royal Geographical Society, in pursuance of its originally expressed aims and objects, and strong in the experience of a long and prosperous career, has endeavoured to arouse the rising generation to a sense of their shortcomings as regards the particular science in the promotion of which it has its own *raison d'être*. It granted prizes to such public schools as chose to compete for them, and after sixteen years' trial discontinued the grant, owing to unsatisfactory results. It opened correspondence with schools and colleges, and made other judicious and laudable attempts to evoke sympathy and support. But all its proceedings have been as it were preliminary, and may be considered rather as foundation-stones of a temple of success than the outer walls or any visible part of the building itself. A more recent attempt to reach the masses was the Exhibition of Educational Appliances. Objects used in geographical instruction at home and abroad were collected and arranged in galleries hired for the occasion, and the public were invited to inspect them. At the same time appropriate lectures were periodically delivered, by competent and experienced men, to the visitors, many of whom were not merely interested amateurs, but persons actually engaged in school teaching. Attention was called to the fact that the Exhibition was purely educational; that there were in it specimens of German, Austrian, and Swiss maps, executed with a finish and detail unusual in our school maps at home; but that as the Society's inquiry embraced Universities as well as schools, part of the appliances exhibited were used in Continental Universities, though in reality some of the finest maps shown were found also in the higher schools of Germany and Austria. Besides maps, there were in the collection globes, models, and text-books, the presentations not being confined to countries visited by the inspector, to whom the task of collection had been intrusted, but from others also; and these were further supplemented by contributions from British publishers.

The result of this new departure—if the term be allowable—was pronounced very satisfactory, and at the close of the Exhibition, or in the spring of the present year, the Council considered what would be the next best step to take in furtherance of their desire to raise the character of geographical study. At a later date, on the recommendation of their Educational Committee, they resolved on addressing the Universities to the effect that chairs or readerships be instituted similar to those which were at that time filled in Germany by Carl Ritter at Berlin and Profs. Peschel and Richthofen at Leipzig. In carrying out the resolution alternative schemes were submitted. The Council would appoint, under approval of the University authorities, a lecturer or reader in geography, paid out of the Society's funds, he being accorded a fitting local status; or each University might join with the Council in the matter of payment, and a reader be appointed by a committee on which the Society should be represented. . . .

It will thus be seen that special efforts have been made and continue to be made to popularise a science which has never, so far as can be ascertained, held its proper place in the educational programme of our schools or Universities. We must not, however, lose sight of one important consideration. More remains to be done than to institute a chair, a professorship, a readership. It must be clearly understood on what general lines of study we are about to proceed. Is geography to be taught in its full, comprehensive sense, as something involving a knowledge, more or less, of mathematics and astronomy, of ancient and modern history, of ethnology, zoology, botany, geology, of men and manners, laws of nations, modes of government, statistics and politics, something requiring in the disciple a quick ear, a searching eye, an appreciation of scenery and outer subjects as well as physical aspects of country, a power of picturesque but an adherence to accurate description? If so—and I believe I have only stated the qualifications of the travelled and finished geographer—would it not be well to inquire whether the component parts of the science should not be reconsidered, and a subdivision effected which would make it easier to deal with than geography as now understood, under the terms physical, political, and perhaps commercial? . . .

Not six months ago I wrote as follows:—"We are authoritatively told that, at one of our greatest public schools, which may be fairly taken as representative of its class, there is no systematic teaching of geography at all, but 'that in the history lessons, as well as in the classical lessons, a certain amount of geography is introduced incidentally.' Again, if we look at the Universities abroad, it has been found the custom, until quite lately, both in France and Germany, to combine the chairs of geography and history under one professor. Now the 'incidental' character of geographical instruction is a tacit declaration of its unimportance, which every day's experience shows to be without warrant; and its combination with history may be an expedient to render it less distasteful than it appears as a separate study. But a useful hint may be taken from the Continental practice, and a partial fusion of two departments effected, which would commend itself to common-sense, and, to judge from the recorded opinions of certain of our educational experts, might not be objected to by head masters in England collectively. Let us, then, endeavour to extract from the lessons of conventional geography that part which is inseparable from the study of nations and people, and place it under a new and more appropriate head. In this view, so-called 'political geography,' stripped of its purely scientific belongings, would be taught in connection with history, and made an essential ingredient in the early training of British statesmen, whose after-reputation should be more or less the outcome of a University career, the grounding of a public or grammar school, or private tuition. It is difficult to reconcile the amalgamation of what may be considered 'scientific' geography with history. One is as thoroughly apart from the other as geology is from astronomy."

The meaning of the verbal combination "political geography" requires some kind of analysis. Conventionally, and in an educational sense, it is the description of the political or arbitrary divisions and limits of empires, kingdoms, and States; their inhabitants, towns, natural productions, agriculture, manufactures, and commerce, as well as laws, modes of government, and social organisation—everything being viewed with reference to the artificial divisions and works made by man. Accepting this interpretation of its objects, who can hesitate to admit its palpable and immediate relation to history? The mathematical science which investigates the physical character of territory and territorial boundaries is in this case but a secondary requirement, and

can be always fairly disposed of in the recognition of results. Otherwise, we have simply commercial geography with ethnography, and considerations which we may call political in the present but which are undoubtedly historical in the past. Surely, then, it would be wise and reasonable to combine the studies of history and political geography—putting a wider interpretation than the conventional one upon the latter designation in such a manner that the two together should be just the sort of *pabulum* dispensed to the rising generation of statesmen, diplomatists, and all who aspire to the name of politician, in its higher sense of capability to promote as well as to discuss the national welfare.

And admirable lecture on "Geography in its Relation to History" was delivered by Mr. James Bryce—the late Under-Secretary for Foreign Affairs—in connection with the recent London Exhibition of Geographical Appliances. Those who are acquainted with it will readily understand why I pause to remark on its enlightened teaching; to those who have not that advantage I would explain that it seems to embody the arguments of Modern Thought on the important question we are now considering, and that a brief allusion to it is therefore no irrelevant introduction here. The lecturer, seeking to demonstrate that history and geography touch one another in certain relations and interests, laid down the proposition that man is, in history, more or less "the creature of his environment"; that "on one side, at all events, he is largely determined and influenced by the environment of nature"; and that "it is in discovering the different effects produced on the growth of man as a political and State-forming creature by the geographical surroundings in which he is placed" that one point of contact is found. He, moreover, maintained that man, "although he may lift himself above his environment, cannot altogether escape from its power." Dividing the influences thus exercised into three classes, he showed that those arising from the configuration of the earth's surface affected movements of races, intercommunications, and barriers of separation; that those belonging to climate affected the occupation or abandonment of particular localities on the score of health, fertility, or non-fertility of soil, and consequently commerce and cultivation; and that those which owed their existence to natural products unmistakably directed the energies of peasantry and people into certain fixed channels of enterprise—a result which applies to the zoology as well as to the mineral and agricultural resources of a country. He made the very true observation that the "animals affect man in his early state in respect to the enemies he has to face, in respect to his power of living by the chase, in respect to the clothing which their furs and skins offer to him, and in respect to the use he is enabled to make of them as beasts of burden or of food"; and he therefore concluded that "zoology comes to form a very important part of the environment out of which historical man springs." A volume might well be written on this suggestive theme alone; and if, as I believe, the proposition of a human being's dependence on environment be admissible in its entirety, what a field of speculation is open to the inquirer! A condition held applicable to the unreckoned millions of to-day must have had a marvellous effect in giving character to original Man!

This conception of man's environment supposed heads or branches of geography, all bearing upon history, which might be distinguished by names such as ethnological, sanitary, commercial, linguistic, political and military, legal—the last leading to the consideration of the Suez Canal and sea-channels in which several States have interests. As time, however, will not allow me to quote the lecturer's apt and well-put illustrations which followed, I may mention that the express object with which they were introduced was to show how "the possession of geographical knowledge, and a full grasp of the geographical conditions" with regard to some of the leading countries of the world, "will enable a person studying their history to make the history more intelligible and real." In strict conformity with this opinion, and in the conviction that the want of geographical knowledge and "full grasp" of geographical conditions will betray men in power to commit dangerous mistakes, calculated to injure the national prestige and credit, and men out of power to become their upholders in error, I would express the hope that, in any future arrangements which may be perfected for the better education of our countrymen, while physical and scientific geography are invested with a degree of prominence and honour to which they have hitherto never attained, that branch of study which we have been accustomed to call political will be reconsidered and, if necessary, newly defined by competent men. The conclusion at which I have myself arrived—one which I am quite ready to abandon before the arguments of sounder reason—is that we have here something which belongs mainly to history, and, in such light, its scientific should be separated from its non-scientific elements. A partition should be made which would equally suit the mind of the student whose tendencies are rather towards metaphysics than mathematics, as of him who is a votary of practical science only. I do not presume to touch upon the action of Universities, except to say that I can conceive no better example could be afforded that the intellect of England had due regard for the material interests of England than by the creation of a chair for scientific geography and the relegation of that which is non-scientific to the chair of history. . . .

Time warns me that I have detained you long enough, and that if my illustrations apply to the argument intrusted to your consideration, the application should at once be made evident. To my own mind the bearing is clear. A Boundary Commission represents the three branches of Science, Research, and Diplomacy—in other words, all that comes under scientific geography and political geography. The first, you will understand, comprises the survey of country, mapping, and determination of localities. The second has to do with the definition of territorial limits, and, in such sense, with history, ethnology, and laws of nations. That all this has been done, and well done, on the present occasion is not disputed, any more than that enlightened attention will be given to the due disposal of results. But are not these matters of sufficient importance to be taught as daily lessons in our schools, and presided over in University chairs? Even those barren and desolate lands of which we have now spoken—and I have myself traversed many miles of such, some, indeed, in the near vicinity of the Perso-Afghan frontier, between Herat and Farah—they may have a meaning which can only be understood by the initiated, by those who have made them a long and seriously-undertaken study. To the many they are but miserable deserts displayed in incomplete maps; to the few they may have a value far beyond their outer show. Were I asked to sketch out the kind of manual which might be useful in preparing officers for dealing with questions such as these, I would solicit reference to a late paper which I contributed to a quarterly journal, and which I have once before quoted. In it I stated:—

"Asia itself is a stupendous study, but the difficulties may be smoothed to the learner by the judicious employment of method which, after disposing of essential generalities, would naturally tend to division and subdivision. The first would imply a region such as Turkestan; the second, a group of States or single States only, such as Bukhára and Khiva. Given, then, a particular area, the next consideration should be to explain its physical geography. This should comprise the scientific description of its mountains, rivers, and valleys. Its geography should be comprehensive in respect of direction, elevation, watersheds, and connection with plains and plateaus; its hydrography should treat of sources and mouths, basins, drainage, and connection with lake and swamp. Climate and the more important forms of animal and vegetable life should follow in due course; indeed, something of geology, zoology, and botany, and it may be more besides, might reasonably be added to satisfy the requirements of purely scientific teaching. After science, history would follow, and, joined to history, an account of the religion, manners, and customs of the people, as affected by the historical narrative; a statement of the artificial lines of separation which have replaced natural boundaries in consequence of the wars, revolutions, or arbitrary changes which have characterised certain reigns or epochs; an exposition of the form or forms of government in vogue at different periods; and, finally, a chapter on trade and commerce, including a notice of indigenous products and manufactures. Maps, applicable to relations of territorial changes, would be of immense value; and an historian's criticism on these relations, if offered in that fair spirit which alone is justified in composing history, would be an indispensable complement." . .

REPORTS

Second Report of the Committee, consisting of Prof. Balfour Stewart (Secretary), Sir W. Thomson, Sir J. H. Lefroy, Sir Frederick Evans, Prof. G. H. Darwin, Prof. G. Chrystal, Prof. S. J. Perry, Mr. C. H. Carpmael, Prof. Schuster, Capt. Creak, and Mr. G. M. Whipple, appointed for the Purpose of

Considering the Best Means of Comparing and Reducing Magnetic Observations. Drawn up by Prof. Balfour Stewart.—It is with deep regret that the Committee record the death of one of their number—Capt Sir Frederick Evans, so well known for the valuable contributions which he had made to terrestrial magnetism. His eminent scientific qualities combined to make him a greatly esteemed member of this Committee, who now deplore his loss.

The Committee have added to their number the following gentlemen:—The Astronomer-Royal, Mr. William Ellis, Prof. W. G. Adams, and Mr. W. Lant Carpenter. They could hardly consider their list complete without the addition of the first two names, and they are glad that, although not members of the British Association, these gentlemen were not unwilling to serve on one of its Committees.

Since the last meeting of the Association Mr. G. M. Whipple has made a comparison between the method of obtaining the solar-diurnal variation of declination adopted by Sir E. Sabine and that of Mr. Wild. These methods were applied to three years' observations at the Kew Observatory, and the results were compared with those deduced by the Astronomer-Royal from the same three years at Greenwich. The comparison will be found in Appendix IV. to this report.

The Committee think that this comparison deserves careful study, but they do not feel themselves able to pronounce as yet upon the comparative merits of these various methods. Nevertheless, they are of opinion that it is highly desirable to record the daily mean values (undisturbed) of the three magnetic elements side by side with their solar-diurnal variations.

It will be seeen by Appendix III. that Sir J. Henry Lefroy has continued his comparison of the Toronto and Greenwich observations. He has obtained from the smooth curves—that is to say, taking Mr. Wild's method—results which appear to show that the turning-point of the declination is decidedly later in local time at Toronto than at Greenwich. Sir J. H. Lefroy attributes this to the fact that these two stations are on different sides of the Atlantic.[1]

Appendix II. exhibits, by aid of a diagram, an interesting comparison of Senhor Capello between the diurnal variation of the inclination and that of the tension of aqueous vapour. It is remarkable to notice the great similarity between these variations; a similarity which holds separately for each month of the year. Senhor Capello hopes that these results may be confirmed by a more extended series of observations.

The researches to which allusion has now been made refer to the solar-diurnal variation, excluding disturbed observations. With respect of disturbances, Sir J. Henry Lefroy has continued his comparison of Toronto and Greenwich, and his results are indicated in Appendix III.

Prof. W. G. Adams has, it is well known, made, in connection with another Committee, extensive comparisons between the simultaneous traces of magnetographs in various places. He is at present engaged on such an undertaking, and the Committee are in hopes that when this is completed he will give them the benefit of his experience. The subject is an extremely interesting one, and it seems not impossible, judging from the Greenwich results as obtained by Sir G. B. Airy, that magnetic disturbances may be in a great measure due to earth-currents, so that an easy approximate method of recording the latter may be obtained from magnetograph indications.

The Rev. S. J. Perry and Prof. Stewart (Appendix V.) have completed their preliminary comparison of certain simultaneous fluctuations of the declination at Kew and at Stonyhurst in a paper which has been published in the *Proceedings* of the Royal Society, No. 241, 1885. The results are virtually those which were stated in the last report of the Committee. The comparison is being continued and extended.

Prof. Stewart and Mr. W. Lant Carpenter (Appendix VI.) have given the results of other four years' reduction of Kew declination disturbances classified according to the age of the moon. These are very similar to the results of the first four years given in our last report. The same observers give a comparison, extending over four years, between declination disturbances and wind values, which appears to them to show that there is some relation between these two phenomena. They are anxious to continue and extend both these inquiries.

Prof. Stewart has pointed out certain general considerations which appear to indicate that the solar-diurnal variation may perhaps be caused by electric currents in the upper atmospheric regions. Dr. Schuster has likewise made a preliminary application of the Gaussian analysis, tending to confirm the hypothesis that currents in the upper regions are the cause of these variations.[1]

By this analysis Dr. Schuster obtains certain relations between the solar-diurnal variations of the three magnetic elements which ought to hold on the hypothesis that these variations are caused by currents in the upper atmospheric regions. One of these is that the horizontal force component of the daily variation ought to have a maximum or minimum at the time when the declination component vanishes—that is to say, attains its mean position. Another is that the horizontal force ought to be a maximum in the morning and a minimum in the afternoon in the equatorial regions, while in latitudes above 45° the minimum ought to take place in the morning. A third is that in the equatorial regions the maximum of horizontal force ought to be coincident with the minimum of vertical force, and *vice versâ*.

These conclusions are sufficiently well confirmed by observations, and thus render hopeful the first attempt to apply the Gaussian analysis to the solar-diurnal variation.

The appendices of Capt. Creak (I.) and of Dr. Schuster (VII.) have reference to this subject, and indicate the importance of some action being taken by the Committee to prepare for a thorough application of the Gaussian analysis to the magnetic variations. It will be seen from the remarks of Dr. Schuster that some time must elapse before observations are obtained sufficiently good and complete to justify a systematic application to them of mathematical analysis. This circumstance has induced the Secretary to lay before this Committee in Appendix VIII. a provisional working hypothesis regarding the cause of the periodic variations of terrestrial magnetism which has gradually grown up by contributions from various quarters.

While this Committee do not hold themselves responsible for the various statements contained in this hypothesis, they would point out the desirability of ascertaining to what extent well-known magneto-electric laws may succeed in accounting for the phenomena of terrestrial magnetism, and likewise the desirability of ascertaining to what extent the magnetic earth appears to be subject to the laws of ordinary magnets.

A preliminary working hypothesis of this nature might serve to elicit facts while the material for the Gaussian analysis is being completed, and it would add to the interest of the final result if we should obtain reason to think that electric currents in the upper atmospheric regions are at once the *immediate causes* of magnetic variations and the *effects* of atmospheric motions in these regions, so that a knowledge of the one set of currents might possibly enable us to determine the other.

Finally, in Appendix IX. we have a list drawn up by Sir J. Henry Lefroy of the various stations where magnetic observations of any importance have been made.

The Committee have drawn 10*l.* 10*s.*, and returned to the Association a balance of 29*l.* 10*s.* They would desire their re-appointment, and would request that the sum of 50*l.* should be placed at their disposal, to be spent as they may think best on the researches mentioned in this report.

Third Report of the Committee, consisting of Prof. Balfour Stewart (Secretary), Prof. Stokes, Prof. Schuster, Mr. G. Johnstone Stoney, Prof. Sir H. E. Roscoe, Capt. Abney, and Mr. G. J. Symons, appointed for the Purpose of Considering the Best Methods of Recording the Direct Intensity of Solar Radiation.—The Committee, in conformity with their last report, have had constructed by Mr. Casella an instrument of the following description:—It consists of a thick-sided copper cube, one side of which is to be exposed to the sun. In the thickness of this side are inserted two thermometers; a third is put in the side opposite; while the bulb of a fourth occupies the hollow centre. If the readings of these instruments are found to have any constant relation, the fourth instrument will be replaced by a flat bulb thermometer exposed to the sun's rays through a hole in the sun-ward side of the cube. The Committee suggest that they be re-appointed, and that the sum of 20*l.* be again placed at their disposal.

From the Report of a Committee, consisting of Profs. G. H. Darwin and J. C. Adams, for the Harmonic Analysis of Tidal Observations. Drawn up by G. H. Darwin.—Major Baird's "Manual of Tidal Observations" is now printed, and will be

[1] See Appendix by Sir G. B. Airy to the Greenwich Observations, 1884.

[1] An account of these researches will be found in the *Phil. Mag.*, April and May 1886.

sold by the British Association, 22, Albemarle Street, W. The Indian tidal results of all previous years, and those given in the various reports to the British Association, have been reduced by Major Baird to the standard form recommended in the report of 1883. To these have been added the results derived by the United States Coast Survey, and the whole has been published in the *Proceedings* of the Royal Society, No. 239, 1885, in a paper by Major Baird and Prof. Darwin. In the course of the Indian tidal operations a discussion has arisen as to the determination of a datum-level for tide-tables. The custom of the Admiralty is to refer the tides to "the mean low-water mark of ordinary spring tides." This datum has not a precise scientific meaning, as the diurnal tides enter into the determination of the datum in an undefined manner; and it follows that two determinations, both equally defensible, might differ sensibly from one another. A datum-level should be sufficiently low to obviate the frequent occurrence of negative entries in a tide-table, and it should be rigorously determinable from tidal theory. It is now proposed to adopt as the datum-level at any new ports in India, for which tide-tables are to be issued, a datum to be called "the Indian spring low-water mark," and which is to be below mean sea-level by the sum of the mean semi-ranges of the tides M_2, S_2, K_1, O; or, in the notation used below,—

$$H_m + H_s + H' + H_o$$

below mean water-mark. This datum is found to agree pretty nearly with the Admiralty datum, but is usually a few inches lower. The definition is not founded on any precise theoretical considerations, but it satisfies the conditions of a good datum, and is precisely referable to tidal theory. If, when further observations are made, it is found that the values of the several H's require correction, it is not proposed that the datum-level shall be altered accordingly, but, when once fixed, it is to be always adhered to. The report then shows how harmonic analysis might be applied to the reduction of a short series of tidal observations, such as might be made when a ship lies for a fortnight or a month in a port. The method has been applied by Mr. Alnutt to the computation of tide-tables at Port Blair and several other ports, and the computed results are compared with those given both by a rigorous instrument and by actual observation. It is remarked that, while better agreement was to be desired, the errors are inconsiderable fractions of the whole intervals of time and heights under consideration. An attempt made to detect the nineteen-yearly tide by observations at Karachi has led to the belief that it is extremely improbable that this important datum will ever be detected.

P. T. Main presented a *Report on our Experimental Knowledge of Certain Properties of Matter*.—The report discussed recent work on the testing of Boyle's law for very low as well as for very high pressures, the researches of Amagat and C. Bohr being included. It then passed to the verification of Gay-Lussac's law. Recent researches on the saturated pressures of vapours at various temperatures, especially those of Ramsay and Young, were next considered, especially to determine (1) whether statical and dynamical methods of observation lead to similar results; (2) whether the pressures of ice and of water-vapour are the same at the same temperature. The important question of the pressure of mercury-vapour, and modern research in the determination of the critical points of nitrogen and other gases, and in the measurement of vapour-densities, were also included.

Prof. George Forbes presented the *Report of the Committee on Standards of Light*.—The Committee had met repeatedly during last winter. It had been proposed in last year's report to carry on experiments on electrical standards in the hope of arriving at an absolute standard of light. One of the first steps was to discover a means of reproducing a definite temperature, and certain experiments were proposed for this purpose. At one of the first meetings of the Committee Capt. Abney announced that he had already found a means of doing this in a different manner to that proposed in the Committee's report, and depending only upon the change of resistance of the carbon filament. Under these circumstances the Committee left this part of the experimental investigation to be reported upon by Capt. Abney. His further researches had, however, led him to believe that the law which he had announced to the Committee did not hold with all qualities of carbon filament. He had, however, been engaged upon further experimental researches, which were almost ready for publication, and which had an important bearing upon the labours of the Committee. In last year's report attention was drawn to the value of the pentane standard of Mr. Vernon Harcourt as a practical reproducible standard, and Mr. Rawson had been since then engaged in a further examination of that standard. Sir James Douglass had also made some experiments which were not quite completed, but had gone so far as to give great promise. Some account of the experiments in that report had been expected by the Committee, but the absence of Sir James Douglass on official business had interfered with this. At one of the first meetings of the Committee the Secretary showed what he had done in the way of improving thermopiles such as it was hoped would be of use in the investigations recommended in last year's report, and he was instructed by the Committee to proceed with the construction of the instrument, which had been completed, and was now to be placed before the Section and described in a separate paper. The Committee requested to be re-appointed, with a grant of 25*l*.

Report of the Committee on Electrolysis, presented by Prof. Oliver J. Lodge (Secretary).—The report, which was only an interim report, stated that only one meeting had been held, but a large amount of correspondence had passed, as well as work done by the various members. This work was discussed in separate papers. The Committee asked to be re-appointed with a grant to defray the expense chiefly of printing selected memoirs, and of getting pure substances.

Report of the Committee on English Channel Tides.—The Committee had received the records of the self-recording tide-gauges at Dover and Ostend for the four years 1880 to 1883. These are so bulky that they content themselves with discussing in an appendix to the report the records of four periods of a fortnight in the year 1883, namely, at the solstices and the equinoxes. Of these diagrams were shown. The Committee suggest that they hand over their papers and records to the Committee for the Harmonic Analysis of Tides.

Prof. Johnson submitted the *Report of the Committee formed in Canada to establish a System of Tidal Observations in that Country*.—He said they had communicated with the Government in the matter, and while, owing to the expense at present incurred in hydrographical work on Lake Ontario and elsewhere, the Government had not yet given their consent, it was hoped that before long their object would be attained. The Committee asked for re-appointment.

Report of the Electrical Standards Committee, presented by Mr. Glazebrook (Secretary).—Eighteen standard coils have been tested during the year, and certificates of their value issued. The attention of the Secretary was called to the fact that the paraffin in some of the coils showed a trace of green coloration round the edges. This has been shown to arise from the action of a small amount of acid, left in the paraffin, on the copper of the case and connecting-rods, and the Committee are considering how to deal with the difficulty. At present the insulation resistance of the coils is extremely high, amounting to as much as 8000 megohms. The Committee wish to express their sense of the great desirability of establishing a National Standardising Laboratory for Electrical Instruments on a permanent basis, and their readiness to co-operate in the endeavour to secure the same. The Committee apply for re-appointment, with the addition of the name of Mr. J. T. Bottomley.

Second Report on the Fossil Plants of the Tertiary and Secondary Beds of the United Kingdom, by J. S. Gardner.—Attention has been devoted exclusively this year to the fossil flowering or phanerogamous plants. The results point to the conclusion that while the Gymnosperms, to which the Coniferæ belong, are of the highest antiquity, there are no angiospermous plants in British rocks older than the Secondary, if we except the problematic plant known as *Spirangium*. Even so late as the Lias no indisputable Angiosperm has been discovered within our area, for the supposed Monocotyledons from the Rhætics, near Bristol, hitherto referred to the family of Pond-weeds under the name *Najadita*, are really cryptogamic plants of the moss tribe, closely allied to the river moss *Fontinalis*. This group had not previously been found fossil, and, so far as it goes, would indicate rather a temperate climate. It is important to notice that these conclusions are shared by Prof. Williamson, Mr. Carruthers, and by all botanists who have examined them, as well as by Mr. Brodie, the possessor of the specimens. The *Lilia*, *Bensonia*, and other supposed Monocotyledons of similar age are very imperfectly preserved, and doubtless referable to Cycads, a family which abounded then.

We have examined a large number of specimens of the anomalous Jurassic plant described by Carruthers as *Williamsonia*. Though there are still many difficulties in the way, our own examination of the specimens in London, Manchester, Cambridge, and elsewhere tends to confirm Saporta's view, referring them to the group of *Pandanaceæ*, so far as that there does appear to be vestiges, in some cases at least, of lignitic structure which may represent the areolæ or carpels. These rather minute cavities and the lignitic matter surrounding them fall away on exposure to the air, and only traces of them are visible. Should Saporta's contention be upheld, *Williamsonia* will be by far the most perfectly known of the Secondary Angiosperms, since all the organs of fructification and even of foliation are more or less known.

A still more definite Monocotyledon is the *Podocarya*, from the Inferior Oolite, originally figured by Buckland, and redescribed by Carruthers. Its resemblance to the fruit of *Williamsonia*, as interpreted by Saporta, is extremely striking, and on suggesting this to that author, he replied that he was in the act of preparing an important work on the very subject. The same work is to include an illustration of the most recent member of the group, obtained from the Grey Chalk of Dover, and which we thought advisable to communicate to him.

Next in point of age, among English Monocotyledons, to the *Podocarya* is the *Kaidacarpum*, from the Great Oolite, also described by Carruthers, and by him referred to the *Pandaneæ*. We have been able to ascertain that a second species, hitherto supposed to be of Cretaceous age from the Potton Sands, is a derived fossil, and undoubtedly Jurassic. A third species was originally figured, without any reference in the letter-press as to its age or locality, by Lindley and Hutton as *Strobilites Bucklandi*; this, however, is far more likely to prove a Jurassic than a Cretaceous fossil if found, and the genus should not be included in lists of plants of the latter age.

The oldest Monocotyledons thus appear to be referable to the *Pandaneæ*, a group of plants distributed in widely distant and remote oceanic islands, and whose fruits are still met with at sea in drifts of vegetable matter.

Next to these in antiquity are two very monocotyledonous-looking fragments from the Jurassic of Yorkshire, which have been fully described in the *Geological Magazine* for May and August. The one is apparently an unopened palm-like spathe, and the other a jointed cane-like stem. Mr. Brodie possesses an undoubtedly monocotyledonous leaf-fragment from the Purbeck of Swindon.

The *Aroïdeæ* have long been supposed to be a group of very high antiquity, but there are good reasons for believing that the supposed remains of aroïdeous plants from beneath the Tertiaries are, without exception, referable to other groups, and actually there are no known traces of them earlier than the Middle Eocene, when they become by no means uncommon.

In a similar manner the fruits once supposed to represent *palms* in the Palæozoic and Mesozoic rocks have been gradually removed or suppressed, and, unless the fragments of palm-like wood in the Gault at Folkestone are taken into account, there are no traces of palms in any of our Secondary strata. They, however, appear as low down in our Eocene as the Woolwich series.

The supposed liliaceous or *Dracæna*-like stems from the Wealden, so frequently mentioned by Mantell, are not easy now to identify; but it is very probable that certain stems of *Endogenites* in the British Museum are those intended, in which case they are of course cycadeous. The Wealden has, indeed, so far yielded no trace whatever of any more highly organised plants than ferns and Gymnosperms, and this, when we consider that Monocotyledons were undoubtedly in existence, is a fact that should be of great significance to speculative geologists. The sediments must represent the deposits of the drainage system of a large area, for they are of vast extent and thickness, varied in character, and abounding in remains of trunks and stems, fruits and foliage of plants. In them, therefore, if anywhere, we might reasonably expect to find at least the traces of reed and rush, but the swamps seem to have been tenanted only by Equisetum and ferns, and the forests by Cycads and Conifers.

Angiosperms are absent throughout the Neocomian and Gault of Britain; and it is only in the White Chalk that we meet with any indications of them.

Of the gymnospermous section of Phanerogams the records are very different. To refer here to the earlier Secondary Coniferæ and Cycadeæ would be quite beyond our province, and it is only those of the Cretaceous, as the last discoverable ancestors in our area of the Eocene flora, that are of immediate interest. These belong, excluding Cycads, chiefly to the newest section of the Coniferæ, the Pine family. We are able to make the following contribution to our knowledge of these:—*Pinites Andræi*, Coemans (Gault, Folkestone); *P. Valdensis*, sp.nov. (Wealden, Brook Point, Isle of Wight); *P. Carruthersi*, sp.nov. (Wealden, Brook Point, Isle of Wight); *P. cylindroides*, sp.nov. (Lower Greensand, Potton); *P. Pottoniensis*, sp.nov. (Lower Greensand, Potton). These are described and figured; the report then gives a list of thirteen species of British Cretaceous Coniferæ previously described.

Passing to the Tertiary forms the report refers to leaves in the basement bed of the London Clay at Colden Common, between Bishopstoke and Winchester: the blocks of clay in which the leaves occur are derived, but the plants are allied to the Alum Bay flora; there are no palms.

Much work has been done in collecting at Sheppey, but there are great difficulties in the way of determining the fruits.

A large series of leaves of *Smilaceæ* has been obtained from Bournemouth, by means of which the number of good species is now reduced to five.

The leaves of *Smilaceæ* are highly characteristic, and can be determined with a large degree of certainty; but it is quite improbable that such will be the case with very many of the families of Dicotyledons.

Fortunately fruits and even flowers are comparatively abundant at Bournemouth, and we consequently anticipate little difficulty in determining leaves belonging to such easily distinguishable fruits as *Alnus*, *Tilia*, *Acer*, *Carpinus*, the *Leguminosæ*, and many others, but the residuum with indeterminable fruits, or fruits that will not float, may be very large. We are thus brought to the question, whether any value beyond that of mere landmarks, or aids to the correlation of rocks, can be attached to the determinations of fossil dicotyledonous leaves arrived at when fruits are absent. Nearly every Tertiary and even many Cretaceous floras are said to comprise *Quercus*, *Fagus*, and *Corylus*, to select these as typical examples. Now, we very much doubt whether the fruits of these genera have been met with in any strata older than the Upper Miocene, we might almost say the Pliocene; whilst in the latter the fruits of at least two of them are very far from uncommon. Fossil hazel-nuts are well known to abound in forest beds such as the one at Brook, in the Isle of Wight, and at Carrickfergus. It does appear to us that it would have been wiser and more consistent, when arriving at these determinations, to have taken the absence of fruits into account, when these were such as would naturally have been preserved. The large proportion of fossil dicotyledonous leaves that have been referred without any hesitation to living genera, must strike every one, in comparison with the relatively few associated fruits that have been determined otherwise than as Carpolithes—a name which is a confession of failure. It will thus be seen that in our opinion the fossil Dicotyledons of our own Eocene must be dealt with in a manner different from that pursued by the majority of foreign writers on kindred subjects, and that a revision of much of their work is urgently needed.

Report on the Caves of North Wales, by Dr. H. Hicks, F.R.S.—The explorations have been confined to the caverns of Ffynnon Beuno and Cae Gwyn, in the Vale of Clwyd. Among the remains discovered in these two caverns up to the commencement of the work this year there were over eighty jaws belonging to various animals, and more than 1300 loose teeth, including about 400 rhinoceros, 15 mammoth, 180 hyæna, and 500 horse teeth. Other bones and fragments of bones occurred also in very great abundance. Several flint implements, including flakes, scrapers, and lance-heads, were found in association with the bones. The most important evidence, however, obtained in the previous researches was that bearing on the physical changes to which the area must have been subjected since the caverns were occupied by the animals. During the excavations it became clear that the bones had been greatly disturbed by water action, that the stalagmite floor, in parts more than a foot in thickness, and massive stalactites had also been broken and thrown about in all positions, and that these had been covered afterwards by clays and sand containing foreign pebbles. This seemed to prove that the caverns, now 400 feet above Ordnance datum, must have been submerged subsequently to their occupation by the animals and by man. One of the principal objects, there-

fore, which the Committee had in view this year was to critically examine those portions of the caverns not previously explored, so as to endeavour to arrive at the true cause of the peculiar conditions observed. When the explorations were suspended last year in the Cae Gwyn Cave it was supposed that we had just reached a chamber of considerable size, but after a few days' work this year it was found that what appeared to be a chamber was a gradual widening of the cavern towards a covered entrance. The position of this entrance greatly surprised us, as hitherto we had believed that we were gradually getting further into the limestone hill. The rise in the field at this point, however, proved to be composed of a considerable thickness of glacial deposits heaped up against a limestone cliff. A shaft, 20 feet deep, was opened over this entrance from the field above. The beds were carefully measured by Mr. C. E. De Rance, Mr. Luxmoore, and the writer, during the prosecution of the work. Below the soil, for about 8 feet, a tolerably stiff boulder-clay, containing many ice-scratched boulders and narrow bands and pockets of sand, was found. Below this there were about 7 feet of gravel and sand, with here and there bands of red clay, having also many ice-scratched boulders. The next deposit met with was a laminated brown clay, and under this was found the bone-earth, a brown, sandy clay with small pebbles and with angular fragments of limestone, stalagmite, and stalactites. On June 28, in the presence of Mr. G. H. Morton, of Liverpool, and the writer, a small but well-worked flint-flake was dug up from the bone-earth on the south side of the entrance. Its position was about 18 inches below the lowest bed of sand. Several teeth of hyæna and reindeer, as well as fragments of bone, were also found at the same place; and at other points in the shaft teeth of rhinoceros and a fragment of a mammoth's tooth. One rhinoceros tooth was found at the extreme point examined, about 6 feet beyond and directly in front of the entrance. It seems clear that the contents of the cavern must have been washed out by marine action during the great submergence in mid-Glacial time, and that they were afterwards covered by marine sands and by an upper boulder-clay, identical in character with that found at many points in the Vale of Clwyd and in other places on the North Wales coast. The bone-earth seems to diminish in thickness rather rapidly outwards under the glacial deposits, but it was found as far out as the excavations have been made. Here the bone-earth rests directly on the limestone floor, with no local gravel between, as in the cavern. It would be interesting to know how far the cave-earth extends under the glacial deposits, but this could only be ascertained by making a deep cutting through the terrace of glacial deposits, which extends for a considerable distance in a westerly direction. The glacial deposits here are undoubtedly in an entirely undisturbed condition, and are full of smooth and well-scratched boulders, many of them being of considerable size. Among the boulders found are granites, gneiss, quartzites, flint, felsites, diorites, volcanic ash, Silurian rocks, and limestone. Silurian rocks are most abundant. It is clear that we have here rocks from northern sources, along with those from the Welsh hills, and the manner in which the limestone at the entrance to the cavern in the shaft is smoothed from the north would indicate that to be the main direction of the flow. The marine sands and gravels which rest immediately on the bone-earth are probably of the age of the Moel Tryfaen and other high-level sands, and the overlying clay with large boulders and intercalated sands may be considered of the age of the so-called upper boulder-clay of the area. The latter must evidently have been deposited by coast-ice. Whether the caverns were occupied in pre- or only in inter-Glacial times it is difficult to decide, but it is certain that they were frequented by Pleistocene animals and by man before the characteristic glacial deposits of this area were accumulated. The local gravel found in the caverns, underlying the bone earth, must have been washed in by streams at an earlier period, probably before the excavation of the rocky floor of the valley to its present depth. From the Glacial period up to the present time excavation has taken place only in the glacial deposits, which must have filled the valley up to a level considerably above the entrances to the caverns. The characteristic red boulder-clay with erratic blocks from northern sources is found in this area to a height of about 500 feet, and sands and gravels in the mountains to the south-east to an elevation of about 1400 feet. The natural conclusion therefore is that the caverns were occupied by an early Pleistocene fauna and by man anterior to the great submergence indicated by the high-level marine sands, and therefore also before the deposition of the so-called great upper boulder-clay of this area. As there is no evidence against such a view, it may even be legitimately assumed that the ossiferous remains and the flint implements are of an earlier date than any glacial deposits found in this area.

Fourth Report on the Fossil Phyllopoda of the Palæozoic Rocks, by Prof. T. R. Jones.—This report tabulates 37 species with their geological range, critical remarks being given on most species. There are 28 species of *Ceratiocaris* from beds ranging from the Carboniferous limestone to the Lower Wenlock; three doubtful forms are recorded from the Upper Llandovery and Tremadoc. The other forms referred to are *Emmelecaris* (four species), *Physocaris vesica*, and *Xiphocaris ensis*, all from the Ludlow beds.

Report on the Volcanic Phenomena of Vesuvius and its Neighbourhood, by Dr. H. J. Johnston-Lavis.—The report gave a description of the volcanic activity of Vesuvius during the past year, illustrated by photographs. The fourth sheet of the Geological Map of Monte Somma and Vesuvius (scale 1 : 10,000) has been completed, and was exhibited at the meeting; this distinguishes in great detail the lava-flows of various dates. The present year has been remarkable for the chances it affords for studying the subterranean structure of the Campi Phlegrei and the volcanic region around Naples. The great main drain which is to convey the sewage of Naples to the Gulf of Gaeta will traverse the region west of Naples on a line running nearly east and west. Five borings have been made to test the ground to be cut through, in which observations on the water-level, temperature, and presence of volcanic gases were made. A deep well is in progress at Lago Fusaro. Five other borings on or near the renowned Starza or fore-shore of Puzzuoli, on the new works of Sir W. Armstrong, Mitchell, and Co., are interesting as being within a few hundred yards of the celebrated so-called Temple of Serapis. Two are on the shore, and three at varying distances out to sea; they fully confirm the opinions generally held as to the oscillations of the ground here. The new Cumana Railway from Naples to Baia and Fusaro traverses the rocky escarpment just west of Naples. This has hitherto been supposed to be composed of a moderately uniform mass of pelagonatised basic marine tuff; but under the middle of the Corso Vitt. Emanuele and the Via Tasso the edge of a trachyte flow was traversed for over 70 metres. Much interesting information is expected from this railway, which will require a number of cuttings and tunnels, and will have to traverse the hot hill behind Baia. A deep well, in progress at Ponticelli on the outskirts of Naples, towards Vesuvius, has already been carried to a depth of over 100 metres; in the lower half of this a series of leucitic lava-streams was traversed, showing the great distances to which the old flows from Monte Somma reached, and also that either great depression of land has taken place, or that Monte Somma once formed a volcanic island. The work in hand, in addition to watching the progress of the works mentioned above, and mapping the old lava-streams, includes a careful study of the ejected blocks of Monte Somma, both chemical and microscopical, and a comparison of these rocks with those of the ancient volcanic regions of the Fassathal in the Tyrol, which they greatly resemble.

Thirteenth Report on the Erratic Blocks of England and Wales, by Rev. Dr. Crosskey.—This describes boulders near Settle and Kendal, to which the attention of the Committee has been called by Prof. T. McKenny Hughes, which are perched on pedestals of limestone striated in the direction of the main ice-flow. The boulders have preserved the rock immediately beneath from denudation. Mr. Plant gives much information upon the boulders in the valley of the Soar near Leicester recently well exposed in deep excavations. Thousands of blocks here occur in the boulder-clay; about one half are from Charnwood Forest, the remainder from the Permian sandstones and Carboniferous rocks of the Ashby coal-field, with blocks of mountain limestone brought fifteen or eighteen miles from the north-west; the rest are from the east side of the Pennine Chain, forty to fifty miles distant to the north-east. Details of various other excavations in and around Leicester were given, from which it is inferred that the Charnwood district was the centre of local ice-action. Dr. Crosskey and Mr. F. W. Martin describe a group of boulders between Shifnal and Tong, the stones consisting of rocks from the Lake district with Criffel granites which have evidently travelled together to their present position.

Report on the Erosion of the Sea-Coasts of England and Wales, by C. E. De Rance and W. Topley.—The information here given referred in part to the East Anglian coast, for which

several returns had been received. The rate and mode of erosion of the chalk cliffs at the north-west part of the Isle of Thanet is described by Mr. R. B. Grantham; in places as much as 20 feet in width of cliff has been lost in five years, but the average loss is not so much.

Capt. T. Griffiths and Mr. H. W. Williams contribute a report on the north-west coast of Pembrokeshire, where the alterations are in places important, and in all are historically interesting.

A report by Mr. K. McAlpine, on Pembrokeshire, illustrated by numerous photographs, was also laid before the meeting.

The Twelfth Report of the Committee on the Circulation of Underground Waters, by C. E. De Rance.—During the thirteen years the investigation had been going on much valuable information had been obtained; the complete dependence of the supply of underground water on the annual rainfall and the character and porosity of the strata on which the rain fell, had been completely established, varying from one inch to twelve inches of rainfall annually absorbed on each square mile; one inch of rain giving 40,000 gallons per day for each square mile of surface exposed. The great value of underground supplies had been shown during severe droughts, the dry-weather flow of the streams and rivers being wholly dependent on underground supplies issuing as deep-seated springs. Large quantities of water could be obtained by deep wells in suitable situations, as was well shown by the Birmingham Corporation supply,—the Aston well yielding 3 million gallons a day, the Witton well 2½ million gallons, King's Vale a quarter of a million gallons, Perry well 2 million gallons, Selby Oak well 1¼ million gallons, giving a total supply from wells of 9 million gallons a day, the remaining supply being from streams yielding 7½ million gallons a day; giving a total supply of 16½ million gallons, of which only 12 are required at present. Large supplies of pure artesian well waters are obtained and used at Nottingham, Liverpool, and Birkenhead. The supplies to other cities were investigated, and the recent successful borings at Stafford commented on.

Report of the Committee, consisting of Mr. John Cordeaux (Secretary), Prof. A. Newton, Mr. T. A. Harvie-Brown, Mr. William Eagle Clarke, Mr. R. M. Barrington, and Mr. A. G. More, re-appointed at Aberdeen for the Purpose of Obtaining (with the consent of the Master and Brethren of the Trinity House and the Commissioners of Northern and Irish Lights) Observations on the Migration of Birds at Lighthouses and Light-vessels, and of reporting on the same.—The General Report of the Committee, of which this is an abstract, is comprised in a pamphlet of 173 pages,[1] and includes observations taken at lighthouses and light-vessels, as well as at several land stations, on the coasts of Great Britain and Ireland and the outlying islands. The best thanks of the Committee are due to their numerous observers for their assistance. Much good work has been rendered by those amongst them who have taken the trouble to forward a leg and wing of such specimens as have been killed against the lanterns, and which they have themselves not been able to identify. This has already led to the determination of several rare birds, which otherwise would have escaped notice. It is evident that, unless the birds can be correctly named, the value of this inquiry is materially diminished, and ornithologists may justly refuse to accept the accuracy of the statements. It is intended, in order to facilitate the sending of wings, to supply the light-keepers with large linen-lined envelopes, ready stamped, and inclosing labels for dates and other particulars. The best thanks of the Committee are also tendered to Mr. H. Gätke for the increased interest he has given to their Report by forwarding a daily record of the migration of birds as observed at Heligoland between January 1 and December 31, with the concurrent meteorological conditions under which the various phenomena occurred. Altogether 187 stations were supplied with printed schedules for registering the observations, and returns have been sent in from 125. About 267 separate schedules have been sent in to your reporters. The general results, as far as the special object of the inquiry, have been very satisfactory, and much information has also been accumulated respecting the breeding habits of sea-fowl on the outlying islands and skerries on the Scotch and Irish coasts, and altogether a great mass of facts and valuable data obtained which cannot fail to be of value to future inquirers. A special point of interest in the Report is the large arrival, with a north-east wind, of pied flycatchers in the first week in May 1885, observed at Spurn Point, Flamborough Head, the Isle of May, and Pentland Skerries. At Flamborough Head the flycatchers were accompanied by male redstarts in large numbers, both species swarming for two or three days. The immigration at this period was not exclusively confined to these two species. Mr. Agnew, writing from the Isle of May, at the entrance of the Firth of Forth, says, under date of May 3:—"An extraordinary rush of migrants to-day; have never seen anything like it in spring. To attempt to give numbers is simply useless. I will just give you the names in succession: fieldfares, redwings, ring-ouzels, blackbirds, lapwings, dotterels, rock-pigeons, hawk, meadow pipits, redstarts, whinchats, tree-sparrows, yellow wagtails, ortolan (obtained), robins, chiff-chaffs, wood-warbler, blackcap-warbler, marsh-tit, whitethroats, and pied flycatchers." And on the 4th: "Stil increasing in numbers, but wind shifted this morning to E. for S.E." A noteworthy incident also of the vernal migration was the great rush of wheatears observed at the Bahama Bank vessel off the Isle of Man, and at Langness on the night of April 13, when many perished and were captured. On the same night, wheatears were killed at the Coningbeg and Rathlin Island Lighthouses on the Irish coast. On the 12th and 13th the rush was very heavy at stations on the west coast of Scotland. No corresponding movement was observed on the east coast of Great Britain on the same night; but at Hanois L.H., Guernsey, on May 10, at night at the north light, and on the Lincolnshire coast and Farn Islands on the 10th and 11th. These entries are sufficient to show the immense area covered by the migration of this species at or about the same period. On the east coast of England the first wheatears were observed at the Farn Islands on February 22. The autumnal migration is first indicated at Heligoland on July 6, and was continued with slight intermissions up to the end of the year. A similar movement affected the whole of the east coast of Great Britain during the same period, but was apparently less constant and persistent than at Heligoland. It has been remarked in previous Reports that the migration of a species extends over many weeks, and in some cases is extended for months. Yet it is observable that, at least on the east coast of England, year by year, the bulk or main body of the birds come in two enormous and almost continuous rushes during the second and third weeks in October and the corresponding weeks in November. In the autumn of 1885 it is again observable that the chief general movements which usually characterise the southward autumnal passage were two in number, and affected the stations over the whole coast-line both east and west of Great Britain. The first of these commenced about October 11, and was continued to the 20th. The second from November 8 to 12. It is worthy of notice that these two chief movements of the autumn were ushered in by, and concurrent with, anti-cyclonic conditions, preceded by, and ceasing with, cyclonic depressions, affecting, more or less, the whole of the British Isles. From this it appears not unlikely that birds await the approach of favourable meteorological conditions, of which, perhaps, their more acute senses give them timely warning, to migrate in mass. Whatever may be the cause which impels these enormous rushes, often continuous for days, it is one which operates over an immense area at one and the same time. The October rush reached its maximum on the 16th, at which date almost all the stations report extraordinary numbers of various species on the wing. As one out of many, we quote from the journal of Mr. James Jack, principal of the Bell Rock Lighthouse:—"Birds began to arrive at 7.30 p.m., striking lightly and flying off again; numbers went on increasing till midnight, when it seemed that a vast flock had arrived, as they now swarmed in the rays of light, and, striking hard, fell dead on balcony or rebounded into the sea. At 3 a.m. another flock seemed to have arrived, as the numbers now increased in density; at the same time all kinds crowded on to the lantern windows, trying to force their way to the light. The noise they made shrieking and battering the windows baffles description. The birds were now apparently in thousands; nothing ever seen here like it by us keepers. Wherever there was a light visible in the building they tried to force their way to it. The bedroom windows being open as usual for air all night, they got in and put the lights out. All birds went off at 6 a.m., going W.S.W. Redwings were most in number, starlings next, blackbirds, fieldfares, and larks." The rush in November chiefly took place in the night; at the Bell Rock the movement ceased at midnight of the 12th, and at

[1] "Report on the Migration of Birds in the Spring and Autumn of 1885." (McFarlane and Erskine, 19, St. James's Square, Edinburgh.)

the Longstone Lighthouse, on the Farn Islands, a little earlier —at 10.30 p.m., when the wind became strong from S.W. From each succeeding year's statistics we have come to almost similar conclusions regarding the lines of flight—regular and periodically used routes where the migratory hosts are focused into solid streams. Three salient lines on the east coast of Scotland are invariably shown, viz. (1) by the entrance of the Firth of Forth, and as far north as Bell Rock, both coming in autumn and leaving in spring; (2) by the Pentland Firth and Pentland Skerries, likewise in spring and autumn; and (3) by the insular groups of Orkney and Shetland, which perhaps may be looked upon as part of No. 2. On the other hand, three great areas of coast-line, including many favourably lighted stations, almost invariably, save in occasionally protracted easterly winds, and even then but rarely, send in no returns, or schedules of the very scantiest description. These areas are Berwickshire, the whole of the east coast south of the Moray Firth, and Caithness and East Sutherland. Each and all of these areas possess high and precipitous coast-lines, if we except the minor estuaries of the Rivers Tay and Dee, and a small portion of the lower coast-line of Sutherland, which face towards the east. On the east coast of England these highways are less clearly demonstrated. The Farn Islands, Flamborough Head, and the Spurn are well established points of arrival and departure; but south of the Humber as far as the South Foreland the stream appears continuous along the whole coast-line, and to no single locality can any certain and definite route be assigned. It cannot be said that the southerly flow of autumn migrants is equally distributed along the entire west coast of England. On the contrary, the schedules afford unmistakable evidence that the great majority of these migrants, so far as the English and Welsh coasts are concerned, are observed at stations south of Anglesey. But while the north-west section of the coast is thus less favoured than the rest, such is not the case with the Isle of Man, which comes in for an important share of the west coast migratory movement. The fact has already been alluded to that large masses of immigrants from Southern Europe pass through the Pentland Firth, and, along with migrants from Faroe, Iceland, and Greenland, pass down the west coast of Scotland, whence many cross to Ireland, and it seems most probable that the remainder leave Scotland at some point on the Wigtown coast, and pass by way of the Isle of Man to the west coast of Wales, and thus avoid the English shore of the Irish Sea. The schedules sent in from the coasts of Flint, Cheshire, Lancashire, and Cumberland show that in 1884–85 comparatively few migrants were observed, and that the great general movement did not affect them in any general degree. These remarks do not apply to migrants amongst the waders and ducks and geese, which, as a rule, closely follow coast-lines, and which are abundantly represented on the Solway and coasts of Cumberland and Lancashire. There is a much-used bird route along the north coast of the British Channel, and thence, from the Pembroke coast, across to Wexford, passing the Tuskar Rock, the best Irish station. The fact of a double migration or passage of birds, identical in species, across the North Sea in the spring and autumn both towards the E. and S.E., and to the W. and N.W., is again very clearly shown in the present report. This phenomenon of a cross migration to and from the Continent, proceeding at one and the same time, is regularly recorded on the whole of the east coast of England, but is specially observable at those light-vessels which are stationed in the south-east district; at the same time, it is invariably persistent, and regular year by year. Our most interesting stations are those on small islands or rocks, or light-vessels at a considerable distance from shore, and the regular occurrence of so many land birds, apparently of weak power of flight, around these lanterns, is a matter of surprise to those unacquainted with the facts of migration. No clear indication of the migration of the redbreast has yet been shown on the Irish coast; the records of its occurrences are few and scattered. The black redstart was recorded at several stations in the southern half of Ireland; specimens were forwarded from Mine Head, the Skelligs, and Rockabill. It is apparently a regular winter visitant to the Skelligs and Tearaght, generally appearing in October and November. The occurrences so far recorded by the Committee of the black redstart on the east coast of Great Britain, in the autumn, range between October 23 and November 3. In the spring of the present year, Mr. G. Hunt, under date of March 20, reports an extraordinary flight of rooks at Somerton, on the Norfolk coast, which he observed from 10.30 a.m. to 6 p.m. He says:—"I observed them flying just above the sand-hills, going due south, and as far as the eye could see both before and behind there was nothing but rooks. There could never for one moment in the day be less than a thousand in sight at one time; they kept in a thin wavering line. The coast line here runs due north and south." Mr. J. H. Gurney reports:—"I saw the rooks and grey crows on the same day in much smaller numbers as were seen at Somerton, which is fifteen miles further south. I again saw them on the 21st, 22nd, 25th, 26th, and 29th, but none after this date; with us, however, grey crows preponderated; the direction was to S.E. An enormous migration of these and many others is recorded from Heligoland, also from Hanover between March 19 and 25." In conclusion your Committee wish to thank H.R.H. the Master and the Elder Brethren of the Trinity House, the Commissioners of Northern Lights, and the Commissioners of Irish Lights for their ready co-operation and assistance, through their intelligent officers and men, in this inquiry. The Committee respectfully request their re-appointment.

Report of the Committee, consisting of Prof. Cleland, Prof. McKendrick, Prof. Ewart, Prof. Stirling, Prof. Bower, Dr. Cleghorn, and Prof. McIntosh (Secretary), for the Purpose of continuing the Researches on Food-Fishes and Invertebrates at the St. Andrews Marine Laboratory.—The Committee beg to report that the sum of 75*l.*, placed at their disposal, has for the most part been expended in the purchase of instruments and books permanently useful in the Laboratory, only a limited proportion having been disbursed for skilled assistance. Since the meeting of the Association at Aberdeen last year several structural improvements in the wooden hospital, now converted into the Laboratory, have been completed, and others are being carried out by the Fishery Board for Scotland. These changes will render the temporary building much more suitable for work. A small yawl of about 21 feet in length has also been added to the apparatus by the Fishery Board. The desiderata now are an increase in the number of good microscopes and other expensive instruments, and an addition to the nucleus of books which workers require always at hand. In this respect the Laboratory has been much indebted to the Earl of Dalhousie, who forwarded a complete set of Fishery Blue-Books, and to the Trustees of the British Museum, who sent such of their publications as bore on marine zoology. Collections of papers have also been forwarded by many observers, amongst whom Prof. Flower, the late Dr. Gwyn Jeffreys, and Prof. Alexander Agassiz are conspicuous. Most of the Continental and American workers in marine zoology and cognate subjects, as well as those of our own country, are indeed represented. The first work of the year was the examination of a fine male tunny, 9 feet in length, caught in a beam-trawl net near the mouth of the Forth, and the skeleton of which is now being prepared for the University Museum. Various interesting anatomical features came under notice, and its perfect condition enabled a more correct figure of its external appearance to be made (*vide Ann. Nat. Hist.*, April and May 1886, and "Fourth Report of the Fishery Board for Scotland," plate 8). The examination of various food- and other fishes in their adult and young conditions was systematically carried out, and notes on the following species will be found in the *Annals of Natural History*, and the "Report of the Fishery Board":—Weever (greater and lesser), shanny, sand-eel, halibut, salmon, common trout, herring, sprat, conger, ballan-wrasse, shagreen-ray, piked dog-fish, and porbeagle-shark. Special attention was also given to the "Mode of Capture of Food-Fishes by Liners," "Injuries to Baited Hooks and to Fishes on the Lines," "Shrimp-Trawling in the Thames," "Sprat-Fishing," and to the "Eggs and Young of Food- and other Fishes," "Diseases of Fishes," the "Effect of Storms on the Marine Fauna," and "Remarks on Invertebrates, including Forms used as Bait" (*vide* "Fourth Report of the Fishery Board for Scotland," 1886). The active work in connection with the development of fishes for the season may be dated from the middle of January, when one of the local trawlers captured a large mass of the ova of one of the food-fishes, viz. the catfish. The embryos in these eggs (which are the size of the salmon's) were well advanced, so that, with the exception of a few unimpregnated ova observed during the trawling experiments of 1884, the earlier stages have yet to be examined. The large size of the embryos of the catfish permitted a satisfactory comparison to be instituted between them

and the salmon, which had formerly been under examination, and the results, with drawings of both forms, are nearly completed, and will be communicated to one of the Societies during the winter. The first pelagic ova, viz. those of the haddock, made their appearance during the very cold weather in the beginning of February, and the examination of these, together with those of the cod and common flounder—both of which were unusually late—enabled Mr. E. E. Prince and the Secretary to extend considerably the observations of last year. Moreover, for the first time, the ova of the ling (*Molva vulgaris*) were examined, and the development followed to a fairly advanced stage. These were procured by a long-line fisherman of Cellardyke (who with others was supplied with suitable earthenware jars[1] and encouraged by a visit to the Laboratory), fertilised about 100 miles off the Island of May, and safely brought, after a considerable land journey, to St. Andrews. The fertilised ova of the plaice and lemon-dab were similarly brought by Capt. Burn, late of the Hussars, from the Moray Frith; for the Laboratory had then no boat suited for procuring a supply nearer home. No fish, however, has been more useful to the workers this season than the gurnard (*Trigla gurnardus*), the spawning period of which seems to have been somewhat later than usual. The first ova were procured about the middle of May, and the embryos of the last hatching (middle of August) still swarm in the vessels. Further observations were also made on the ova and young of the lumpsucker, Montagu's sucker, shanny, stickleback, sand-eel, *Cottus*, &c. Amongst others the ripe ovum of *Ammodytes tobianus* has been examined. It is colourless, translucent, and has a beautifully reticulated capsule. Mr. Prince is of opinion that, as suggested in the "Report of H.M. Trawling Commission," it most nearly resembles a pelagic egg. Moreover, the information necessary for filling up the gaps between the very early stages of the young food-fishes near the surface and their appearance off the shore as shoals of young forms more or less easily recognisable specifically has been considerably increased. Much of this knowledge has been obtained by the aid of a huge tow-net of coarse gauze—upwards of twenty feet in length—attached to a triangle of wood, ten feet each way, sunk by a heavy weight and kept steadily at the required depth in fathoms by a galvanised iron float, such as is used for the ends of herring-nets. Since the completion of the net, however, the services of the Fishery Board tender *Garland* have only once been available, and the yawl has been at our disposal only a few weeks. In these brief opportunities, however, the young of various fishes have been obtained at stages hitherto unknown, and some rare invertebrates and a new Medusa have been captured. Enough, in short, has been seen to indicate the value of this apparatus, and of certain modifications of the ordinary beam trawl for work on the bottom. The hatching and rearing of the embryos of the common food-fishes have been attended with much greater success than last year or the previous one, and a large series of microscopic preparations (chiefly sections with the Caldwell and rocking microtomes) has been made by Mr. E. E. Prince, embracing the entire development of the food-fishes from the early ovum to a late larval stage. The study of these preparations is now being proceeded with; but in traversing a field so extensive as the embryology of these important Teleosteans a great expenditure of time and labour is required. It is hoped, however, that the results will be completed during the winter (*vide* for other observations the *Annals of Natural History* for April, May, June, and August 1886; NATURE, June 1886, &c.). Since the beginning of June, Dr. Scharff has been occupied with the investigation of the intra-ovarian egg of a number of Teleostean fishes. Among the ovaries examined were those of *Trigla gurnardus*, *Gadus virens* and *G. luscus*, *Gadus merlangus*, *Anarrhichas lupus*, *Conger vulgaris*, *Blennius pholis*, *Lophius piscatorius*, and *Salmo salar* The researches were made on fresh ovaries and on spirit specimens. Most of those reserved for section-cutting were previously treated either with picro-sulphuric or weak chromic acid. Special attention was paid to the structural changes in the growing nucleus. The origin of the follicular layer surrounding the egg, as well as the origin and development of the yolk, will be dealt with in a paper to be published shortly. Considerable advancement has been made in the study of the development of the common mussel by Mr. John Wilson. Some of the very early larvæ are described in the report of last year, along with an account of the artificial methods employed. This year embryos were developed for forty days in vessels suitable for microscopic manipulation. Normal growth continued during the first fourteen days. At the end of this period the largest embryos had shell-valves ·128 mm. in length. They are transparent and almost semicircular, the dorsal (hinge-) line being nearly straight. The powerful velum could be wholly withdrawn within the valves. The alimentary system was conspicuously developed. In the beginning of June great numbers of young mussels were found swimming actively on the very surface of the sea close to the shore, and measuring ·134 mm. They differed from the most advanced of those artificially reared only in their being more robust, the stage reached being the same in both. At various periods somewhat later in the season many older, though still microscopic, mussels were captured with the tow-net in St. Andrews Bay from the shore seaward for 4 miles. Besides the careful study of their development, Mr. Wilson has also been engaged with the histology of the mussel (especially that of the generative organs) at various stages, up to the adult condition. The Committee beg to recommend a renewal of the grant (100*l.*) for the ensuing year.

[1] Containing about a gallon. These were partially filled with pure seawater containing the fertilised ova, and simply tied over with porous cheesecloth.

Report of the Committee, consisting of Prof. McKendrick, Prof. Struthers, Prof. Young, Prof. McIntosh, Prof. Alleyne Nicholson, Prof. Cossar Ewart, and Mr. John Murray (Secretary), appointed for the Purpose of Promoting the Establishment of a Marine Biological Station at Granton, Scotland.—The Committee report that the sum of 75*l.*, placed at their disposal, has been used to aid in defraying the expenses of carrying on the work of the Scottish Marine Station at Granton. Two reports on the work of the institution during the past year are given below; they have been sent in to the Secretary by Mr. J. T. Cunningham, the Superintendent, who has charge of the zoological investigations; and Dr. Hugh Robert Mill, who is responsible for the physical work:—

The biological work of the Station falls into three principal divisions: (1) Embryology and morphology; (2) faunology; (3) the accommodation of students and investigators. (1) Efforts to elucidate some facts bearing on the reproduction and development of Myxine formed the principal part of the work under this head during the autumn and winter. In the summer the aquarium had been arranged, and a large tank was specially devoted to the purpose of keeping specimens of the animal in confinement. After careful attention to the matter, it was found that the creatures refused entirely to feed while in captivity; they lived several months, but no signs of reproductive activity appeared, with one exception noted below. It was then determined to continue the examination of large numbers of specimens every month in the year in order to find if the ova were shed at any limited season. As almost nothing accurate was known on the whole subject, the first problem was to obtain ripe males and females. In November the testis in its immature condition was recognised, and it was subsequently found that with few exceptions all very immature specimens were hermaphrodite, containing immature testicular tissue at the posterior end of the generative organ. Microscopic examination of the largest ova obtained showed that the well-known polar threads belonged to the vitelline membrane, and were developed in tubular depressions of the follicular epithelium. In December, January, February, and March, females were obtained which had just discharged their ova, the collapsed capsules, still quite large, being present in the ovary. At the end of January two females were obtained in which the polar threads were so far developed as to form projections at the ends of the inclosing follicle. One specimen with eggs in this condition was taken from the aquarium. No perfectly ripe ova were ever obtained. In February moving spermatozoa were discovered in hermaphrodite specimens, but the total quantity of milt present was quite insignificant. The greater number of the specimens examined were obtained from fishermen's lines baited for haddock; some were taken by baited traps. In March dredging was carried on off St. Abb's Head, with a view to obtain deposited fertilised eggs of Myxine, but none were found. It has thus been shown that Myxine deposits its eggs in the months of December to March, and that the females are taken on the hook immediately after the eggs have been shed. But no method has been discovered of obtaining adults in the ripe condition, or of obtaining the fertilised ova and embryos. The research and its results are described in a paper in the *Proceedings* of the Royal Society of Edin-

burgh, and more fully in a paper which will appear in the next number of the *Quarterly Journal of Microscopical Science*. At the beginning of the present year the systematic examination of the ova of all species of fish which could be obtained was commenced. The pelagic ova of the cod, haddock, whiting, and gurnard had been examined in the previous spring, and those of a large number of additional species have now been figured and described at successive stages of development. The results of this work are now being published in full by the Royal Society of Edinburgh, and will appear as a memoir in the Society's *Transactions*. (2) The faunological investigations have been carried on as time permitted since the opening of the Station, and have, since June last, been receiving particular attention. A Report on the Chælopoda, in the preparation of which Mr. G. A. Ramage is giving his assistance, will appear in the coming autumn; a Report on the Sponges is being prepared by Mr. J. Arthur Thomson; and miscellaneous notes on other classes will be incorporated with these special Reports. (3) The following is a list of those who have carried on studies at the Station:—

	Name	Began	Left	Subjects
1885.	Dr. Kelso, Edinburgh ...	Aug.	Sept. 26	Teleostean ova
	And. D. Sloan, Edinburgh	Aug. 8	April 1886	Cœlenterates
	A. H. W. Macdonald, Edinburgh	Oct. 5	Nov. 1885	General
	G. L. Gulland, Edinburgh	Oct. 6	Nov. 1885	Crustacea
1886.	G. A. Ramage, Edinburgh	Ju e 3	—	Chælopoda, &c.
	M. M. Kay, Edinburgh ...	July 24	—	General
	Miss Macomish, London ...	Aug. 2	—	Mollusca
	J. Arthur Thomson, Edinburgh	Aug. 9	—	Sponges, &c.

The yacht is kept up in the same condition as at the opening of the Station, and the number of men is unaltered. The ark at Millport is again in use this summer, and is in the charge of Mr. David Robertson. Mr. Cunningham worked there for one week in June, having found at Millport a particularly favourable opportunity for the study of Teleostean ova. Many other naturalists have taken part in the *Medusa's* dredgings in the Clyde district during the present summer. The services of Alex. Turbyne, the keeper of the Station, in making excursions in trawlers to procure fish ova, have been most valuable. All those interested in the Station are greatly indebted to Mr. Robert Irvine, of Royston, for the friendly assistance which he has always been ready to afford on every occasion. Preserved specimens of marine animals and plants are still sent out to applicants, and some attention is being paid to the question of oyster-cultivation in the Firth of Forth.

J. T. CUNNINGHAM, B.A., F.R.S.E.

Physical marine research has, from the commencement, formed one of the distinctive features of the Scottish Marine Station. During last year work has been carried on in this direction by Dr. H. R. Mill and Mr. J. T. Morrison; other gentlemen have occasionally made use of the facilities of the Station. Regular meteorological observations are continued twice daily, and include the temperature at surface and bottom of the water. An elaborate set of experiments with Mr. John Aitken's new forms of thermometer-screen were completed last year by Mr. H. N. Dickson, who has discussed the results in connection with those obtained by him with the same apparatus on Ben Nevis. Experiments with various anemometers are still in progress. Atmospheric dust is being collected on several islands in the Firth of Forth, by means of large funnels and carboys, which are periodically emptied and the contents forwarded to Mr. Murray for examination. Monthly trips along the Firth of Forth for the observation of temperature and salinity have taken place regularly from river to sea; preliminary results have been communicated to the Royal Society of Edinburgh from time to time, and a complete discussion of salinity is nearly ready for publication. It shows remarkable relationships between salinity and configuration, which have suggested new definitions of the words *river*, *estuary*, and *firth*. Special attention has been devoted to the relation of salinity and temperature to tide in the estuary of the Forth. Besides the observations of the scientific staff of the Station, thermometer readings are taken by volunteer observers at different parts of the Forth river-system and in the adjacent parts of the North Sea. The *Medusa* has made regular trips on the Clyde since April last at intervals of two months. Temperature and salinity observations are made in all parts of the estuary and firth from Dumbarton to the North Channel, and in all the connected lochs. These trips have yielded results of great interest and novelty. They are communicated in several papers to various Sections of the present meeting. The temperature of two deep fresh-water lakes—Loch Lomond and Loch Katrine—has been observed at all depths once a month since November 1885, in continuation of Mr. J. Y. Buchanan's work. Daily temperature observations have been established on a number of rivers and at several points on some. The Station has charge of observations on the Thurso, in the north of Scotland, the Forth and Teith, and the Tweed; and it has also been the means of inducing independent observers to undertake similar work on the Tummel (a tributary of the Tay), the Tay, and the Derwent, in Cumberland. These are all salmon rivers, and the observers being interested in fishing have already succeeded in showing some connection between temperature and the movements of salmon. In consequence of experience gained in physical marine investigations the apparatus used for the purpose has been progressively modified and improved—the Scottish thermometer-frame and water-bottle may be pointed to as special instances. The Station has, since September 1885, been able to advise and assist several public bodies in starting observations of temperature and salinity, the National Fish Culture Association of England, the Dundee Harbour Trust, and the Fishery Board for Scotland being amongst the number. Thermometers have been lent to several naturalists for use on short scientific voyages. The collection of all existing records of sea and river temperature round the coast of Scotland is proceeding, and promises, when completed, to be of great value in showing the different sea-climates of the east and west coasts—a question of much importance in relation to the distribution of marine species.

HUGH ROBERT MILL, D.Sc., F.R.S.E.

Report upon the Depth of Permanently Frozen Soil in the Polar Regions, its Geographical Limits and Relations to the Present Poles of Greatest Cold, by a Committee consisting of Lieut.-General J. T. Walker, C.B., F.R.S., General Sir J. H. Lefroy (Reporter), Prof. Sir W. Thomson, Mr. Alex. Buchan, Mr. J. Y. Buchanan, Mr. John Murray, Dr. J. Rae, Mr. H. W. Bates (Secretary), Capt. W. J. Dawson, R.A., Dr. A. Selwyn, and Prof. C. Carpmael.—The inquiry referred to the Committee necessitated reference to residents in many distant regions, and time must elapse before any large harvest of observations can be hoped for; nevertheless, the Committee are in a position to quote several valuable communications, especially one from Mr. Andrew Flett, adding materially to what was previously known on the subject of the extension of permanently frozen soil, or ground ice, in America. It will be convenient to arrange the data now available, in their order of latitude.

1. Lat. 71° 18′ N., long. 156° 24′ W.—At the wintering station of the United States Expedition of 1881-82, under Lieut. P. H. Ray, United States America, that officer found the temperature of the soil 12° F. at 28 feet from the surface, and the same at 38 feet.

2. Lat. 68° N., long. 135° W.—At Fort Macpherson, on Peel River, Mr. Andrew Flett, who passed twelve years there, reports:—"The greatest depth of thawed-out earth I came across round that post was 3½ feet, October 10, 1865. The greatest depth of frozen ground was 52 feet 3 inches, September 27, 1867, near the mouth of Peel River. The bank had fallen in; at the bottom the perpendicular cliff, which I tried with a boat pole, was frozen as hard as a rock. A black sandy soil. The surface was not above two feet thawed-out. The cliff was measured with the tracking line." This account leaves it doubtful whether the frost may not have entered the soil from the face of the cliff. On the other hand it is evident that it extended to a greater depth from the surface than was measured.

3. Lat. 67° N., long. 142° W., on the Youcon.—The same gentleman writes:—"I spent twelve years on the Pelly or Youcon River, on the west side of the Rocky Mountains. Round old Fort Youcon ground ice is found at 6 feet; this I have seen in the river banks in September where they had caved in; but no particular notice has been taken as far as I know by any one, unless it be Chief Factor Robert Campbell, now residing in Merchiston, Strathclair, P.O., Manitoba."

4. Lat. 65° N., long. 120° W., on the Mackenzie River, about ten miles above the mouth of Bear River.—The same gentleman writes:—"I have seen many landslips on the Mackenzie, which

more frequently takes place in rainy weather—July, August, and sometimes September: but I never examined them particularly excepting one, which we came near being buried by in camp. This was about August 15, 1876. By a pole, I found the bottom of the slide frozen hard, a grey clay and gravel mixed, *from where the earth broke off was not over 6 feet.* The surface soil sandy. Some way back from the river bank the country is muskeg more or less, and by removing the moss by hand we came to hard frozen ground in August." The sentence printed in *italic* is somewhat ambiguous. It is understood to mean that the bank was not much more than 6 feet high, and was hard frozen at that depth; the depth to which the frost extended is therefore unknown.

5. Lat. 64° 20′ N., long. 124° 15′ W., on Mackenzie River.—The face of a cliff from which a recent land-slide had occurred, was measured by the present reporter in June 1844. The soil was frozen to a depth of 45 feet from the surface. (*See* "Magnetic Survey," p. 161.)

6. Lat. 62° 39′ N., long. 115° 44′ W., at Fort Rae, on Great Slave Lake.—Capt. Dawson, R.A., observed the temperature of the soil monthly at his station of circumpolar observation, 1882-83. The following table contains his results in degrees Fahr.:—

Months	1 Foot	2 Feet	3 Feet	4 Feet
1882	°	°	°	°
September ...	40·6	37·9	36·1	34·5
October ...	32·5	32·7	32·5	32·3
November ...	23·9	29·1	30·9	31·3
December ...	15·8	24·6	28·8	30·8
1883				
January ...	8·3	19·9	25·7	28·5
February ...	11·1	21·2	24·5	26·3
March	9·5	20·8	22·7	24·8
April	18·9	25·2	24·3	25·3
May	34·0	32·0	33·8	30·5
June	43·5	36·5	32·4	31·5
July	48·0	41·0	37·0	34·5
August	47·3	41·9	38·5	36·5

The mean temperature of the air at 5 feet 10 inches above the surface, in the same months, was as follows:—

1882	°	1883	°
September	44·40	February	−10·41
October	32·59	March	− 7·71
November	9·30	April	19·30
December	−15·20	May	36·30
1883		June	51·49
January	−26·80	July	61·11
		August	56·50

We learn from this table that the soil is frozen at a depth of 4 feet from November to June inclusive, and is at the lowest temperature at that depth in March. It further shows that, like the waters of the Scottish lakes, as proved by the observations of Mr. J. Y. Buchanan and Mr. J. F. Morrison in Loch Lomond and Loch Katrine last winter, the mean temperature of the soil reaches its minimum about the time of the vernal equinox. The rise of earth-temperature in February above that recorded in either January or March is remarkable. It does not appear, from the convergence of the lines when projected, that temperatures below 32° F. extend lower than 11 or 12 feet. Capt. Dawson writes:—"There are two reasons why these earth-temperatures are above what is probably the average in that latitude. (1) The ground had a slope of 1/16 to the south-west; and (2) it was fully exposed to the rays of the sun; now, in most places, the ground is either covered with thick moss or shaded by brushwood, and its surface-temperature on the hottest day is not likely to exceed 70° F., whereas earth exposed to the rays of the sun may easily reach a temperature of 120° F." Fort Rae is situated on a long arm or inlet of Great Slave, having a depth of 10 or 12 feet of water.

7. Lat. 62°, long. 129° 40′, Jakutsk, Siberia.—The great depth of permanently frozen soil in this part of the valley of the Lena has long been well known; but the following extract, translated from a recent paper by Dr. Alex. Woeikof, of St. Petersburg, entitled "Klima von Ost-Siberien," contains information on the influence of local conditions which will make it of value to observers, and we therefore reproduce it.

"The further north," he remarks, "the longer is the duration of cold in valleys in comparison with that on higher ground. The effect extends to a part of autumn and spring, and is observable in the mean temperature of the year."

The following observations of earth-temperatures are a proof:—

	At Depth				Limit of
	20 ft.	50 ft.	300 ft.	381 ft.	Frozen Soil
Jakutsk[1] . . .	13°·6	17°·1	25°·0	26°·6 Fahr.	620 feet.
Mangan mine .	22°·1	25°·2	...	...	269 ,,
Schelou mine .	22°·1	25°·7	...	...	298 ,,

Thus, on heights in the vicinity of Jakutsk (these are heights on the left bank of the Lena, near Jakutsk) the earth temperature is from 8°·1 to 8° 6 F. higher than it is in the town and valley at the same depth, and it is even lower at 300 feet in the former than at 50 feet in the latter locality. The total depth of frozen soil is, according to Mittendorf ("Sibirische Reise," Bd. i.) more than twice as great in the valley as it is on the heights: and observe that these lesser heights are in winter relatively colder than higher isolated mountains. Mittendorf also states that no frozen soil was found at 60 metres above the level of the river at the mouth of the Maja, in Aldan, but that it was found four miles and a quarter up the stream at three metres above the level of the river, and that about 28 miles further, in the mountains, there is a deep hollow from which aqueous vapour is constantly rising.

Kuppfer asserts that in Bergrivier Nertschinsk, in the Trech Swjatitilei mine, frozen soil was found at a depth of 174 feet, but that in Wossdwischenst mine, which lies 230 feet higher, the frozen soil ceased at 50 feet. Even in Altai it is acknowledged that many valleys are colder than the neighbouring heights.

Dr. Woeikof sums up a number of observations in the following sentences, which apply to the greater part of East Siberia, but more particularly to the north-east portion.

(1) As the greater cold coincides with calms and light winds, the valleys and lower grounds are colder than the heights.

(2) The temperature of isolated mountains is relatively higher than that of lesser elevations.

(3) The lowering of temperature in the valleys is so lasting and considerable that the mean of the year is also lowered, as is proved by the observations of earth-temperature.

(4) The depth of the frozen soil is greater in valleys than on the neighbouring heights, probably also than it is on the higher mountains.

(5) In the tundras of the far north (answering to the barren grounds and muskegs of the North-West Territory of Canada), the winter is warmer than in the valleys of the forest-zone. Probably because the stronger currents of the air do not permit the cold stratum to remain so long stagnant.

8. Lat. 61° 51′, long. 125° 25′, Fort Simpson, on Mackenzie River.—The summer's heat was found in October 1837 to have thawed the soil to a depth of 11 feet, below which was 6 feet of ground ice (Richardson), making the depth of descent of the frost 17 feet. The result is anomalous; at other posts in the same region the summer thaw is much more superficial. Thus, it will be observed above, that in the month of October, at Fort Rae, the soil was at a nearly uniform temperature, but slightly above the freezing-point, from the depth of 1 foot to 4 feet. Franklin found a summer thaw of only 22 inches at Great Bear Lake, and the writer was informed that it was only 14 inches at Fort Norman (lat. 64° 41′). Fort Simpson is situated on an island of deep alluvial soil, bearing timber of large size, and possessing an exceptional climate.

9. Lat. 57°, long. 92° 26′, York Factory, Hudson's Bay.—Sir J. Richardson has stated that the soil was found frozen to a depth of 19 feet 10 inches in October 1835, the surface being thawed to a depth of 2 feet 4 inches.

10. Lat. 55° 57′, long. 107° 24′, Lake à la Crosse.—It is stated that no frozen soil was found in sinking a pit to a depth of 25 feet in 1837, and that the earth was only frozen to a depth of 3 feet in the winter of 1841. Both records are anomalous, and call for verification.

11. Lat. 53° 40′, long. 113° 35′, at Prince Albert, on the Saskatchawan.—Mr. W. E. Traill, who was in charge of this post in 1872, reports that a settler in the neighbourhood came to frozen ground at a depth of 17 feet, but did not learn whether they passed through the frozen strata, or, if such was the case,

[1] M. Schergin's shaft.

what was the thickness of it. The same gentleman, writing from Lesser Slave Lake (lat. 55° 33′), remarks that he has never come across any indication of perpetual ice during the twenty-two years he has passed in the North-West Territory.

12. Mr. Andrew Flett, writing from Prince Albert, April 21, 1886, says:—"Hundreds of wells have been sunk in this settlement; one I had sunk myself, beginning of July 1881, 27 feet deep—saw no frozen earth. As far as I have noticed on this prairie land, when there is a good fall of snow when the winter sets in, the frost does not penetrate so deep as when there is no snow till late, and in some years very light snow. I had a pit opened on the 9th inst. (April); the surface was thawed 3 inches; we got through the frozen earth at 4 feet 7 inches. On the 11th inst. I saw a grave dug in the churchyard at Emmanuel College, one mile from my place, 5 feet deep, and had not got through the frost. My place is on higher ground, loam soil."

13. Mr. W. Ramsay, settled on the South Saskatchawan, thirty-five miles from here, sunk a well 40 feet, May 27, 1884—no frost.

14. Mr. Jos. Finlayson, three miles from here, sunk a well beginning of July 1882, 46 feet. He saw no frost.

15. Mr. J. D. Mackay, on the same section as the above, sunk a well 27 feet, July 15, 1884, found particles of frozen earth at 7 feet deep.

16. Mr. W. C. Mackay, my next neighbour half a mile west of this, sunk a well about June 20, 1884, found particles of frozen earth at 5½ feet.

17. Lat. 53° 32′, long. 113° 30′, Fort Edmonton, on the Saskatchawan, 2400 feet above the sea.—Dr. James Hector, on March 5, 1858, found the soil frozen to a depth of 7 feet 6 inches (*Journal R. G. S.* vol. xxx. p. 277).

18. Lat. 51° 14′, long. 102° 24′.—At Yorkton, Mr. J Riaman, when digging a well last summer (1885), found the frost at a depth of 19 and 20 feet, and continuing for a depth of 30 inches. In this case, therefore, the total depth to which frost descended was about 22 feet. Mr. J. Tarbotton, of Yorkton, in communicating the last observation, remarks:—"The depth to which frost penetrates during the winter, varies, I find, with the character of the winter itself and with the nature of the locality. I made observations in an open unprotected spot, where there was little or no snow, and found frost to the depth of 5 feet 9 inches. This occurred last July, and the frost was then about 2 feet deep (*i.e.* had descended to 7 feet 9 inches). But in the bluffs near my house, I dug a cellar, at the same time, going down between 8 and 9 feet, encountering no frost at all.

"This year, however, when digging another well in April, in almost the same place, I encountered frost at 2 feet, and the ground continued solid until I had gone down from 4½ to 5 feet from the surface. From this, and from the information I obtained from others, I am safe in saying that the frost penetrates here on an average 5 feet, except when we have had a great depth of snow in the beginning of winter, in which case it does not penetrate nearly so far. The bluffs referred to are groves of poplar from 3 to 6 inches in diameter, on the edge of an open plain."

Prof. Charles Carpmael, Director of the Meteorological Service of Canada, to whom most of the above reports were addressed, remarks:—"We can easily imagine that at a depth of 17 feet at Prince Albert, there might be no frost at all in winter, but owing to the slow travelling downward of the wave of cold, it might have reached a depth of 17 feet in the early summer.

"It is easily seen that the annual mean temperature of the air might be considerably below the freezing-point without the occurrence of permanently frozen soil, for in winter the soil is often covered deep in snow, so that the temperature of the soil might be but little below 32°, although the temperature of the air were 30° or 40° F. below zero. Again, the heat which had entered the soil in summer would only be removed by slow conduction, whereas the summer heat would not only travel downwards by conduction, but be carried into the soil by percolation of the warm water through the surface."

19. Lat. 50° 30′, long. 103° 30′, the Bell farm, near Indian Head.—Frozen soil is said to have been met with in the summer of 1884 at a depth of 12½ feet; details are wanting.

20. Lat. 49° 53′, long. 97° 15′, city of Winnipeg and the neighbourhood.—Mr. Ch. N. Bell reports that frozen soil has been found as under in various cemeteries.

Brookside Cemetery on the open prairie close to the city, soil rich black loam, varying in depth from 1 to 2 feet, subsoil heavy grey clay.

	On the Higher Ground Ft.	In.	On the Lower Ground Ft.	In.
December 23, 1884 ... Frozen to	0	10	2	2
January 3, 1885	1	0	3	0
March 21, ,, ...	1	4	3	6
May 6, ,, ...	4	4	5	0
June 25, ,, ... None down to	6	0	6	0
January 14, 1886	0	10	1	6

A further communication of June 1, 1886, states that the frost only descended 3 feet 6 inches on the higher ground in the winter of 1885-86, and had at that date disappeared. It descended 5 feet in the lower ground, but had almost disappeared.

At. St. John's Cemetery in the city, "I am advised by the clergyman," says Mr. Bell, "that frost has been found at from 5 to 8 feet depth"; careful investigation will be made there this year.

St. Boniface, a suburb of Winnipeg to the east.—The frost penetrates from 5 to 8 feet, according to the season, varying locally under the conditions of the exposure, tillage, dryness, and heat or frost cracks. During the summer of 1885 frost was found at a depth of 5 feet, and down to 7 feet, when the work was stopped. This was in July or early in August. The locality was probably exposed to the action of the sun.

21. Lat. 49° to 49½°, long., in the valley of the River Pembina to the extreme south of the North-West Territory.—Dr. Alfred Selwyn, Director of the Geological Survey of Canada, who has two sons settled in this region, states that those gentlemen have had several wells sunk, the deepest about 40 feet, and have never seen any permanently frozen ground. There is similar negative evidence from Brandon, a little further north.

It would be premature to draw any general conclusions from the observations thus far collected. There is want of proof of the existence of permanent ground ice beyond the district of Mackenzie River in the North-West, but frozen soil has been shown to exist at a depth of 17 feet at Fort Simpson, at Prince Albert, and at Yorkton, and it may be questioned whether the wave of summer heat has time to descend to such a depth before it is overtaken by the refrigerating influence of the early winter. It certainly exists also in the neighbourhood of Hudson's Bay, on the eastern side, and it is evident that under favourable conditions frost, without being permanent, may in some cases last in the soil all the year round over a wide area, and in other years disappear.

At whatever level we locate the maximum of absorbed heat, it must be remembered that when the winter sets in, and freezes the surface, which it does rapidly to the depth of a foot or two, the heat will then be abstracted in both directions, and its rate of descent checked.

Report of the Committee, consisting of Sir Joseph D. Hooker, Sir George Nares, Mr. John Murray, General J. T. Walker, Admiral Sir Leopold McClintock, Dr. W. B. Carpenter, Mr. Clements Markham, and Admiral Sir Erasmus Ommanney (Secretary), appointed for the Purpose of Drawing Attention to the Desirability of Further Research in the Antarctic Regions.—Your Committee, after having given full consideration to the great importance of effecting a further exploration of the Antarctic Polar Sea, desire, in the first place, to express their opinion that it would be most essential, before approaching Her Majesty's Government with the view of urging the expediency of equipping such a naval expedition as would be required for the carrying out an exploration of such magnitude, interest, and importance, that the requirements for its success and a plan of operations should be most carefully considered, and the results embodied in a written form for the approval of the Council of the Association and for the information of the Government. Furthermore, in order to obtain the co-operation which the matter requires from eminent men in science, your Committee feel it necessary for their body being enlarged by the addition of influential members of the Association, and of other bodies representing the various branches of science interested in the investigation of this comparatively unknown region, and especially of the Royal Geographical Society. Your Committee have to point out that our knowledge of the South Polar region is chiefly confined to the grand discoveries effected by that celebrated expedition under the command of Capt. Sir James C. Ross, conducted between the years 1839 and 1843 with sailing-ships. Since that period the facilities for effecting a more complete research have been greatly augmented by the application of steam propulsion to vessels better adapted for ice-navigation.

This has been proved by continuous experience in the Arctic seas during the late half-century. For the above reasons your Committee deem it desirable to defer making their report, with a view to giving more definition to the objects sought to be obtained and to the best means of obtaining them, as also to expand this Committee, in order to elicit to the fullest extent the opinions and to secure support from those conversant with the various branches of science which are to be investigated during an exploration which, from its very important and serious nature, eminently merits the favourable consideration of this great and enterprising maritime nation.

NOTES

THE 59th annual meeting of the Association of German Naturalists and Physicians will take place at Berlin from the 18th to the 24th inst. General meetings will be held on the 18th, 22nd, and 24th, the sections, of which there are thirty, meeting at other times when and where they wish in the various places offered them for that purpose. At the same time there will be an exhibition of scientific apparatus, instruments, and educational objects. On the morning of each day a journal will be issued containing information of interest to members, and as much as possible of the proceedings at the various meetings of the preceding day. The Physical Section is under the Presidency of Dr. von Helmholtz and Dr. Kirchhoff. Amongst the papers to be read are the following:—The microscope as an aid to physical investigation, by Dr. Lehmann; the determination of the electro-chemical equivalents of silver, by Dr. Köpsel; electrical discharges, by Dr. Goldstein; on Palmieri's investigations into the development of electricity in the condensation of steam, by Dr. Kalischer. The Presidents of the Chemical Section are Drs. Hoffmann and Landolt. In this Section there will be papers on silver oxydul, by Herr von der Pforten; a new synthesis of naphthaline derivatives, by Dr. Erdmann; and on a peculiar phenomenon of reaction, by Herr Liebreich. In the Botanical Section there will be papers on Goethe's influence on botany, and on the reception of water by the external organs of plants. In the Zoological Section papers will be read on dual eyes in insects, on the origin of the frontal ganglion in Hydrophilus, on freshwater Bryozoa, the Protozoa of Kiel Bay, on the boundaries of zoo-geographical regions from the point of view of ornithology, the fauna of North German lakes, and on the old Peruvian domestic dog. In the Section for Geography and Ethnology there will be several papers on Africa, especially on the Congo region; one on the Kurds, others on South Polar exploration, on the Goajira Indians, and on the importance of the Xingu for the ethnology of the northern part of South America. A great majority of the sections are occupied with medical subjects. One of these will be devoted to the discussion of the condition of Europeans in different climates, their diseases, acclimatisation, &c. The last section of all is devoted to scientific education.

SIR HENRY ROSCOE has given notice that in the next session of Parliament he will call attention to the Report of the Departmental Committee on the National Science Collections, and will move a resolution.

IN reply to a question by Sir John Lubbock in the House of Commons on the 9th inst., the Chancellor of the Exchequer stated that the appointment of a Minister of Education, as recommended by the Committee of 1884, had not yet come under the notice of the Government, nor could he hold out any hope that it would be likely to come very soon under its notice. Lord Randolph Churchill said he suspected the proposal would involve an increased charge upon the public revenues, "and every alteration, reform, or modification of a department which would involve an increased charge possesses in my eyes an incurable defect."

EARTHQUAKES have continued at Charleston during the past week, but the shocks are decreasing greatly in frequency and violence. One occurred on Saturday night and one on Sunday, but no harm was done by either. The Mexican Government has been officially informed that Tequisixtlan was shaken by an earthquake at 4.30 on the morning of September 3. The movement was from east to west. A Naples correspondent of the *Times* writes that the shock of the 28th ult. was severer than any which has been felt for some years. The panic was therefore great, and was increased by superstition. There were two shocks—one was horizontal, the other vertical, but they followed each other in such rapid succession that they appeared to be one shock, and for many hours after the replica was expected with much apprehension. The shocks occurred about 11 p.m., and were felt severely at every place in the Bay of Naples, and in the Island of Capri, which has no volcanic element in its formation. Similar reports were received from Puglia, Calabria, and Sicily, where the shock was very severe. At Forio, in the Island of Ischia, it was felt, and created a panic. Vesuvius has long been in a state of comparative repose. Prof. Palmieri says that at 4 p.m. on the 28th it showed signs of renewed activity by frequent thunders, and by throwing masses of lava into the air.

MR. POND, the Government Analyst of New Zealand, has proved by actual experiment that the dust thrown out during the recent volcanic eruptions is of a highly fertilising kind. He obtained samples of the dust from three different places, and sowed a quantity of clover and grass seeds in each. The soil was kept moistened with distilled water, so that no manurial elements might be imparted by the water used. In all cases the growth was almost as vigorous as in rich volcanic soil. The rapid growth of the plants and their colour show that the dust is a benefit to the soil on which it has fallen.

THE programme for the autumn meeting of the Iron and Steel Institute, which is to be held in London on October 6, 7, and 8 next, has just been issued. The Council of the Institute has arranged to hold the meeting in London this year, for the second time in the history of the Society, with a view to affording Members the opportunity of studying the mineral resources, &c., of the colonies, as illustrated by what is shown at the Exhibition, and of coming into contact with colonists and Indians who are interested in mineralogical operations. That being so, perhaps the most interesting paper in the list is one on the iron-making resources of our colonies, prepared by Mr. Gilchrist (whose name is associated with the well-known basic process) and Mr. Edward Riley. Among other papers to be read there is one on the chemical composition and mechanical properties of chrome steel, by M. Brustlein; another on combustion with special reference to its application in the arts, by Mr. F. Siemens; another on the treatment of high-class tool steel, by Mr. A. Jacobs, of Sheffield; and one on modifications of Bessemer converters for several charges, by Mr. John Hardisty, of Derby.

THE Paris Academy of Sciences has issued in separate form the text of the discourses pronounced at the Museum of Natural History on the occasion of M. Chevreul's centenary, August 31, 1886. The speakers were M. Fremy, Director of the Museum; M. Jules Zeller, President of the Institute; M. Janssen, on behalf of the Academy of Sciences; M Broch, Corresponding Member of the Institute; Colonel Le Mat, in the name of the Washington National Institute; M. Ressmann, Italian Plenipotentiary; M. Gilbert Govi, President of the Neapolitan Academy of Sciences; M. de Bouteiller, on behalf of the Paris Municipal Council and the General Council of the Seine; M. Chaumeton, President of the Association of French students; MM. Nadault de Buffon, Dehérain, Leroy, Auguste Vitu, Gerspach, and Réné Goblet. The brochure is printed in uniform size and type, with the weekly *Comptes rendus* of the Academy.

THE Paris newspapers have published a congratulatory communication from the Academy of Sciences in Berlin to M. Chevreul, from which the following is an extract:—"He who would form a complete idea of your so busily occupied life should follow the entire course of your creative activity, which has been directed to all departments of chemistry. He must follow all the innumerable detailed researches which have enabled you to determine the nature of various minerals and of a large number of salts, as well as the composition of many organic matters. He should study your chemico-physiological works, by which you have made such great advances towards the knowledge of the most important secrets of the animal organism as well as your labours on the most varied questions of public hygiene. He ought to follow the excursions which enabled you to fix the laws of the contrasts among colours, and to class them systematically and scientifically. He ought to study your lectures on the chemical principles of dyeing. He should finally imagine himself at the period when misty ideas of the most false and fantastic kind threatened to surround and obscure the mind, and when, with the record of history in your hands, you dissipated the mists by making your countrymen recognise in the delusions of the past the errors of the present time. Having thus represented in all its extent the activity that you have shown throughout your long life, we hold that your name should be inscribed in one of the first places on the list of the great men who have carried the scientific glory of France to the extremities of the earth."

IN a long communication to the *Times* of September 7 from its Correspondent with the Grenada Eclipse Expedition, it is stated that a botanical garden is in course of formation under Mr. Elliott, with a view to the development of the resources of the island. Mr. Elliott, the article goes on to state, "has made frequent excursions into the high woods for the latter purpose, and the results of his botanical exploration of the island, which will soon be made known, are very satisfactory, many valuable woods having been found. It is hoped by means of the botanic garden to encourage the planters of the Windward Islands to cultivate the minor products of this fertile region, and especially to improve their fruits by exhibiting the finest kinds in the gardens brought from other regions and giving information showing how it can be done. No more healthy sign of the progress of the colony could be afforded than in the enterprise of the Colonial Government in establishing such a garden and the interest taken in it by the planters of the island. So much for applied botany. During the stay of the Expedition pure botany has been studied with much success by Mr. George Murray, of the British Museum, the naturalist attached to the Expedition, who arrived a fortnight before the observers of the eclipse to gain the necessary time for finding good working grounds. His special mission is an inquiry into the life-history of certain marine *Algæ* called the *Siphoneæ*. The forms of this group are well enough known to European botanists, but the development and life-phenomena of most of the genera composing it have not yet been investigated. He has been greatly gratified to find an abundant supply of material for his special research, though the island is poor in *Algæ* owing to the small rise and fall of the tide, which exceeds a foot only at spring tides. The operation of examining this material is conducted in a well lighted and very convenient room set apart for the purpose by His Excellency the Governor, who has in this instance, too, shown the greatest sympathy with the object of the work, and an unfailing helpfulness towards its accomplishment. So far as the examination of the material collected has gone, it promises to yield an answer to the question of the nature of the reproduction and development of the types investigated, but whether the information will result in fixing definitely the position of the *Siphoneæ* as a group or in the breaking up of the group and the incorporation of certain genera into other orders, already better known, cannot, of course, yet be determined. The land and marine fauna are also engaging Mr. Murray's attention to the extent of collecting these, and the reptiles and small mammals have in this department of work been kept particularly in view."

MR. JOHN TAYLOR, a pupil of Dr. Marshall Ward, who went out some time ago as botanist to the Bahamas Government, is evidently pursuing his work under difficulties. While he and his companions were on shore at Acklin Island, 30 miles from Long Cay, on August 13, the cook, a Haytian, who was left in sole charge of the vessel, made off with it under cover of darkness, and up to the 19th no trace of ship or cook was found. Mr. Gardiner had on board nearly all his scientific books, and all the instruments, &c., necessary for a month's good work. He lost everything of that kind he had, including his Zeiss microscope; besides all his manuscript scientific diary, and list of the Bahamas flora, not to mention a sum of money, bedding, &c. His total loss he estimates at 75*l.*; we are sure the Bahamas Government will not allow Mr. Gardiner to sustain a loss which to him must be serious.

THE translation of an English botanical book into German is so much a reversal of the present fashion that it is of some interest to know that a translation of Dr. Maxwell Masters' "Vegetable Teratology" has been made by Mr. Udo Dammer, and published by Haessel of Leipzig. Many additional notes have been added by various German and Italian botanists, as well as by Dr. Masters, and some additional woodcuts provided.

THE celebrated waterfall of Teverone, which Horace calls "*præceps Anio*," has been employed to put in operation two dynamos of 100 horse-power for the illumination of the city of Tivoli. Others are being fitted up. The motive power, which is to be utilised by a company from the designs of M. Cantoni, is equivalent to several thousand horses. The illumination of Rome is contemplated, as well as the distribution of force to a distance from the station. The excavations and canals are conducted under the house of Mæcenas, which is described as situated at *udum Tibur*, now Tivoli.

TWO more of the Paris theatres are now illuminated by incandescent light—the Palais Royal by Edison, and the Variétés by Woodhouse. With the Opera and the Eden Theatre this brings the number up to four. Every evening the Industrial Exhibition at the Palais des Champs Elysées is lighted also by electricity.

WE have received a copy of a paper read by Mr. H. C. Russell before the Royal Society of New South Wales, on "Local Variations and Vibrations of the Earth's Surface," in which he records his own experiences on this subject in the hope that other astronomers will do the same, and thus by united action assist in the work of tracing these vibrations and changes. Mr. Russell's observations took place at Lake George, and were made chiefly by means of an automatic recorder of the height of the water in the lake. Although the instrument used has not the extreme sensitiveness to minute vibrations which Mr. Darwin's reflecting mirror and similar instruments have, yet it was so placed that all such changes became magnified by the relatively enormous extent over which it extends its sensitive part, if this expression may be used; for any change in gravity, or the direction of the vertical, is not seen as it affects the base of a small instrument a few feet square, but as it affects a surface 20 miles long and 5 to 6 miles wide. Barometric and wind changes, too, so difficult to see in other instruments, at once became evident here by their effects on such a large body of water, and the lake-gauge for these reasons is not only capable of showing changes quite as minute as the Cambridge pendulum apparatus, but also of keeping a perfectly satisfactory record of

these changes, so written that many, if not all, the causes can be traced in the curves which they produce. Various tables and diagrams are appended to the paper.

COLONEL GILDER has started from Winnipeg on his expedition to the Arctic regions, with the object of reaching the North Pole.

THE deaths are announced of M. Paul Soleillet, the explorer of Shoa in North-East Africa, and of Herr Robert Flegel, the explorer of the Niger and Binué.

THE celebrated traveller and botanist, Dr. Schweinfurth, lectured recently at Berlin on the Kew Botanical Gardens, which he characterised as the finest in the world. Kew, he said, is the Botanical Foreign Office for all nations, for it is the centre of all botanical news from all parts of the world.

WE have received "An Account of the Progress of Astronomy in the Year 1885," compiled for the Smithsonian Institution by Prof. W. C. Winlock. The investigations reviewed comprise (among others) Prof. Pritchard's photometric researches as consigned in the Oxford "Uranometria," M. Dunér's catalogue of stellar spectra of the third type, Drs. Gill and Elkin's determination of southern star-parallaxes, Prof. Bakhuysen's of the rotation-period of Mars, Prof. de Ball's of the nutation constant, Prof. Peters' of the orbit of 61 Cygni, and Prof. Langley's inquiries into the temperature of the moon's surface. M. Faye's theory of the origin of the solar system, with Prof. G. H. Darwin's criticisms upon it in NATURE, are prominently dealt with. We hear with pleasure of the progress towards completion of Prof. Rowland's photographic map of the normal solar spectrum. The amount of detail contained in it may be judged of from the one fact that 120 lines are visible between H and K, the original negatives showing 150. The most striking astronomical events of the year, *i.e.* the outburst of new stars in Andromeda and Orion, the photographic discovery of a nebula in the Pleiades, and the meteoric shower of November 27, are chronicled in due and interesting detail. Seven comets were observed in 1885, of which five were seen for the first time, the others being expected returns of Encke's and Tuttle's. Nine minor planets were discovered. The Report concludes with a useful bibliography of astronomical works published in 1885.

IN March, 1884, Prof. Holden offered to observe at the Washburn Observatory the 303 fundamental stars for the southern zones of the "Astronomische Gesellschaft." The offer was accepted; the work was begun May 2, 1884, and finished December 25, 1885. The results are contained in vol. iv. of the "Publications of the Washburn Observatory," now before us. When Prof. Holden was appointed to the Lick Observatory in October 1885, 468 observations were still wanting to complete the series. These were very creditably supplied, before the end of the year, by his assistants, Mr. Updegraff and Miss Lamb. In all, 6444 observations were made with the Repsold meridian-circle; each star of the 303 was completely observed six times; and instrumental constants were determined for each night. No pains were spared to secure accuracy. The probable error of a single bisection of Polaris was estimated at not above $0''{\cdot}1$ for poor seeing, and $0''{\cdot}05$ under the most favourable conditions. A list of corrections to standard star-catalogues (p. 69) forms a valuable addition to the contents of the volume.

WE have to acknowledge the receipt of the Calendars for the Session 1886–87 of the University Colleges of Dundee and Bristol, and of the Durham College of Science of Newcastle-on-Tyne.

THOSE interested in natural history will be glad to hear that Mr. Quaritch issues this week vol. iii. (the "Quadrupeds") of the Memorial Edition of "Bewick's Works," which he is publishing—to be complete in five volumes.

THE additions to the Zoological Society's Gardens during the past week include a Spring-bok (*Gazella euchore* ♂) from South Africa, presented by Capt. John Hewat, C.M.Z.S.; two Talapoin Monkeys (*Cercopithecus talapoin*) from West Africa, presented by Mr. R. E. Dennett; two Red-headed Finches (*Amadina erythrocephala* ♂ ♀) from South Africa, two Saffron Finches (*Sycalis flaveola* ♂ ♀) from Brazil, presented by Mr. H. B. James; a Leadbeater's Cockatoo (*Cacatua leadbeateri*) from Australia, presented by Mr. J. Davis; a Roseate Cockatoo (*Cacatua roseicapilla*) from Australia, presented by Mr. G. H. Hawtayne, C.M.Z.S.; a Herring Gull (*Larus argentatus*), British, presented by Mr. E. Penton, jun., F.Z.S.; a West African Python (*Python sebæ*) from West Africa, presented by Major A. Morton Festing; a Smooth Snake (*Coronella lævis*) from Hampshire, presented by Mr. W. H. B. Pain; a Leonine Monkey (*Macacus leoninus* ♂) from Arracan, deposited; two Crested Pigeons (*Ocyphaps lophotes*), a Geoffroy's Dove (*Peristera geoffroii*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

THE INNER SATELLITES OF SATURN.—Writing in the *Astronomische Nachrichten*, No. 2743, Prof. Asaph Hall states that he has now finished the reduction and discussion of the observations of Titan and the five inner satellites of Saturn made at Washington since the mounting of the 26-inch refractor in 1873. These observations have been made with the filar micrometer, and most of them are observed angles of position and distances. The average probable error of a single observation for the position of a satellite is $\pm 0''{\cdot}27$. A remarkable result of the discussion is that the Washington observations of the five inner satellites can be satisfied within the limits of their probable errors by circular orbits. At the beginning of this discussion Prof. Hall hoped that the observations would determine the positions of the lines of apsides with such accuracy that the motions of these lines would be known, and that thus we might obtain data for a new determination of the mass of the Ring, and of the figure of the planet. But the resulting circular orbits for the inner satellites make the position of a line of apsides indeterminate, and for the present the mass of the Ring remains unknown.

On account of the difficulty of making good micrometrical measurements of the inner satellites of Saturn, astronomers have revived the old method of observing their conjunctions with the ends of the Ring, or with some other marked feature in the Saturnian system. A series of observations of conjunctions with the ends of the Ring was made at Toulouse in 1876 and 1877 by MM. Tisserand and Perrotin; and in order to test the old method of observing, Prof. Hall has compared these measures with his elements of the five inner satellites. The result at which he arrives is that the probable errors of a single residual are larger for the Toulouse observations ($= \pm 0''{\cdot}41$ in the mean) than in the micrometrical measurements at Washington. Prof. Hall therefore concludes that observations of these satellites with filar micrometers are among the best we have, and since they are definite measurements, and are made in very different positions, a result deduced from them is more likely to be free from constant errors. He suggests that probably the best way to effect an improvement in such measurements is to devise some new arrangement of the wires of the filar micrometer.

THE INVENTION OF THE SEXTANT.—Dr. J. L. E. Dreyer points out, in the *Astronomische Nachrichten*, No. 2739, an historical error which has crept into several astronomical works, although it was refuted some fifty years ago by Prof. Rigaud in a series of papers communicated to the *Nautical Magazine*. In the books referred to, it is stated that the principle of the construction of the sextant was communicated to John Hadley by his brother, a Capt. Hadley, who had in his possession a sextant given to him by Capt. Godfrey, brother of Thomas Godfrey, of Philadelphia, the real inventor of the instrument. But it appears there never was such a Capt. Hadley. The brothers of John Hadley were—one a barrister, the other a physician; and he himself was not an instrument-maker by profession (as has been asserted), but, as an amateur, occupied himself with mechanical pursuits, and was the first to bring the polishing of reflecting-telescopes to any perfection. On May 13, 1731, John Hadley

communicated to the Royal Society a description of his reflecting octant; and, after some hesitation, Halley declared himself satisfied that Hadley's idea was quite different from that of Newton, who had invented an instrument founded on the same principle. It is no doubt true that Thomas Godfrey, a glazier of Philadelphia, had invented an instrument of this kind about the year 1730; but the first intelligence of his invention did not reach England before the month of May 1732, in a letter from James Logan to Halley. Godfrey's instrument was made of wood by Edmund Woolley, a carpenter, about November 1730, and had been tried on board the ship *Truman*, of which John Cox was master. The first model of Hadley's octant had, however, been constructed by his brother George about the middle of the summer of 1730. The thanks of those interested in the history of astronomy are due to Dr. Dreyer for the effort which he has made to correct the errors on this point which are found in Poggendorff's "Biographisch literarisches Handwörterbuch," in Wolf's "Geschichte der Astronomie," and elsewhere.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *SEPTEMBER* 19–25

(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 September 19

Sun rises, 5h. 43m.; souths, 11h. 53m. 42·7s.; sets, 18h. 5m.; decl. on meridian, 1° 25′ N.: Sidereal Time at Sunset, 17h. 59m.

Moon (at Last Quarter September 21) rises, 20h. 39m.*; souths, 4h. 7m.; sets, 11h. 44m.; decl. on meridian, 15° 12′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	4 55	11 29	18 3	6 0 N.
Venus	3 50	10 45	17 40	9 56 N.
Mars	10 44	15 11	19 38	18 12 S.
Jupiter... ...	7 7	12 52	18 37	3 43 S.
Saturn... ...	23 34*	7 37	15 40	21 32 N.

* Indicates that the rising is that of the preceding evening.

Occultations of Stars by the Moon (visible at Greenwich)

Sept.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
20 ...	130 Tauri... ...	6 ...	23 34 ...	0 30† ...	68 229
21 ...	26 Geminorum...	5½ ...	22 46 ...	23 26 ...	23 273
25 ...	B.A.C. 3345 ...	6 ...	1 53 ...	2 41 ...	61 206

† Occurs on the following morning.

Sept.	h.	
22 ...	12 ...	Saturn in conjunction with and 3° 29′ north of the Moon.
23 ...	— ...	Sun in equator.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2	81 16 N.	Sept. 21,	19 4	*m*
ζ Geminorum ...	6 57·4	20 44 N.	,, 24,	0 57	*M*
U Monocerotis ...	7 25·4	9 32 S.	,, 21,		*M*
U Cancri	8 29·3	19 17 N.	,, 25,		*M*
δ Libræ	14 54·9	8 4 S.	,, 21,	2 11	*m*
U Coronæ	15 13·6	32 4 N.	,, 22,	1 45	*m*
U Ophiuchi... ...	17 10·8	1 20 N.	,, 22,	4 27	*m*
		and at intervals of	20	8	
β Lyræ...	18 45·9	33 14 N.	Sept. 18, 21,	30	*M*
			,, 22,	2 0	*m*
η Aquilæ	19 46·7	0 43 N.	,, 25,	5 0	*m*
S Cygni	20 3·1	57 40 N.	,, 24,		*M*
U Cygni	20 16·1	47 32 N.	,, 20,		*M*
T Cephei	21 8·0	68 2 N.	,, 20,		*m*
δ Cephei	22 24·9	57 50 N.	,, 22,	22 0	*M*

M signifies maximum; *m* minimum.

Meteor Showers

The following are amongst the showers of the period:—Near θ Cassiopeiæ, R.A. 14°, Decl. 50° N.; near α Arietis, R.A. 31°, Decl. 18°; and near Polaris, R.A. 68°, Decl. 87° N.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

UNIVERSITY COLLEGE, LONDON.—We notice from the prospectus of the Engineering Department that the examination for the Gilchrist (Entrance) Engineering Scholarship of 35*l.* per annum is to be held on the 28th and 29th inst. Candidates must be under nineteen, and the subjects of examination are:—(1) Mathematics; (2) any two or more of the following—(*a*) mechanics, (*b*) mechanical drawing, (*c*) examination on some subject connected with engineering, (*d*) French or German, (*e*) the use of tools. The examination is intended to be of such a standard as can be passed by lads from school who have begun to acquire some knowledge of mechanical pursuits. The appliances of the engineering laboratory (under Prof. Alexander B. W. Kennedy) have been very much extended during the past year, mainly through a grant from the Gilchrist Trustees, and are now very complete in the direction both of experiments in elasticity and the strength of materials, and in the economic work of engines and boilers. Laboratory work is so arranged that students go through a systematic course of experimental instruction in these and other connected subjects during the session.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, September 6.—M. Émile Blanchard in the chair.—On presenting to the Academy a copy of a volume issued on the occasion of M. Chevreul's centenary, August 31, 1886, M. Berthelot remarked that this seemed a suitable occasion for reviving the old custom of celebrating Academic solemnities by the publication of special scientific and literary essays. The present work, in the preparation of which MM. Ch. Richet, G. Pouchet, E. Grimaux, E. Gautier, Dujardin-Beaumetz, E. Demarçay, and Berthelot had co-operated, has been executed with rare taste and care by the editor, M. Alcan, and by him dedicated to M. Chevreul on behalf of himself and his fellow-contributors.—Fluorescence of the compounds of manganese subjected to electric effluvium in vacuum, by M. Lecoq de Boisbaudran. In the experiments here described the author has aimed especially at determining the effects due to the presence of manganese. The fluorescence of some of its compounds is an extremely sensitive reaction, by means of which imponderable traces of this metal may be detected in natural or artificial substances that might otherwise be supposed free from its presence.—Paralytic ataxy of the heart, by M. Mariano Semmola. In this communication the author resumes the results of his further observations on cardiac disorders, already reported in the *Transactions* of the International Medical Congress, seventh session, London, August 1881.—Remarks in connection with three Italian essays submitted to the Academy, by M. Govi. The first of these papers deals with an episode in the life of Galileo, showing that the hostility of the Jesuits to the Florentine philosopher was not due to the letter addressed by him to his brother in 1606, announcing the expulsion of the Order from Venice. The second describes a curious plano-convex lens executed by Torricelli some time between 1644 and 1647, and recently discovered in the Cabinet of Physics attached to the University of Naples. The third refers to an unpublished letter written by Volta in 1785 on Lavoisier's pneumatic theory, which, although not accepted without reservations, is defended against the assumptions of an Englishman named Lubbock, who had essayed to transform oxygen into a new principle called by him the "sorbile principle."—On certain differential equations of the first order, by M. Roger Liouville. It is shown that the differential equation—

$$y' + a_1 y^3 + 3a_2 y^2 + 3a_3 y + a_4 = 0,$$

is reducible to the quadratures if its coefficients $a_1, \ldots a_4$ and their derivatives $a'_1, \ldots$ satisfy the equation—

$$a_1 L' + K L^{\frac{2}{3}} - 3[a'_1 + 3(a_2^2 - a_1 a_3)]\, L = 0,$$

where L represents the combination

$$L = a_3 a'_1 - a_1 a'_2 + a_1 (a_1 a_4 - a_2 a_3) + 2a_2 (a_2^2 - a_1 a_3,$$

and K an arbitrary constant which may vanish.—Note on the

theory of dissociation, by M. G. Chaperon. It is argued that the theory of dissociation may be expressed with simplicity by means of certain cycles, which are easily formed, if the possibility be admitted of separating at a constant temperature several mixed gases or vapours without the expenditure of convertible labour or of heat.—On the conjugation of the Parameciæ, by M. E. Maupas. Fresh observations on *Paramecium caudatum* have led the author to the determination of a fact of great physiological importance, which had hitherto escaped his notice, and which seems to foreshadow in these organisms the fecundating processes of the higher animals.—On the family of the Polyclinians, by M. Lahille. The Polyclinians of Roscoff—studied, for the first time, in 1872 and 1873, by M. Giard—are here divided into two distinct families—Polyclinidæ and Aplididæ.—On the affinities of the Eocene ferns of West France and Saxony, by M. Louis Crié. The already-determined affinities of the Tertiary flora of these two regions are here considerably enlarged by a comparative study of their respective ferns.—Note on the telluric currents, by M. J. J. Landerer. The author's further observations on meteorological phenomena connected with electricity lead to the general inference that the great telluric current of the globe has its origin in the difference of the negative potentials. The constancy and amplitude of the *régimes* of the winds whence it results insure both its normal direction and permanence.—On the discovery made in Belgium of a grave contemporary with the mammoth and rhinoceros, by M. Nadaillac. In a cave recently explored by MM. Marcel de Puydt and Sohest near Spy, in the province of Namur, were discovered two skulls of the Neanderthal type associated with the remains of *Rhinoceros tichorhinus* and *Elephas antiquus* (?). It thus appears that the Neanderthal race had already penetrated to the Meuse valley in the remotest times. From the relics found in the undisturbed soil of this cave it appears that they could make flint implements, utilise the tusks of the mammoth, manufacture earthenware baked in the fire, that they buried their dead, and in a word possessed the first rudiments of civilisation.

BERLIN

Chemical Society, July 12.—C. Scheibler, Vice-President, in the chair.—Ferd. Tiemann gave an account of some reactions of substituted amidoximes.—C. Scheibler discussed the important question for the sugar industry, whether a definitely characterised strontium dihydrate ($SrO,2H_2O$) exists as such, or whether the substance having the percentage composition of a dihydrate is not rather a monohydrate (SrO,H_2O) containing a higher hydrate mixed with it. He described his experiments on the action of carbon dioxide on the hydrates of the alkaline earths at different temperatures and containing varying amounts of water. He finds that the facts agree with the latter view.—H. Noerdlinger has studied the oxidation products obtained by the action of nitric acid on myristic acid: the chief products are succinic and adipic acids, besides smaller quantities of glutaric, pimelic, suberic, oxalic, and carbonic acids.—R. J. Friswell and A. G. Green described their researches on the constitution of diazoamidobenzene, from which it is concluded that the constitutional formula $C_6H_5 . N : N . NH . C_6H_5$ usually assigned to it is the correct one.—M. Rosenfeld described lecture experiments for the demonstration of the volumetric decomposition of hydrochloric acid and of the sublimation of sulphur.—J. Bongartz gave an account of compounds which aldehydes, ketones, and ketonic acids give with thioglycolic and thioacetic acids.—R. Otto discussed the conditions under which the whole of the arsenic can be removed from hydrochloric acid by hydrogen sulphide, and he showed that the last traces of arsenic can be precipitated when the addition is made of a certain quantity of a substance which gives an insoluble precipitate with the hydrogen sulphide. Since crude hydrochloric acid always contains such substances (*e.g.* ferric chloride, chlorine, &c.), it can readily be freed from arsenic by means of hydrogen sulphide.—P. Klason gave an account of a new method for the estimation of sulphur and of the halogens in organic compounds by burning them in a current of oxygen.—H. Kiliani has isolated the lactone of levulosecarboxylic acid, and has more closely examined the pentoxypimelic acid resulting from the oxidation of dextrosecarboxylic acid, and also its lactone.—E. Fischer has obtained a base named isoglucosamine, $C_6H_{13}NO_5$, by the reduction of phenylglucosazone with zinc dust and acetic acid, aniline and ammonia being simultaneously produced; isoglucosamine is isomeric with glucosamine, and closely resembles the latter in its properties, and probably bears the same relation to levulose as glucosamine does to dextrose.—J. Tafel described a new method of preparing primary amines, which consists in the action of sodium amalgam and glacial acetic acid on the alcoholic solution of the substances produced from ketones or aldehydes and phenylhydrazine; the reaction takes place according to the equation—

$$R : N_2H . C_6H_5 + 4H = RH . NH_2 + NH_2 . C_6H_5.$$

—E. Erlenmeyer offered an explanation of the remarkable isomerism occurring in the cinnamic acid and acrylic acid series.—K. Heumann and Th. Heidlberg are experimenting with a view to ascertain the influence exerted on the shade of certain dyes by the introduction of substitution groups and elements: in the present communication they describe the effect produced by the introduction of chlorine.—W. Staedel and H. Bauer gave an account of their experiments on the methylation of metanitraniline; on the demethylation of tertiary aromatic amines, and also on a convenient method of preparing azo-compounds.—G. Ciamician and P. Silber had a paper on the constitution of certain di-substitution derivatives of pyrroline.—K. Elbs and G. Steinike have studied α-naphthylphenylketone.—W. Kelbe has found ordinary cymene and an aromatic hydrocarbon of the formula C_9H_{12} in rosin-spirit.—R. Anschütz and P. N. Evans have found that antimony pentachloride boils under diminished pressure without appreciable decomposition.—A. G. Ekstrand gave the results of his research on the naphthoic acids; he has prepared and described the various nitro-derivatives.

BOOKS AND PAMPHLETS RECEIVED

"American Journal of Mathematics," vol. viii. No. 3.—"18th and 19th Annual Reports of the Trustees of the Peabody Museum," vol. iii. Nos. 5 and 6 (Cambridge, Mass.).—"Field and Other Experiments Conducted on the Farm and in the Laboratory of Sir J. B. Lawes, June 1886."—"A History of the Theory of Electricity," vol. i., by Isaac Todhunter and Karl Pearson (University Press, Cambridge).—"Industrial and High Art Education in the United States," by J. E. Clarke (Washington).

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