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. Valiensis*, 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.

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-

[1] Containing about a gallon. These were partially filled with pure sea-water containing the fertilised ova, and simply tied over with porous cheese-cloth.

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	June 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 Frozen Soil
	20 ft.	50 ft.	300 ft.	381 ft.	
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		On the Lower Ground	
		Ft.	In.	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.