his life upon, the old idea; but it clearly expressed what was then beginning to be felt by many who turned their unbiassed attention to the subject, and it is the keynote of nearly all the museum reforms of recent date. During the long discussion which followed, the new idea found powerful advocates in Huxley, Hooker, Sclater, Wallace, and others; but Owen, whose official position made him the chief scientific adviser in the construction of the new National Museum of Natural History, never became reconciled to it, and, unfortunately, threw all the weight of his great authority into the opposite scale.

The method of application of this principle depends entirely upon the general nature of the museum, whether that of a nation, a town, a school, or a society or institution established to cultivate some definite branch of knowledge. It is mainly of national museums that I am speaking at present, and it is only in national museums that the fulfilment of both functions in fairly equal proportions can be expected. In almost all other museums the diffusion of knowledge or popular education will be the primary function, and if the true principles of arrangement of such museums be once grasped, this is a function which can be carried out upon the largest or the smallest, or any intermediate scale, according to the means of the institution and requirements of the locality.

The collections for the advancement of science, on the other hand, are of value mainly in proportion to their size, and no museum at present existing has come anywhere near what is required for the exhaustive study of natural history. If any one were now to endeavour to write a complete monograph of any family in the animal kingdom, he would search in vain for materials for doing so, not only in any one museum, but in all the museums in the world put together.

Soon after the arrival in our Natural History Museum of the great and carefully selected and labelled collection of Indian birds, presented by Mr. A. O. Hume, containing upwards of 60,000 specimens, a well known ornithologist commenced the volumes devoted to birds in the excellent series of manuals on the fauna of British India, edited by Mr. Blanford. I am told that when he began the work he was seen sitting at his table rubbing his hands with delight at the prospect of success in his labours guaranteed by such an unprecedented mass of material. But after a few weeks the scene had changed. He was pacing up and down the room, wringing the same hands in despair at the hopelessness of solving the tangled problems of the variation according to age, sex, season, and locality, the geographical distribution, and the limits and relationship of any single species, owing to the absolutely insufficient number of properly authenticated specimens at his command. Every zoologist will recognise this as a scarcely exaggerated description of what he meets with at every step of his work. Except, perhaps, for some special and limited groups, which may be taken up in private collections, a national museum alone can possibly attempt to bring together the materials required for such exhaustive work, but it is undoubtedly the duty of all national museums to endeavour to do this. There should be in every great nation one establishment at least where problems may be attacked with some prospect of success, and the only conditions upon which collections for this purpose can be maintained are that they should be so arranged as to occupy the smallest possible space compatible with their proper preservation and convenience of access; and that they should be removed from all the deteriorating influences of light and dust, and at the same time be perfectly available for the closest examination by all those whose knowledge is sufficient to enable them to extract any information from them. This means that they cannot be *exhibited* in the ordinary sense of the word; although it must not be supposed that they are on that account in less need of orderly and methodical arrangement. There is certainly a danger of collections which are not generally exhibited becoming neglected, and degenerating into the condition of mere accumulations of rubbish. Anything of the kind is absolutely incompatible with the true requirements of specimens kept for research. They specially need to be arranged in an orderly and methodical manner, and to be thoroughly well catalogued and labelled, so that each may be found directly it is wanted, and to be frequently inspected to see that they are free from moth or other deleterious influence. The object of keeping them in this condition is, indeed, that they should be preserved and not destroyed, as many exhibited specimens ultimately are. Much curatorial ingenuity may be exercised in the methods of stowing and arranging such specimens to the best advantage. The conditions of access to them will be precisely those now accorded to books or manuscripts in a library, prints and drawings in an art museum, the records and public documents in the Rolls Office or Somerset House.

As the actual comparison of specimen with specimen is the basis of zoological and botanical research, and as work done with imperfect materials is necessarily imperfect in itself, it is far the wisest policy to concentrate in a few great central institutions the number and situation of which must be determined by the population and resources of the country, all the collections (especially those containing author's types or the actual specimens upon which species have been established, and which must be appealed to through all time to settle vexed questions of nomenclature) which are required for the prosecution of original research. It is far more advantageous to the investigator to go to such a collection, and take up his temporary abode there while his research is being carried out, with all the material required at his hand at once, than to travel from place to place and pick up piecemeal the information he requires, without opportunity of direct comparison of specimens.

On the other hand, in local museums, such collections are not only not required, but add greatly to the trouble and expense of the maintenance of the institution, without any compensating advantage. Here it will be the duty of the curator to develop the side of the museum which is educational and attractive to the general visitor, and to all who wish to obtain that knowledge, which is the ambition of many cultivated persons to acquire without becoming a specialist or expert. The study of the methods by which such museums may be made instructive and interesting offers an endless field for experiment and discussion, and the various problems connected with it are treated of not only in the literature I have referred to, but in a more practical manner in many museums in various parts of the world.

Without pursuing this question further at the present time, I should like to repeat from a previous address on the same subject[1] certain propositions which are fundamental in the arrangement of collections of the class of which I am now speaking.

The number of the specimens must be strictly limited, according to the nature of the subject to be illustrated, and the space available. None must be placed either too high or too low for ready examination. There must be no crowding of specimens one behind the other, every one being perfectly and distinctly seen, and with a clear space around it. If an object is worth putting into a gallery at all, it is worth such a position as will enable it to be seen. Every specimen exhibited should be good of its kind, and all available skill and care should be spent upon its preservation, and rendering it capable of teaching the lesson it is intended to convey. Every specimen should have its definite purpose, and no absolute duplicate should on any account be admitted. Above all, the purpose for which each specimen is exhibited, and the main lesson to be derived from it, must be distinctly indicated by the labels affixed, both as headings of the various divisions of the series and to the individual specimens.

(To be continued.)

MARINE BIOLOGICAL ASSOCIATION.

THE report of the Marine Biological Association of Great Britain was read at the annual meeting of the Association held in the rooms of the Royal Society on June 28. From it we learn that the buildings, fittings, and machinery of the Plymouth laboratory are in a satisfactory condition, and have not necessitated any special outlay.

The question of the boats has occupied the council very seriously during the past year. The old steam-launch *Firefly* is still at work, although it was decided to replace her a year ago. A new steam-launch, of about the same size as the *Firefly*, was recently purchased, but has proved to be unsuitable for rough work. The little sailing-boat, *Anton Dohrn*, is in excellent repair, and continues to be very useful.

The need of a deep-sea-going boat has become most pressing, but there are no funds in hand sufficient for its purchase and maintenance. This need has been particularly felt of late in the fishery inquiries in which the Association has been engaged in the North Sea as well as at Plymouth.

The type-collection is increasing satisfactorily under Mr. Garstang's care. In addition to the specimens at Plymouth, a

[1] British Association for the Advancement of Science. Report of Newcastle Meeting, 1889.

series of selected specimens has been arranged and exhibited at various *soirées*. This exhibition series is being enlarged.

Owing to the generosity of Mr. J. P. Thomasson, who has made a second donation of £250 for this purpose, it has been possible for the council to retain the services of Mr. Holt for fishing inquiries in the North Sea for a second year.

Mr. Garstang has been appointed for a second year to superintend the collection, preservation, and supply of material. The character of the specimens supplied by the laboratory has improved very greatly under his care.

Mr. Cunningham has continued his observations on the rate of growth and probable ages of young fish, a paper on which was published in the November number of the Association's journal. He has also continued his experiments on the colouration of the under-side of flat-fishes. Since Christmas he has been occupied in an inquiry into the question of the destruction of immature fish, the first results of which appear in the May number of the journal.

Mr. Cunningham has also succeeded in artificially fertilising the eggs of the flounders which he has reared in the laboratory tanks during the last three years from a length of half an inch; the eggs developed, and the larvæ were artificially fed for ten days after the absorption of the yolk-sac. This result is of great importance and interest.

Mr. Holt has been at work now for eighteen months upon an investigation of the fisheries of the North Sea, and his papers in the journals for November and May supply a large amount of important information. The Council contribute to the expenses of the Cleethorpes Aquarium of the Marine Fisheries Society (Grimsby) in return for Mr. Holt's use of their laboratory and tanks.

Mr. Garstang has captured a large number of rare forms during the past year, and he has added five new species to the list of the British fauna. As a result of his work during the past year, an intimate knowledge of the localities of the fauna has been acquired, so that specimens can be obtained without delay.

The receipts for the past year include the annual grants from H.M. Treasury (£1000) and the Worshipful Company of Fishmongers (£400); annual subscriptions have produced £160, composition fees £16, the rent of tables at the laboratories, £34, the sale of specimens £205, and the admission to the tank-room £70, the total amounting, with lesser sums, to £2199.

The Vice-Presidents, Officers, and Council proposed by the Council for 1893–94 are :—President: Prof. E. Ray Lankester, F.R.S.; Vice-Presidents: The Duke of Argyll, K.G., K.T., F.R.S., the Duke of Abercorn, K.G., C.B., the Earl of St. Germans, the Earl of Morley, the Earl of Ducie, F.R.S., Lord Walsingham, F.R.S., Lord Revelstoke, the Right Hon. A. J. Balfour, M.P., F.R.S., the Right Hon. Joseph Chamberlain, M.P., Prof. G. J. Allman, F.R.S., Sir Edward Birkbeck, Bart., M.P., Sir Wm. Flower, K.C.B., F.R.S., the Right Hon. Sir John Lubbock, Bart., M.P., F.R.S., Prof. Alfred Newton, F.R.S., Sir Henry Thompson, Rev. Canon Norman, F.R.S., Captain Wharton, R.N., F.R.S.; Council—elected Members: F. E. Beddard, F.R.S., Prof. F. Jeffrey Bell, Prof. W. A. Herdman, F.R.S., Sir John Evans K.C.B., F.R.S., A. C. L. G. Günther, F.R.S., Prof. A. C. Haddon, Dr. Sydney J. Hickson, Prof. W. C. McIntosh, F.R.S., Right Hon. E. Majoribanks, M.P., E. B. Poulton, F.R.S., P. L. Sclater, F.R.S., Adam Sedgwick, F.R.S., Prof. Charles Stewart, Prof. W. F. R. Weldon, F.R.S., Hon. Treasurer: E.L. Beckwith; Hon. Secretary: G. Herbert Fowler.

THE CONDITIONS DETERMINATIVE OF CHEMICAL CHANGE.[1]

NOTWITHSTANDING the large amount of evidence now placed on record that substances commonly supposed to be capable of directly interacting do so only in the presence of at least one other substance, chemists do not appear to have arrived at any clear and consistent understanding of the conditions determinative of chemical change: as each fresh case is recorded, we continue to express surprise, overlooking the fact that Faraday, in his early "Experimental Researches in Electricity," clearly foresaw what the conditions were, and that but a slight extension of his generalisations is needed to frame a comprehensive theory. The subject is of such importance that it appears to me desirable to discuss the bearing of recent observations, especially as they to some extent necessitate the modification of views that I have expressed elsewhere, and in order to attract the attention of physicists, to whom we must now look for guidance in these matters.

Eight years ago, in the course of the discussion on Mr. H. B. Baker's communication on combustion in dried gases (Proc. Chem. Soc., 1885, 40), I defined chemical action as *reversed electrolysis*: in other words, in order that chemical action may take place, it is essential that the system operated on comprise an electrolyte. I then pointed out that as neither hydrogen nor oxygen was an electrolyte, a mixture of only these two gases should not be explosive; and, moreover, as water was not an electrolyte, and it was scarcely probable that water and oxygen or hydrogen would form an electrolyte, it was difficult to understand how the presence of water pure and simple should be of influence in the case of a mixture of hydrogen and oxygen. This forecast has since been verified, the remarkable series of experiments carried out by V. Meyer in conjunction with Krause and Askenasy having clearly demonstrated that the formation of water from hydrogen and oxygen takes place at an irregular rate, and is, therefore, dependent on the presence of a something other than water—I imagine an acid impurity. But this is a consideration which has not yet received the proper attention, and it is, therefore, desirable to emphasise its importance by reference to other cases. Mr. Baker's recent preliminary note on the influence of moisture in promoting chemical action (*ante*, p. 229) affords several interesting examples:—Thus, he states that neither does hydrogen chloride combine with ammonia, nor is nitric oxide oxidised by oxygen if moisture be excluded. In the former case, the addition of water should suffice to determine the combination, as water and hydrogen chloride together form a "composite electrolyte" (*cf.* Roy. Soc. Proc., 1886, No. 243, p. 268); as neither nitric oxide nor oxygen, however, forms a composite electrolyte with water, in this case water alone should not determine the occurrence of change; but if, by the introduction of a trace of "impurity" in addition to water the presence of a composite electrolyte were secured (however high its resistance, owing to the smallness of the amount of "impurity"), action would set in, and when once commenced would proceed at an increasing rate, as nitric acid would be formed and the resistance of the electrolyte would consequently diminish. On this account it will be a task of exceeding difficulty to experimentally demonstrate that nitric oxide and oxygen are inactive in presence of water alone; but there can be no doubt that such must eventually be admitted to be the case, provided always that it is permissible to extrapolate Kohlrausch's observations, and to conclude from them that *pure* water is a dielectric. The gradual increase in the rate of change here contemplated corresponds to the period of induction observed by Bunsen and Roscoe in their observations on the interaction of chlorine and hydrogen; the statement recently made by Bodenstein and V. Meyer (*Berichte*, 1893, 1146) that a mixture of chlorine and hydrogen behaves irregularly on exposure to light is a valuable confirmation of Pringsheim's observations, and there is now no room for doubt that *pure* chlorine and hydrogen would be incapable of interacting. That no such irregularity is observed on heating iodine with hydrogen is not surprising, as hydrogen iodide would be formed from the very outset, and the electrolyte present would exert a minimum resistance almost at once. There is, however, a significant difference in the behaviour of the two mixtures, as hydrogen chloride should behave as hydrogen iodide, so that the problem is but incompletely solved: it may be that the one mixture was more nearly pure than the other, or it may be that the formation of hydrogen chloride from hydrogen and chlorine, under the influence of light, is dependent on the presence of some *particular substance, together with water, and does not take place* under the influence of any substance capable of forming a composite electrolyte with water; probably, however, the difference observed is chiefly due to the fact that only one of the actions is reversible under the conditions prevailing in the experiments.

Lastly, attention may be directed to the formation of sulphuric oxide from sulphurous oxide and oxygen, which is readily effected in presence of a catalyst, such as finely divided platinum; it cannot be supposed that the mere presence of platinum would condition the occurrence of change, and doubt less moisture is also necessary, the platinum or other catalys

[1] Reprinted from the Proceedings of the Chemical Society, No. 125.