

to the Commissioners to operate detrimentally in the case of local authorities.

With regard to the alleged obligation of the Crown to defend the coasts from the inroad of the sea, the Commissioners, with one exception, consider that the evidence laid before them does not warrant this conclusion, and that there is not any settled principle of the Crown or statute law to support the contention that there is a responsibility for sea defence resting primarily upon the nation at large; the fact that there is erosion in some places does not affect the nation generally, and there is not any ground for the contention that sea defence is a national service.

SEASONAL VARIATIONS OF MARINE ORGANISMS.

THE present short article has been written, not for the plankton specialist, but for readers who may have had their interest aroused by some reference in purely technical papers to seasonal variations. Aquatic organisms (vegetable and animal) may be divided into two groups, those which are fixed to the bottom or cannot leave the substratum, and those which are independent of it, and live swimming or floating in the water.

Of the latter, the pelagic organisms, some, such as fishes, swim about actively, whilst others are passive organisms, with but feeble organs of locomotion or none. They float about almost like inanimate objects, at the mercy of tides and currents, and they vary in size from microscopic flagellates up to large medusæ. These more or less passive pelagic organisms (both vegetable and animal) are what Hensen in 1887 characterised under the term plankton. The study of the plankton has advanced by leaps and bounds in the last few years, and fresh discoveries (often the results of new methods and ingeniously devised apparatus) have acted as stimuli to the work.

From being a qualitative science, planktology has become quantitative, and is becoming as exact in its methods as biometrics. Formerly the investigations were considered sufficiently intense and accurate if a net made of fine silk was pulled horizontally through the water, so that the planktonic organisms were filtered out and captured. Now, it is necessary to use other methods, to pass the water through special filters, and to centrifuge measured quantities in order to catch those exceedingly small creatures which pass quite easily through the finest silk cloth. These very small organisms are of supreme importance, for what they lack in size they make up for in numbers, and some of the most keenly discussed theories in marine biology of the last few years may have to be seriously modified when more detailed observations have been made on their occurrence.

Serial investigations have shown that the plankton varies both qualitatively and quantitatively through the different seasons. It is never absent even under an ice cover in fresh-water lakes, and just as the opening of the buds serves as an indication of spring, so the appearance of certain organisms tells of the approach of the same season in the waters. Summer and autumn are both equally well marked in the aquatic world, and this applies to the seas as well as to lakes and ponds.

Some organisms are always present, but most planktonic animals and plants appear at certain seasons, and then disappear, whilst others take their places. In fact, it is quite impossible to write an account of the plankton of any waters from a series of catches made in a period of a few weeks only. A plankton investigation must extend through at least one year, so that catches may be examined repre-

sentative of all seasons. If such a research be carried out it becomes at once obvious that the plankton varies according to certain external conditions, amongst which might be enumerated, sunlight and temperature of the water, chemical constitution of the medium, and, finally, the motion of the latter, particularly as regards vertical currents.

The application of quantitative methods to the study of the marine plankton has shown that, contrary to all expectation, the colder waters of the globe are more productive than those of the tropics. Compared with temperate and Arctic seas, the open ocean of the tropics is a desert so far as the plankton is concerned, with occasional oases. In our own waters the quantity of plankton present varies enormously during the year. Catches made with a net hauled vertically under the same conditions average perhaps about 1 c.c. in volume during the early months of the year. In the short space of a week in March or April, this volume may rise to 40 c.c., or even more, and remain constant for a period of some weeks, falling eventually to about 1 or 2 c.c. again during the summer. It is of the utmost importance that the causes of these variations in the quantity of the plankton should be discovered. What determines the productivity of any particular region? Why is there an extraordinary increase in quantity during certain weeks of the spring and autumn? These are amongst the most fundamental questions in the biology of the sea.

If every year was the same so far as meteorological conditions were concerned, and the plankton variations of successive years were absolutely identical, we should never be able to do more than make speculations as to the causes of such variations. Nature, however, varies the meteorological and hydrographical conditions for us, and we find that there are also corresponding annual variations in the plankton. Thus the spring and autumn maxima of the latter may be earlier one year than another, or may extend over a longer period. It is the work of the planktologist to analyse these changes and endeavour to correlate plankton variations with hydrographical and meteorological conditions.

In the Irish Sea, for example, an attempt has been made by Prof. Herdman and others to arrive at some of the causes of the seasonal variations by taking serial plankton catches through a period of several years, the hydrographic conditions prevailing being also observed. It ought to be possible in this way to correlate certain biological and physical variations. It was found in the first years of this plankton investigation that the spring and autumn maxima were due to a large extent to an enormous increase in diatoms, an increase followed by the appearance of dinoflagellates. The copepods followed these spring dinoflagellates, and attained their greatest development in the early summer. This order of succession has held good throughout all the years of this investigation (1907-11). Whilst, however, the highest monthly averages were in April in 1907 and 1910, they occurred in May in 1908 and 1909. The two years, 1907 and 1910, resembled one another so far as meteorological conditions are concerned in having a larger amount of sunshine during the early months than was the case in 1908 and 1909; and the question arises whether this early sunshine was a determining factor in the early appearance of the vernal maximum.

It was expected that this year, 1911, would perhaps throw some light on the question, and whatever the result may be when the hydrographic and meteorological conditions are worked out, the plankton maximum has certainly been very different from that of any of the previous years.

Up to the present the cause of the vernal phyto-

plankton maximum still seems to be wrapped in mystery, and the same may be said of the greater productivity of the cooler waters.

Several theories have been proposed from time to time by Brandt and others to explain the vernal maximum, and of these Nathanson's appears to be the most fundamental. This author believes that vertical currents, which aid in the circulation of food materials, are responsible for the productivity of the sea in plankton. These currents are always present at certain places, and there one can always rely on finding a rich plankton. They are also present at certain seasons in other larger areas of the sea, and in lakes, and these seasons correspond to the times of maxima.

It is most probable that this explanation is not sufficient alone, and that the sunlight, the temperature of the water, and the chemical constitution are also determining factors.

The conditions surrounding the plankton are very complex, and it will probably require many years of investigation before the predominant factors in the problem can be discovered.

The work is slow and laborious, but still it aims at the solution of one of the most important problems in the metabolism of the ocean. This is the point of view from which the planktonic work at the Port Erin Biological Station is being carried out under Herdman's direction, and similar work is being prosecuted by planktologists elsewhere. It has lately been asserted that the most important part of the food of aquatic organisms is derived from organic compounds in solution in the medium in which they are living. At the present time it is impossible to say with any certainty how far this thesis may be correct, but whether it be the case or not, the plankton still retains its importance as either the immediate or the ultimate source of those organic substances upon which all marine and fresh-water animals depend.

WM. J. DAKIN.

NOTES.

It is announced in the July issue of *The Popular Science Monthly* that during his visit to Washington at the time of the annual meeting of the National Academy of Sciences Sir John Murray, K.C.B., F.R.S., presented a fund of £2000. to the academy for the purpose of founding an Alexander Agassiz gold medal, which is to be awarded to men of science in any part of the world for original contributions to the science of oceanography.

WE regret to announce that Mr. W. I. Last, director of the Science Museum, South Kensington, died on August 7 at his residence, 11 Onslow Crescent, S.W., in his fifty-fourth year. Mr. Last was apprenticed in 1873 with Messrs. Hayward Tyler and Co., and when barely twenty years of age won the Senior Whitworth Scholarship; he held his scholarship at the works of Sir Joseph Whitworth, and at the same time he followed a course of study at the Owens College, Manchester, gaining numerous prizes during this period. In 1886 he was elected an Associate Member of the Institution of Civil Engineers, and in the following year the council awarded him a Watt medal and a Telford premium for his paper on setting out the curves of wheel teeth. In 1890, after some years spent in practical work at home and abroad, he was appointed to the post of keeper of the machinery and inventions division of the South Kensington Museum; shortly afterwards the naval division was also entrusted to his care. Recognising that objects which involved mechanical movement are most intelligible as well as most attractive, both to students and to the public, when

shown in motion, he arranged numerous ways of effecting this under museum conditions. One of the best methods which he devised and introduced for this purpose was the supply of compressed air for working the objects by their own driving mechanism. The plan of sectioning objects to show the working parts of machines and details of construction was carried out by Mr. Last with much success. The collections have been very widely extended under his supervision. Mr. Last received his appointment as director of the whole Science Museum in 1904. The excellence of his work on the collections was the subject of comment in connection with the recent inquiry as to the museum.

THE death at Nice is announced, at the age of seventy years, of Dr. Louis C. De Coppet, distinguished by his researches on the solubilities of salts and the lowering of the freezing point of water by the presence of salts in solution.

WE are informed by the National Association for the Prevention of Consumption that it has been decided by the Rome authorities to postpone the International Congress on Tuberculosis, which was to have been held in Rome on September 24-30, to next April.

THE London County Council, on the recommendation of the Local Government Records and Museums Committee, has resolved that the whole of the objects of London interest collected by the Council from time to time, including the boat of the Roman period discovered on the site of the new County Hall, be offered on permanent loan to the trustees of the London Museum. The museum will be accommodated in the State apartments of Kensington Palace, which was placed by the King at the disposal of trustees for the exhibition of the collections. The accommodation at Kensington Palace is understood to be of a temporary nature, the intention being eventually to house the objects in a building worthy of London.

IT is announced in *The Times* that an experiment in the direction of utilising aeroplanes in the postal service of the country is likely to be undertaken shortly by the General Post Office. The proposal is for a regular aerial service for a limited period between London and Windsor. Arrangements have been made with a number of large firms for the fixing in their establishments of special "aerial" letter-boxes, in which letters intended for the aerial service must be posted. Daily clearances will be made by postmen, and the collections will be dispatched to the central clearing house. Here the letters will be placed in sealed bags and conveyed by motor-van to the aerodrome at Hendon, where the bags will be securely fixed to the machines. The airmen will then start on the journey to Windsor, covering the distance of 21 miles in, it is estimated, half an hour. At Windsor the aeroplane staff will be responsible for the conveyance from the aerodrome by road of all the letters to the town post-office, where they will be dealt with in the usual way.

THE annual autumn meeting of the Institute of Metals will be held at Newcastle-on-Tyne on September 20-22. Sir C. A. Parsons, K.C.B., F.R.S., is acting as chairman of the local committee, and Dr. J. T. Dunn as honorary secretary. The meeting will open at 10 a.m. on Wednesday, September 20, when the members will be welcomed at Armstrong College by the Lord Mayor of the city, Sir W. H. Stephenson, and the local committee, after which a series of papers will be read and discussed, Sir Gerard A. Muntz, Bart, president, being in the chair. In the afternoon members will have the opportunity of visiting