

we know nothing whatever about the "daily increment" in the producing organisms of the open ocean, and therefore the futility of every attempt at comparison is evident. The small volume of plants and animals peculiar to the upper strata of the warm regions of the ocean cannot, in consequence, justify the conclusion that the production is small. The abundance of animals found in the deeper layers of the open ocean seems to indicate rapid production associated with rapid consumption in the upper plant region of the sea.

Although it is as yet quite impossible to form an opinion on the absolute magnitude of the production in certain regions, it has been supposed that the relative amount of nutriment contained in various waters might be compared. As mentioned by Gran on pp. 367-381, botanists are of opinion that in the open ocean, far from land, certain of the nutritive substances essential to plant life, especially nitrogen, are present in very small quantities (the minimum of Liebig), and consequently the plants cannot develop as profusely as they otherwise would do. Pelagic plant life draws its principal supply of dissolved or undissolved nitrogen either from the coasts (see remarks on detritus), or from localities where cold and warm currents meet. In these latter localities the conditions may suddenly become favourable for the development of life, just as development in boreal waters begins in spring, when the rays of the sun raise the temperature of the surface water. The organic substances contained in the cold waters become transformed into inorganic salts through the action of bacteria, and these salts are used by the microscopic plants to build up new protoplasm. Murray and Irvine<sup>1</sup> first drew attention to the importance of this process in the ocean, which plays a great part wherever large sheets of cold and warm water are mixed.<sup>2</sup>

The boreal waters should, accordingly, present favourable conditions for developing an abundant animal life during the warm season, the coast waters carrying detritus spread out over the whole oceanic area, while arctic currents mix with the warm Atlantic Gulf Stream, for instance in the Barentz Sea, north and east of Iceland, and off the coast banks of Labrador and Newfoundland.

<sup>1</sup> "On Coral Reefs and other Carbonate of Lime Formations in Modern Seas," *Proc. Roy. Soc. Edin.*, vol. xvii., 1890.

<sup>2</sup> Similar ideas have been expressed by Nansen, "The Oceanography of the North Polar Basin," *Norwegian North Polar Expedition*, Christiania, 1902.