

the ocean. Franklin appears to have been the first to make a scientific exploration of the Gulf Stream, by means of an extensive series of observations of the temperature of the surface waters of the Atlantic ; he attributed the origin of the Gulf Stream to the action of the trade winds.<sup>1</sup>

Bergman in 1779 and Marcet in 1822 recognised that the variations in the quantitative and qualitative composition of sea-water from different regions of the ocean were exceedingly slight. In 1818 Dr John Murray of Edinburgh published an extremely valuable research on the water of the Firth of Forth ;<sup>2</sup> he showed that by treating portions of the same sample of water in different ways, widely different quantities of the various salts might be obtained, and that the only satisfactory method of proceeding was to determine each base and each acid separately. The attempt to discover whether the composition of sea-water differed at separate places was frequently made, but the conditions of observation were unsatisfactory. The samples could not be relied upon as properly collected or preserved, and much uncertainty remained on the subject.

In 1865 a paper by Professor Forchhammer of Copenhagen, on the Composition of Ocean Water, was published in the Philosophical Transactions,<sup>3</sup> recording the result of twenty years of patient work, and its publication marks an era in the history of ocean chemistry. Forchhammer worked under great disadvantages ; his samples of water were brought home by seafaring men from different parts of the world in corked bottles, and they were necessarily all taken from the surface or immediately beneath it. Forchhammer did not attempt to determine quantitatively all the elements that occur in sea-water, but confined himself to the very accurate estimation of the principal components, viz., chlorine, sulphuric acid, magnesia, lime, potash, and (by difference) soda. Although his methods have since been improved on, all the analyses were models of care and accuracy, and all his results have been confirmed and extended by Professor Dittmar's elaborate research, carried on under conditions immensely more favourable, on the water samples carefully collected on board the Challenger. Forchhammer's grand conclusion was that although the salinity of sea-water may and does vary within certain limits, yet if samples be taken in all parts of the open sea, avoiding the vicinity of land and the mouths of large rivers, the proportion of each constituent to the total salts will be found to be the same everywhere, the differences in surface water being merely differences due to dilution and concentration.

In the works of Müller, Duperrey, Freycinet, Jacquinot, Péron, Quoy, Gaimard, Lesson, Gaudichaud, Eydoux, Souleyet, Reynaud, and Scoresby, are to be found many interesting accounts of marine organisms found on the coast or in surface waters, which

<sup>1</sup> Franklin, American Phil. Soc., vol. ii. pp. 315 *et seq.*, Philadelphia, 1790 ; for further details on the Gulf Stream see J. E. Pillsbury, "The Gulf Stream and its Investigation," Rep. U.S. Coast and Geodetic Survey for 1890, App. 10, p. 488, Washington, 1891.

<sup>2</sup> *Trans. Roy. Soc. Edin.*, vol. viii. p. 205, 1818.

<sup>3</sup> *Phil Trans.*, vol. clv., p. 203, 1865.