

from the decomposition of their waste products and dead bodies,—cannot but work continual and extensive changes in the internal constitution of the sea-water salts and of the materials in suspension in sea-water or lying on the floor of the ocean, the intensity of these changes varying with the temperature, the amount of sunlight, and other conditions.

Carbon, hydrogen, oxygen, nitrogen, sulphur, and phosphorus may fairly be regarded as entering into the composition of the tissues and fluids of all marine organisms; in addition, carbonate of lime, silica, and other substances entering into the composition of the hard parts may be regarded as essential to the life of numerous species of animals and plants.¹ When marine organisms cease to live the resolution of their complex compounds at once begins. The carbon and hydrogen pass off mainly as carbonic acid and water, the nitrogen forms ammonia, and the sulphur and phosphorus give rise to volatile sulphuretted and phosphuretted compounds; in short, decay takes place accompanied by all its well-known phenomena.² The skeletal structures of the organisms become altered at the same time, and, passing into solution, may ultimately be wholly reduced, in the presence of sea-water, into their ultimate inorganic components. At the bottom in great depths the process of decay might be an exceedingly slow one were the only available oxygen that which is present in solution in the sea. There is evidence, however, of some remarkable chemical reactions which it is desirable here to indicate.

The analyses of sea-water inform us that earthy and alkaline sulphates make up a very large part of the total sea-water salts. When these are exposed to the action of carbon, or of organic matter, which, of course, contains carbon, the sulphates are reduced and sulphides formed; the carbon unites with the oxygen, formerly combined with the metal and metalloid, to form carbonic acid.³ Thus for every molecule of sulphate decomposed in this way one molecule of sulphide and two molecules of carbonic acid are formed. As, practically, all the carbon of marine organisms must thus ultimately be resolved into carbonic acid, the quantity of that acid produced in this way must be enormous, and cannot but exert a great solvent action not only on the dead calcareous structures, but also on the minerals in the muds on the floor of the ocean. Were these reactions to end at this stage the bottom of the sea would soon become so poisoned by sulphides as to be unfit to support either animal or vegetable life. As soon, however, as the sulphides are produced, the carbonic acid, which is formed at the same time, decomposes the sulphides, forming earthy and alkaline carbonates,

¹ Pouchet and Chabry, "De la production des larves monstrueuses d'Oursin, par privation de chaux," *Comptes Rendus*, tom. cviii. pp. 196-198, 1889; "L'eau de mer artificielle comme agent tératogénique," *Journal de l'Anatomie*, 1889, pp. 298-307.

² These changes are not, of course, due to simple oxidation, but are brought about in a large measure by the influence of organisms familiarly named Bacteria, it being now generally accepted as a fact that all putrefactive changes are brought about or initiated by these minute organisms.

³ Murray and Irvine, *Proc. Roy. Soc. Edin.*, vol. xvii. p. 93.