

Huxley,¹ deep-sea clays and muds might be said to be of organic origin. In the *Globigerina* limestones of Malta the tracks of Echinoderms and Annelids, which had eaten their way through the deposits, may now be seen in the solid rocks.² In examining the samples of Blue Muds, and especially those near the mouths of rivers, many oval-shaped bodies, about 0.5 mm. in length, were observed. These were described by some observers as Foraminifera. Mr. Murray, after numerous observations, came to the conclusion that they were mostly the excreta of Echinoderms, principally of Holothurians.³ When these pellets are voided by the animal they are covered by a slimy substance; many of them may indeed be united in a chain. In some deposits this dung is exceedingly abundant, but as a rule it is impossible to recognise these oval bodies in any of the organic oozes, and in the Red Clays only some doubtful examples have been met with. They appear to fall asunder when the deposit is granular, like a *Globigerina* Ooze, or when long exposed without being covered up, as in the case of the Red Clays.

It is abundantly evident, then, that much organic matter is mixed with the marine deposits, especially with the surface layers. In the Blue Muds the decomposition of this matter in the deeper layers leads to the reduction of the oxides in the red upper layer and to the formation of sulphides, which give a blue colour to the deposit, but in the Red Clays and Red Muds the quantity of organic matter is insufficient to completely effect this change, and the deposit as a whole remains of a red colour.⁴

The changes connected with the decomposition of albuminoid matter in marine deposits must also be associated, at least in their initiatory stages, with the formation of glauconite in the chambers of Foraminifera and other calcareous organisms, and the production of glauconitic grains in Green and Blue Muds along continental shores. In like manner the formation of phosphatic grains and nodules may be connected with changes brought about by the decomposition of organic substances in terrigenous deposits.

c. CHANGES PRODUCED BY ORGANISMS IN THE CONSTITUTION OF SEA-WATER AND DEEP-SEA DEPOSITS.

When we remember the large number of marine organisms in the ocean, and the organic materials carried into the sea from the land, it is evident that the functional activity of these organisms,—together with the nitrogenous organic matter arising

¹ See p. 190.

² Murray, *Scot. Geogr. Mag.*, vol. vi. pp. 449–488, 1890.

³ See under Additional Observations, pp. 101, 103.

⁴ J. Y. Buchanan says :—"The mud below the surface layer, in localities where ground life is abundant, remains blue, being protected by the oxidation of what is above it" ("Sulphur in Marine Muds," *Proc. Roy. Soc. Edin.*, vol. xvii. p. 37, 1890). This does not appear to be the correct interpretation, for Blue Muds, accumulating by additions at the surface, must all pass through the stage of the red upper or surface layer. The blue colour of the deeper layers must be due to a subsequent change from the reduction of the higher oxides in the red upper layer, and the formation of sulphide of iron through the decomposition of the organic matter present in the deeper parts of the deposit.