

MARINE MICROBES

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Microbes assume greater importance in the marine ecosystem because of their abundance, biomass and activity in a number of biological and chemical processes that provide the driving force for vital biogeochemical cycles. These microbes include organisms such as bacteria, actinomycetes, fungi, yeasts, viruses, flagellates, ciliates, diatoms and unicellular and multicellular algae. Photosynthetic microbes play a most important role in the reception and conversion of solar energy into biological energy which passes through various trophic levels. The numbers and kinds of microbes occurring in the marine world are influenced by environmental conditions and the presence of higher organisms. The environmental conditions, in turn and the health of marine plants and animals are affected by the presence and biochemical activities of microbes.

Because of their size and chemical ability, microbes can live or at least survive, in a remarkable variety of habitats compared to their terrestrial counterparts, these are capable of tolerating saline conditions, low temperature and hydrostatic pressures. Even from deepest part of oceans these microbes have been isolated. The microbial habitats in the marine environment are broadly divided into six categories; (1) neustonic habitats (air-sea interface); (2) planktonic habitats (free floating); (3) Fecal-estonic habitats (organic debris); (4) epibiotic habitats (attached to surfaces); (5) endobiotic habitats (symbiotic/pathogenic) and (6) benthic habitats (sea floor).

Morphologically these microbes are much like their better known terrestrial or freshwater counterparts. While most of the microbes found in the sea are specifically indigenous to the marine environment, many mechanisms make for an interchange of microbes between land and the sea. Majority of them collected from the sea at places remote from the possibility of terrigenous contamination require seawater or its equivalent for their survival and growth. Because of the fact that most of the marine environment is less than 5 °C, many of the bacteria do grow slowly at refrigeration temperatures (0° to 5°). Unlike terrestrial and freshwater bacteria, most of the marine bacteria taken from depths of 7000 to 10,000 m grow only when incubated at pressures characteristic of their natural habitat i.e. 700 to 1000 atm.

In the photosynthetic zone, the abundance of bacteria appears to be more closely related to the distribution of phytoplankton. This is attributed partly to the organic matter which the phytoplankton provide and partly to solid surfaces. Bacteria occur only to a limited extent free-floating in water; most of them are attached to suspended particles. In general their abundance increases with depth upto 25 or 50 m and then it decreases. We now have evidence to show that in terms of total energy flow, processes in the ocean mediated by microorganisms are atleast as important as those mediated by

net plankton and larger organisms. According to few estimations, the biomass of bacteria in the total system may approach that of the entire fauna. Since turnover of microbial biomass is much faster than the turnover of macroscopic biomass it results in a much greater flux of energy and materials. It has been suggested that nearly half of the oceans total primary production is being processed by microbes.

Assuming that a portion of the large reservoir of dissolved organic matter in the sea is an immediate by-product of primary production (photosynthetic process), the heterotrophic growth of bacteria probably represents a major pathway whereby this fraction of organic matter is converted into particulate matter and enters the food chain. Different estimates of bacterial production put the values between 0.7 and 1.4×10^9 t C. yr^{-1} . Sometimes the value has been as high as 24×10^9 t C. yr^{-1} . The bacterial carbon especially in coastal waters can vary between 4% and 25% of total plankton carbon biomass. Several species of marine animals including annelids, gastropods, sea-urchins, amphipodes, mysids, prawns and fish have been shown experimentally to benefit by feeding on deposits of detritus and ingesting bacteria.

The chief processes in which microorganisms are known to be involved are the following :

1. Release of much of the primary production of plankton and macrophytes as dissolved organic matter (DOM) or as dead particulate organic matter (POM) and colonization of the latter by microbes.
2. Uptake of DOM by bacteria with the production of live and dead POM.
3. Decomposition of the less refractory portions of POM of plant origin.
4. Consumption of bacteria in large quantities by planktonic filter feeders and benthic detritivores.
5. Conversion of DOM to particulate form by physico-chemical processes and subsequent colonization by microorganisms.
6. Sedimentation of POM to the sea floor and subsequent incorporation into aerobic food chains on the sediment surface or decomposition by anaerobic organisms in deeper layers of sediment.

From a geobiological point of view, the contribution of bacteria to the sulphur cycle in the sea is second in importance only to their essential role in the formation and transformation of carbon and nitrogen compounds. In the case of anaerobic decomposition of organic detritus, bacteria use sulphate, nitrate and carbon dioxide as hydrogen acceptors leading to the formation of H_2S , NH_3 or CH_4 . Out of these processes quantitatively the most important is

Sulphide is oxidized to elemental sulphur and sulphate by white sulphur bacteria and purple photosynthetic bacteria. The proportion of carbon oxidation being catalyzed by sulphate reducing bacteria in the marine environment is nearly 53%. In deeper marine sediments at a depth of 30-50 cm significant amounts of methane are present showing that CO_2 is being used as a hydrogen acceptor. Beyond 50 cm depth the methane production increases and concentration reaches upto 10 to 15 mm.

When the organic productivity is high and the conditions become reducing in the sediments, the bacteria attack organic matter with the selective removal of oxygen, nitrogen, sulphur and phosphorus, thereby leaving carbon complexes that are relatively rich in hydrogen (crude oil). In this process bacteria often produce appreciable quantities of methane, an important constituent of crude oils and natural gas.

As the bacteria appear to be the principal dynamic agents which lower the redox potential of marine sediments, they are indirectly responsible for the changes in chemical composition, reactivity, diagenesis, colour, biota and other properties of the sediments. As mentioned earlier, reducing conditions favour the formation and preservation of petroleum hydrocarbons. The role of bacteria in the formation and dissolution of ferro-manganese nodules has been well established. The extensive observations of several workers have established that calcium carbonate precipitation is influenced by microbial activities; mostly by their effects on the pH which affects the solubility of calcium carbonate.

Bioluminescent bacteria are most common in the marine environment. They are mainly saprophytic but some of them grow as symbionts in the light glands of certain fishes and squid.

Besides these basic processes, marine bacteria are involved in biodeterioration of materials, biofouling, corrosion of metals, diseases of marine animals and plants and microbiological pollution of seawater. In addition, these organisms are also known to produce a number of biologically active compounds such as antibiotics, anticancer compounds, plant growth hormones and vitamins.