

Rule of population density of halophiles in the deep-sea

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ABSTRACT

The marine environment occupies about 70% of the earth and the deep-sea area below 1,000 m depth accounts for about 90% of the marine environment. The deep-sea environment which makes up about 63% of the earth's area is the major environment on the earth. The effects of high hydrostatic pressure, which is one of most distinctive features of deep-sea on the microbial diversity was less discussed, even though the pressure regulated genes were reported (1). Do microorganisms range all over the deep-sea environment chaotically? We have studied the microbial biodiversity at the ocean floor of the Izu-Bonin Arc, the Iheya Ridge and the Mariana Trench by isolating microorganisms using various media (2). From the Challenger Deep of Mariana Trench, one of the deepest sites in the world, various microorganisms have been isolated (3), including both non-extremophiles and extremophiles such as alkaliphiles, thermophiles and barophiles. Halophiles, however, were not found in the Challenger Deep. It was expected that the relative abundance of halophiles in the deep-sea microbial flora would decrease as the depth of the sampling points increased (3). Does the deep-sea environment exclude halophiles? In an attempt to answer this question, we focused on the ratio of halophiles to non-extremophiles (abbreviated as "H/N") in the deep-sea and investigated the microbial flora in the sediments of the various deep-sea sediments. Deep-sea sediment samples used in this study were collected at various depths in the range of 1050 - 10898 m by means of a sterilized sediment sampler operated by the manned submersibles or unmanned ROV. Microorganisms were isolated from deep-sea sediment by spreading the sediment on solid agar plates prepared using Marine Broth 2216 (Difco, Detroit, MI, USA) or Marine broth 2216 with 12%(w/v) NaCl

added to attain a final NaCl concentration of 15%(w/v). The plates were incubated at 25°C for 1 week. Non-extremophiles were grown on Marine Broth 2216 and halophiles were grown on Marine Broth 2216 containing 15%(w/w) NaCl. As the result, the population density of halophilic microorganisms in the sea bottom sediment decreases as the depth of the sea increases. The H/N of the deep-sea floor was calculated by regression analysis using the following equation.
 $H/N=(0.999475)^{\text{depth(m)}}$

This trend is due to a decrease in the intracellular concentration of potassium ions, which is a major compatible solute for osmotic stress in microorganisms. The hydrostatic pressure shows opposite effect of osmotic pressure on the microorganisms. The high hydrostatic pressure would cause penetration of H₂O molecules opposite to high osmotic pressure, then intracellular potassium ions would be released.

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