

## Characterization of Psychrotrophic Bacteria in the Surface and Deep-Sea Waters from the Northwestern Pacific Ocean Based on 16S Ribosomal DNA Analysis

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**Abstract:** Seventy-eight 4°C-culturable bacteria were isolated using ZoBell 2216E medium from surface (0–200 m) and deep-sea (1000–9671 m) waters in the northwestern Pacific Ocean. Growth studies indicated that all 4°C-culturable bacteria were psychrotrophs. Six phylotypes were observed in the surface water samples and 8 phylotypes in the deep-sea waters. Phylogenetic characterization based on 16S ribosomal DNA sequence analysis of the representative phylotypes revealed that some bacterial genera, *Pseudoalteromonas*, *Photobacterium*, and *Vibrio*, were common to surface and deep-sea waters, and others, *Pseudomonas* and *Halomonas*, specifically occurred in surface water. Overall, the members of Vibrionaceae appear to be dominant in both habitats.

**Key words:** marine psychrotrophs, 16S rRNA, RFLP, Vibrionaceae, *Vibrio*, *Photobacterium*, *Pseudoalteromonas*.

### INTRODUCTION

Waters in the euphotic zone and the deep sea in tropical and temperate zones provide significantly different habitats for marine microorganisms. In general, the deep sea is permanently cold, below 5°C, and has been referred to as a psychrosphere (Morita, 1975). The euphotic zone, in which photosynthesizing organisms occur, is limited to a relatively

shallow surface layer comprising the top 200 m of the ocean (Libes, 1992) and is well lighted throughout the year, and the continual input of energy from the sun maintains the surface water at temperatures much higher than those in deeper waters. This means that there is a great difference in density between surface and deep waters, and such waters are thermally stratified (Nyabakken, 1982).

Bacteria adapted to low temperatures have been classified on the basis of their temperature relationships by various investigators (Gounot, 1991). However, the terms psychrophilic and psychrotrophic, defined by Morita (1975), have been the most widely accepted definitions. Psychrotrophic bacteria, which are distinguished from psychrophilic bacteria by their growth abilities both at 4°C and at 20°C, have been known to be widely distributed in natu-

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