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Dynamics of Attached Bacteria at the Water-Sediment Interface in a Mesotrophic Swampy Bog of Japan

MOTOO UTSUMI[1], YUKIHIRO NOJIRI[1], NOZOMI YTOW[2] and HUMITAKE SEKI[2]

[1]*National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba, Ibaraki 305, Japan*
[2]*Institute of Biological Sciences, University of Tsukuba, 1-1-1 Tennoudai, Tsukuba, Ibaraki 305, Japan*

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The population dynamics of attached bacteria at the water-sediment interface were studied in a mesotrophic swampy bog, Matsumi-ike, near Tsukuba, Japan. The density of attached bacteria was higher at the sediment boundary layer than in the water column, and low inside the sediment (deeper than 10 mm below the sediment surface) throughout the year. The density of bacteria attached on the glass slide was highest during spring when the source of organic matter in the water column was mainly withered cattail, and gradually decreased toward summer, while the phytoplankton became the dominant source of organic matter in the water column. The epibacterial populations in the water column and at the boundary showed almost the same seasonal fluctuation in attachment and detachment rates. However, bacterial growth rates did not show the same seasonal fluctuation, and annual average growth rates on the glass slides were all lower than that of bacterioplankton (free-living bacteria in water) in the water column.

Keywords:
- Attached bacteria,
- bacterial population dynamics,
- swampy bog,
- water-sediment interface,
- organic nutrients,
- bacterial attachment rate,
- bacterial detachment rate.

1. Introduction

In a swampy bog at the climax stage of limnological succession, phytoplankton and withered emergent plants are the major nutrient sources for bacterioplankton, assuming that the influx of allochthonous organic matter into the bog is negligible (Ytow *et al.*, 1994). There is a lot of phytoplankton biomass during the period from spring to autumn but little during winter. The emergent plants start to grow during spring, die and fall into the water during early winter supplying organic debris. This organic debris can be an important starting point of the detritus food chain in the bog ecosystem. Furthermore, the deposition of organic debris accelerates the progress of limnological succession (Wetzel, 1975).

A large number of bogs with the depths of less than a few meters are found in the watershed of Lake Kasumigaura (Seki, 1974). Most of these bogs are ponds with open water and inlets or outlets of small discharge. They are commonly protected by surrounding pine forests and marshy meadows. These environments characterize the watershed of Lake Kasumigaura to some extent (forest with 23.4% and marshy with 2.0% of the watershed), although this area is an important rice-producing district (agricultural fields with 43.7% and housing land with 5.3%) of the watershed. Some bogs in Tsukuba Science City are modified as a part of gardens in the research institutions (Bloom and Asano, 1981) and may be well maintained, and not polluted. Matsumi-ike Bog (140°06′40″ E, 36°05′20″ N), where this study has been conducted, is one of these bogs in a marsh in the campus of the University of Tsukuba.

Aquatic bacteria associated with a solid surface utilize the nutrients concentrated on the solid surface (ZoBell and Anderson, 1936). Due to limnological succession, a swampy, shallow bog has a large interface area between water and solid surface and abundant particulate organic materials (POM) in the water column. In a shallow bog, the contribution to the nutrient cycling of epibacteria relative to bacterioplankton should have much greater significance than in deeper ponds or lakes.

In previous work (Aida *et al.*, 1988; Batomalaque *et al.*, 1992), the study of epibacterial population dynamics focused on bacteria in the water column, but dynamics of the epibacterial population at the sediment/water interface has not been studied in bogs. We report here dynamics of the epibacterial population at the bottom boundary layer in Matsumi-ike Bog, a mesotrophic swampy bog.

2. Materials and Methods

The attachment, detachment and growth kinetics of the epibacterial population at the boundary between the water column and the ooze sediment were studied at Matsumi-ike Bog (Naganuma and Seki, 1985) throughout the year from 1992 to 1993.

A set of 6 glass slides (non-fluorescence) were submerged at the boundary between the water column and the ooze sediment for 3 days to examine the vertical distribution