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Larval settlement of a bivalve *Theora lubrica**

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1. Introduction

A small semelid bivalve *Theora lubrica*, selective deposit-feeder, predominates on the extreme surface of soft muddy sediment in eutrophic waters of Japan, and has largely increased in recent years (KIKUCHI and TANAKA, 1976; IMABAYASHI and ENDO, 1985). The benthic juveniles die out gradually as an ambient dissolved oxygen reduces, but a small number of adults barely survives even in late summer when oxygen-deficient water develops markedly at bottom layer(TANAKA and KIKUCHI, 1979; IMABAYASHI, 1989). On the other hand,the bivalve is capable of spawning all the year round except for some populations (KIKUCHI and TANAKA, 1976), and therefore the planktonic larvae can settle continuously on a favorable area.

Other characteristics of the bivalve are as follows;

1) The benthic juveniles are eaten by large benthos, e.g., penaeid shrimp buried in sediment.
2) The yearly production is estimated 21 g dry weight/m² in the Seto Inland Sea (unpubl.).
3) The species takes an opportunistic life in macrobenthic community (KIKUCHI and TANAKA, 1976).

The study deals with a mechanism of its larval settlement. Investigation was mainly conducted in Hiuchi-Nada, the Seto Inland Sea, which has been greatly eutrophicated and polluted because of industrial development (OCHI and TAKEOKA, 1986; KAGAWA, 1986). Seasonal fluctuations and distributions of the planktonic larvae and benthic juveniles are examined in relation to oxygen deficiency and tidal current. The survival rate and growth are also estimated.

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2. Distribution and tolerance to oxygen level in benthic life

The bivalve, together with polychaetes, was abundant in the muddy sediment of eastern Hiuchi-Nada. In late summer when thermal stratification was formed (OCHI and TAKEOKA, 1986), dissolved oxygen concentration was generally diminished in near-bottom layer while the planktonic bivalve were found at ovarall bottom layer. During summer, although the bottom water located 0.5 m above sediment frequently decreased to 1 ml/l (oxygen saturation: 15%), the bivalve was last survived among macrobenthic community. The density was remarkably low at stations under 3 ml/l (45%). These oxygen-deficiency produced hydrogen sulfide from muddy sediment including much organic substances.

Respiration was measured in a laboratory. The oxygen uptake kept a given level to almost anoxic condition at a temperature of 10 and 15℃, while decreased at higher oxygen saturation (about 20%) at 20℃. It means that the bivalve has a strong tolerance to low oxygen, especially at low temperature.

It is, therefore, deduced that the death in late summer is directly caused by hydrogen sulfide.

In 1972, most of the macrobenthos died out because the anoxic water mass developed on a large scale. Before long the bivalve firstly increased, and thereafter several kinds of polycheates recovered the densities in eastern Hiuchi-Nada. In recent years the bivalve has been gradually dispersed to the western region (IMABAYASHI and ENDO, 1985). From its opportunistic life, western Hiuchi-Nada is considered to be steadily affected by oxygen-deficient water.

3. Distribution and density of planktonic larvae

Larval settlement was examined in a favorable

nursery area for benthic juveniles (IMABAYASHI, 1984; IMABAYASHI and IWATANI, 1988, 1990), a collection of which was made with a core-typed bottom sampler. The settlement occurred at metamorphosing stage, which widely ranged from 132 to 196 μm in shell length. Planktonic larvae collected with plankton net were represented by umboned stage, larger than 125 μm, because this size is the smallest size for identification (TANAKA, 1981).

Seasonal change in the density of planktonic larvae was different from that of benthic juveniles, which died out in late summer. Planktonic larvae hardly decreased during summer, although fluctuated from 10^2 to 10^4 shell/m^3 in a year.

Vertical and horizontal distributions indicated that the density was high at bottom layer and near coast. On the other hand, planktonic larvae were always migrating along the bottom, according to a large tidal oscillation with a spring range of 2.9 m. Hence it is due mainly to these larval migration that a large settlement occurs at a favorable area and period for benthic life.

Survival rate at the settlement was estimated from the wild and reared populations. Umboned larvae (132–164 μm) and metamorphosing larvae were simultaneously collected at the peak of settlement (May-July) and at the recovery of settlement (September-December). Survival rate of the umboned larvae was approximately 20%, whose value was the same rate as that during metamorphosing stage. On the other hand little mortality was observed after the settlement by rearing the metamorphosing larvae obtained in a field, and thereafter benthic juveniles hardly died within 2 weeks. Before umboned stage a high and constant mortality was expected from various rearing conditions.

It is, therefore, suggested from a schematic survival process that the survival rate changes remarkably after the settlement (Fig. 1).

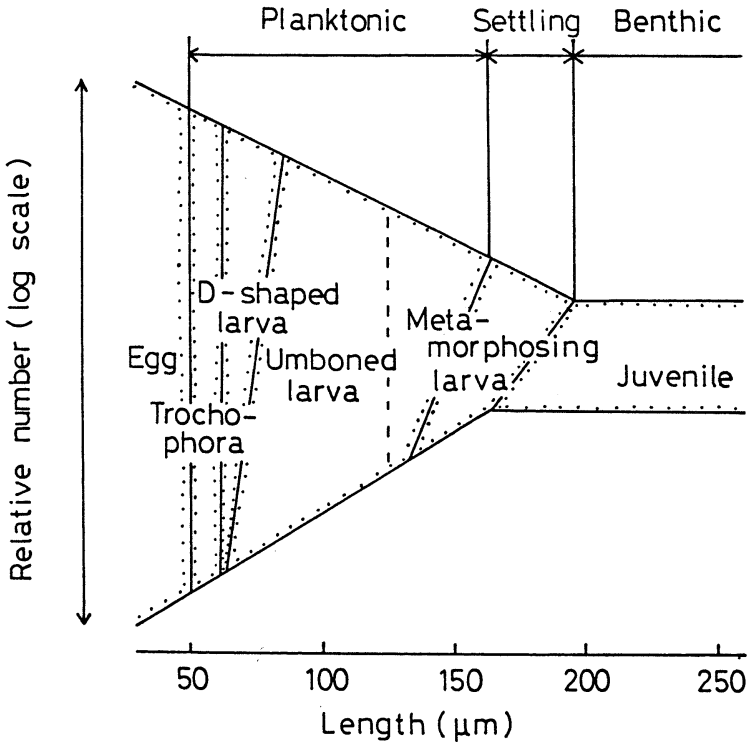

Fig.1. Schematic survival process at the settlement of *Theora lubrica*.

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