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NATURAL CONVECTIVE MOTION AND ITS SIGNIFICANCE IN PHYTOPLANKTON STRUCTURE DUE TO GRAZING BY SUSPENSION-FEEDERING BIVALVES

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Introduction

In order to overcome the problem of eutrophication different ways and methods have been proposed to improve water quality. Among them we have proposed a method using the self-purification process with the aid of suspension-feedering bivalves. This suspension-feeders are capable of filtering large volume of water, capture substantional amount of suspended matter and play a major role in determining phytoplankton standing stock through feeding and nutrient excretion activities. Nakamura et al. (1988) showed that *Corbicula japonica* is quite abundant in Lake Shinji and dominates the macrobenthos standing stock in numbers as well as in biomass (it comprises almost 97% of macrozoobenthos). Bivalves in Lake Shinji have areal distribution chiefly located on the littoral zone (0-3 m deep), with population density up to 3800 individuals per m^2. The abundance of phytoplankton is, however, inverse to that of bivalves with high concentration in pelagic and low in littoral zone. Then the question arises how and when plankton is transported to the littoral benthic layer to be uptaken by bivalves. In order to understand the transport mechanism, we have conducted a continuous measurement in Lake Shinji.

Materials and methods

Measurements were carry out from 1996.8.1 at 18:00 until 8.3 13:00, every 6 hours interval, in seven stations situated on a straight line perpendicular to north shore (Fig 1). In each station were measured salinity, temperature, depth, chlorophyll a and DO. Temperature and salinity were measured by STD (Alec Electricity, ASD100-PK) at 10 cm intervals. Chloropyll a and DO were measured by Turner Designes Model 10 and by DO meter (YSI, Model 58) at 50 cm intervals.

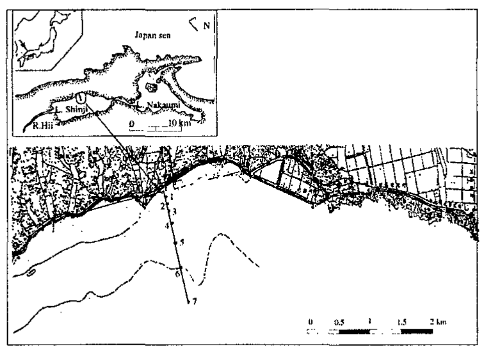

Fig 1. Map of Lake Shinji and location of measurement stations

Results and discussions

In Fig 2 are shown morning, afternoon, and evening picture of temperature and chloropyll a distributions, respectively. Diurnal differential heating and nocturnal cooling make feasible that, the shallow littoral waters to have higher temperature than deper pelagic region and vice versa. During nighttime a horizontal temperature gradient is set up in the littoral region and the isotherms appeares almost vertical, with time cooler water propagated along the bottom toward the pelagic region of the lake. Chloropyll a concentration distribution was quite similar to that of temperature. The concentration in the littoral region was the lowest at nighttime and highest at daytime. It is strongly suggested that the low chl. a concentration appeares as aresult of intensive filtration of water by bivalves.

Estimation of uptake rate of phytoplankton by bivalves

The mass balance of chl. a, was done based in a box model analysis as is shown in Fig 3 which indicate and a possible way how the suspension-feedering bivalves (bottom habitants) due to the convective circulation can graze the phytoplankton (mostlylocated at surface). Two methods are employed to estimate the uptake rate of phytoplankton by suspension- feeding bivalves, *Corbicula japonica*. Material balance of chlorophyll in the littoral is given by the following equation;

$$V\frac{\Delta C}{\Delta T} = (C_{\infty} - C_0)\, Q - R\, S \qquad (1)$$

where: period of observation, $\Delta T = 11$ hr (8/2 13-1400--8/3 0-100 hours); difference in chlorophyll a concentration, $\Delta C = 5\ mg/m^3$; average concentration in littoral zone, $C_0 = 5.5\ mg/m^3$; concentration in pelagic water, $C_{\infty} = 10\ mg/m^3$;circulation flow rate, $Q = 300\ m^3/11$ hr; (circulation flow rate is estimated having in regard the volume

Key Words:Suspension-feederng bivalves, convective circulation, differential heating and cooling, chl. a, natural purification, phytoplankton.

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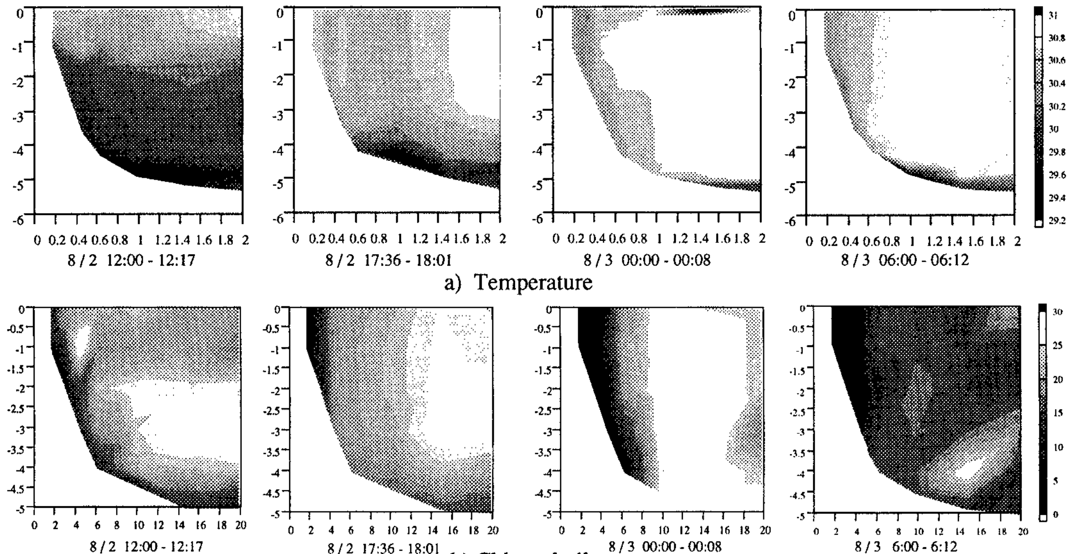


Fig 2. Temperature and chlorophyll a distributions

circulation flow rate, $Q = 300\ m^3/11\ hr$; (circulation flow rate is estimated having in regard the volume of water restricted within isotherm 30.8°C and its replacement during the interval of observation); volume of littoral water, $V = 450\ m^3$; surface area of sediment, $S = 400\ m^2$. Using above values we can estimate R as;

$$R = 0.82 \text{ mg Chl.a/m}^2 / \text{hr}.$$

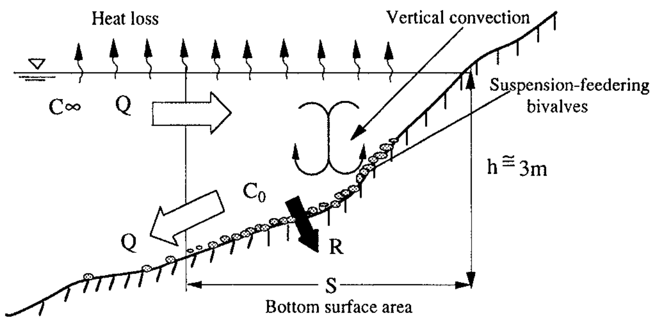
Using literature values on the filtration rate, F, biomass density, m, and weight conversion factor, γ, from Nakamura et al (1988), we can also estimate the uptake rate as $R' = F\ C_0 m\ \gamma = 0.72 \pm 0.17$ mg Chl.a / m²/ hr. This value is very close to R estimated from field obtained values, suggesting high credibility for the mass-balance method.

Conclusions

Simultaneous and continuous measurements of temperature, salinity, DO and chlorophyll a concentration, enables us to figure out the role of convective circulation in an estuarine ecosystem.

Diurnal heating and nocturnal cooling lead to net density gradients that drive strong horizontal mass exchange.

Analyses of material balance of chlorophyll a concentration in littoral water suggest that natural convective motion during night time, enhance a possibility for bivalves *Corbicula japonica*, to capture phytoplankton contained in water column and that associated circulation current provide material coming from pelagic region.



$$\int_{t_1}^{t_2} V \frac{\Delta T_{l(m)}}{\Delta t} dt = \int_{t_1}^{t_2} \frac{S_0 H}{C_p \rho} dt - \int_{t_1}^{t_2} Q(T_l - T_p)\, dt \qquad V\frac{dC_0}{dt} = (C_\infty - C_0)Q - RS$$

Fig 3. Box model analysis and schematic expressing of mass balance of chl. a.

Combination of active filtration by bivalves and their fisheries yield relieve the estuarine ecosystems of hypertrophication and thus controls natural purification process through benthic-pelagic coupling.

References

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