# THE ROLE OF CONVECTIVE CIRCULATION IN COUPLING PELAGIC AND BENTHIC PROCESSES IN A BRACKISH LAKE

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## Introduction

Nowadays Lake Shinji is suffering seriously from 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 in well as 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.

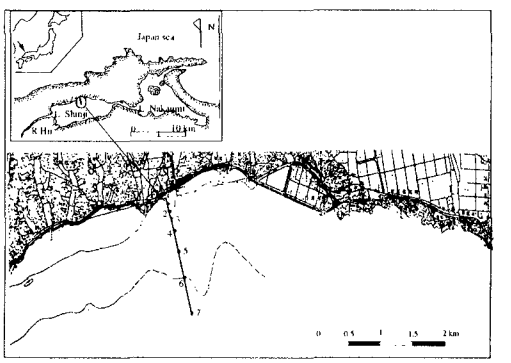


Fig 1. Map of Lake Shinji and location of measurement stations

## 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 was measured by STD ( Alek 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.

## Results and discussions

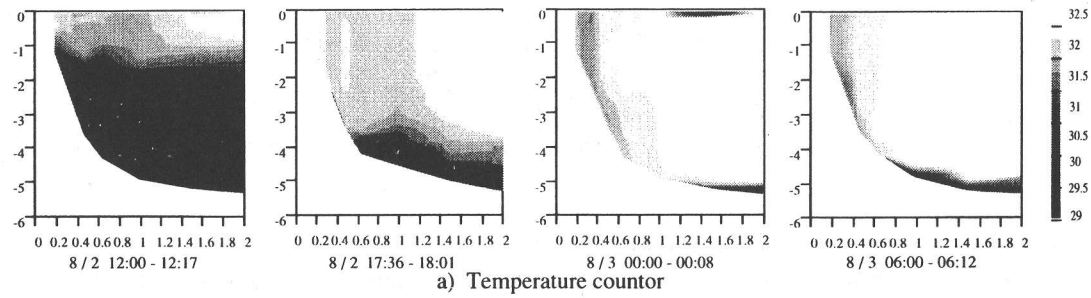
In Fig 2 are shown morning, afternoon, and evening picture of temperature and chloropyll a distributions, respectively. In the daytime a daily thermocline was formed at 1.5 m due to solar radiation, but it was destroyed by 18:00 hr because of wind mixing. A secondary thermocline was formed below the first one at about 4.5 m depth. During nighttime a horizontal temperature gradient is set up in the littoral region. With time cooler water propagated along the bottom toward the pelagic region of the lake. Chloropyll a concentration distribution was quite similar to temperature distribution. The concentration in the littoral region was the lowest at nighttime and highest at daytime. It is strongly suggested that the low concentration water was formed by the action of filtration by bivalves.

## Estimation of uptake rate of phytoplankton by bivalves

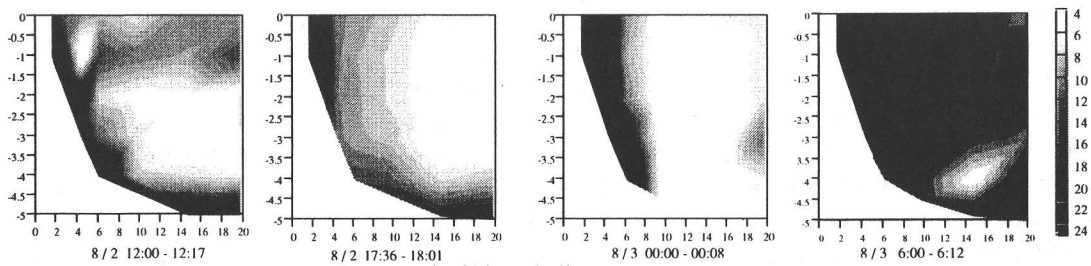
In Fig 3 is given a scheme how the bivalves can get the phytoplankton through the convective circulation which is initiated due to the pressure difference caused from horizontal temperature gradient. Two methods are employed to estimate the uptake rate of phytoplankton by suspension- feeding bivalves, *Corbicula japonica*. Material balance of chlorophyll in the littoral is given by equation

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

Where: Period of observation : $\Delta T$ = 11 hr (8/2 13-1400--8/3 0-100 hours). Difference in chlorophyll a concentration: $\Delta C = 5\ mg/m^3$.




a) Temperature countor




b) Chlorophyll countor

Fig 2. Temperature and chlorophhyll a distributins

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 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: $R = 0.82$ mg Chl.a/$m^2$ / hr . Using literature values on the filtration rate, F, biomass density, m, and weight conversion factor, $\gamma$, from Nakamura et al (1988), we can also estimate theuptake rate as $R' = F\ C_0 m\ \gamma = 0.72 \pm 0.17$ mg Chl.a / $m^2$ / hr .This value is very close to R estimated from field obtained values, suggesting high credibility for the mass-balance method.

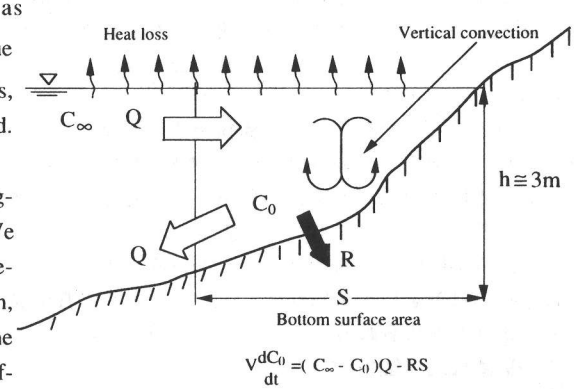



Fig 3. Schematics expressing mass balance of chl. a

## Conclusions

Convective circulation in brackish lake is a significant mechanical process thermally produced. We have conducted simultaneous and continuous measurements of temperature, dissolved oxygen concentration, chlorophyll a, salinity, in a littoral zone of a mesohaline brackish lake, Lake Shinji in order to figure out the effect of convective circulation on uptake rate of phytoplankton by suspension-feeding bivalves *Corbicula japonica*. 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 this circulation especially during cooling period, mainly support bivalves feeding, of phytoplankton and thus controls natural purificationprocessthroughbenthic-pelagic coupling.

## References

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Nakamura et al. Role of the bivalve *Corbicula japonica* in nitrogen cycle in a mesohaline lagoon. (1988) Marine Biol,.99