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# SUMMER ZOOPLANKTON COMPOSITION, VERTICAL DISTRIBUTION AND BIOMASS IN LAKE IKEDA, SOUTHERN KYUSHU, JAPAN

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**Abstract**

Summer zooplankton composition, vertical distribution and biomass of limnetic zooplankton in Lake Ikeda, Japan were investigated during September 2006. A total of eleven species including four copepods, five cladocerans and two rotifers occurred. Cladocera was most dominant group followed by Copepoda and Rotifera; they represented 63%, 33% and 4% respectively. *Diaphanosoma brachyurum*, *Bosmina longirostris* and *Eodiaptomus japonicus* were found abundantly. The Cadocera *Daphnia galeata* is newly recorded for the first time from Lake Ikeda. Vertical distribution showed that most of zooplankton population preferred either deep epilimnion (10 m) or hypolimnion (20 m) but, avoided surface water. Biomass was highest at 10 m depth. According to Carlson's trophic state index (TSI) Lake Ikeda is still mesotrophic lake, however, appearance of *Daphnia galeata*, a new invader, indicates that process of eutrophication is prevailing.

**Keywords:** Zooplankton, summer composition, vertical distribution, Lake Ikeda.

## 1. Introduction

Lake Ikeda is a caldera lake situated in southern Kyushu Island, near Ibusuki town, Japan. It has surface area 10.95 $km^2$ and a maximum depth 233 m and stands as fourth deepest lake of Japan. It is a warm monomictic lake and stratifies in summer. It was a very clear water lake having secchi transparency of 26m in 1929 (Baloch *et al*., 1998). Surface water temperature usually ranges in between 12-30ºC, being lowest in February and highest in August. Previous studies on the lake (Baloch, 1995, 1998) revealed that zooplankton populations usually remain scarce at lowest temperature and highest in spring with a sharp decline before highest temperature. Lake Ikeda is considered as mesotrophic lake gradually changing to eutrophic one. The present study is a follow-up study and primarily aims to note any change in zooplankton community and water quality of this lake after passing a decade.

## 2. Materials and Methods

Quantitative zooplankton samples were collected at deepest point (center of lake) from three different depths, 0 m, 10 m and 20 m, using Niskin Bottle (2.5 l×2) making a total volume to 5l. Each sample was filtered through a plankton net having mesh size 95µ. One qualitative zooplankton sample was also collected using Marukawa closing plankton net (95µ mesh) from 20-0 m depth to enumerate relative abundance of main zooplankton and to check rare species. All zooplankton samples were preserved in 5% formalin on the spot. Water samples were also collected for Chlorophyll *a*, (Chl *a*) a total of 200-300 ml lake water was filtered through 1µ. Filtered and non filtered water samples (one liter each) were taken for Total Phosphorus (T-P), silicate, Nitrite, Nitrate and Ammonia determination. Temperature was noted from water column at surface through a depth of 21 m, at an interval of 2m using compact thermometer. Chl *a* was determined by Fluorometric analysis (Welschmeyer, 1994). Phosphates, T-P, nitrate, Nitrite, Ammonia and Silicate were analyzed according to JIS (1986) methods. Carlson´s Trophic State Index (TSI) was calculated for T-P and Chl *a* (Carlson, 1977).

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Zooplankton were identified up to species level under stereo microscope using illustrations given by Tanaka (2002). Relative abundance of major zooplankton species were enumerated by counting three aliquot sub samples of 1mm using Sedgwick-Rafter counting cell and are presented as percentage. Nauplii were not included in counting. For quantitative analysis whole samples were analyzed and counted. Zooplankton body lengths were measured according to Clark (1999) and following regression equations to different zooplankton were used to convert into biomass (dry weight).

*Bosmina*, $W=17.7369\times L^{2.2291}$
*Daphnia*, $W=7.4997\times L^{1.5644}$
*Diaphanosoma*, $W=5.0713\times L^{1.0456}$
*Cyclops*, $W=5.6713\times L^{1.9347}$
*Diaptomus*, $W=7.8273\times L^{2.6484}$
Where, W= weight (µg) and L= length (mm)

## 3. Results

Thermal stratification was evident in the lake, epilimnion sank down up to 12 m, while thermocline was found in between 12-20 m depth and hypolimnion was below 20 m **(Fig. 1)**. The water quality parameters showed a homogeneous distribution of Silica in the three depths. Nitrite was less than 0.001 mg/l at all depths however, Nitrate was higher in deep waters. Total Phosphorus and Chl *a* showed inverse proportion to each other; T-P was higher at surface but Chl *a* was higher at 20 m depth **(Table 1)**.

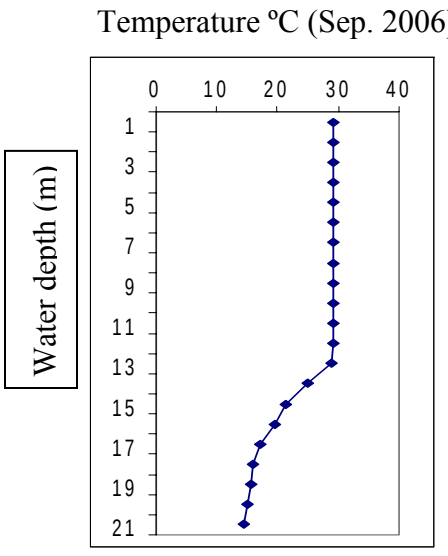



**Fig. 1. Vertical profile of water temperature ºC.**

**Table 1. Chemical parameters at different water depths in Lake Ikeda.**

| Parameters | Depth (0.5 m) | Depth (10 m) | Depth (20 m) |
|---|---|---|---|
| Silica (mg/l) | 1.98 | 1.99 | 1.98 |
| Nitrite (mg/l) | <0.001 | <0.001 | <0.001 |
| Nitrate (mg/l) | <0.001 | 0.054 | 0.308 |
| Ammonia (mg/l) | 0.0037 | 0.0056 | 0.0003 |
| Phosphate (mg/l) | 0.007 | 0.008 | 0.005 |
| T-P (mg/l) | 0.015 | 0.012 | 0.01 |
| Chl *a* (µg/l) | 1.23 | 1.21 | 3.34 |
| DO (mg/l) | 7.2 | 6.79 | 6.64 |
| Conductivity (µS/cm) | 107 | 111 | 111 |

Zooplankton showed low number of species as well as low populations. A total of eleven species were observed including four copepods, five cladocerans and two rotifers **(Table 2)**.

**Table 2. Zooplankton species identified from Lake Ikeda.**

**COPEPODA**
*Eodiaptomus japonicus*
*Mesocyclops leuckarti*
*Thermocyclops hyalinus*
*Limnocaea genuina*
**CLADOCERA**
*Diaphanosoma brachiurum*
*Diaphanosoma orientalis*
*Daphnia galeata**
*Cereodaphnia reticulata*
*Bosmina longirostris*
**ROTIFERA**
*Asplanchna priodonta*
*Ploesoma lenticulare*

*Newly recorded species

*Daphnia galeata* was never recorded from this lake previously and it is recorded for the first time from Lake Ikeda during present investigation. The populations of *Ceriodaphnia reticulata* and

*Daphnia galeata* were very scarce but nevertheless, present. The abundant species were two cladocerans, *Diaphanosoma brachyurum* and *Bosmina longirostris* and one copepod, *Eodiaptomus japonicus*. Among zooplankton *Diaphanosoma* spp. were included *D. brachyurum* and *D. orientalis* and were the most abundant (37%) while *Eodiaptomus japonicus* contributed (30%) and *Bosmina longirostris* (27%). Rotifers were very scarce and only *Asplanchna priodonta* contributed (4%) of total population. Cyclopoids were included *Thermocyclops hyalinus* and *Mesocyclops leuckarti,* they were less abundant (3%). Another cladoceran *Ceriodaphnia reticulata* contributed < 1% **(Fig. 2)**.

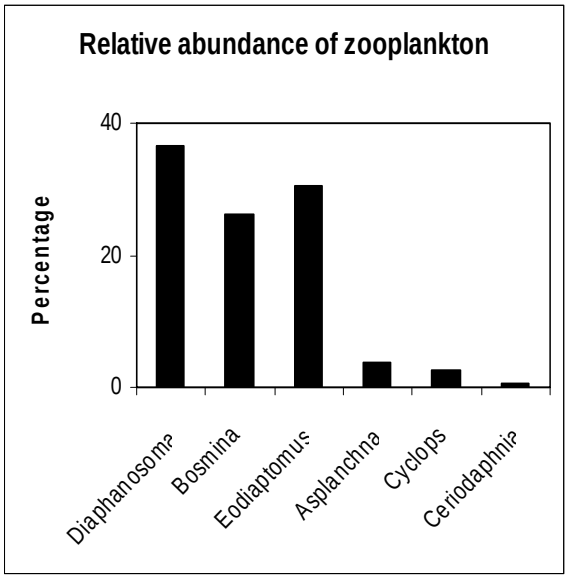



**Fig. 2. Relative abundance (Percentage) of zooplankton.**

The vertical distribution showed that copepods and cladocerans appeared at different depths; highest population of *Diaphanosoma* spp. were seen in deeper epilimnion, but lower populations were observed at surface and at 20 m depths (Fig. 3). *Bosmina longirostris* population increased with increased depth and highest population occurred at 20m depth. *Eodiaptomus japonicus* was well distributed throughout all three depths. Cyclopoids were absent at surface layer but present at 10 m and 20 m, with comparative higher population below thermocline. Total zooplankton were lower at surface but fairly distributed at 10 m and 20 m depths.

Biomass of major zooplankton species also followed the same pattern as was population however, total biomass was comparatively higher at 10 m depth **(Fig. 3)**. Carlsons Trophic State Index (TSI) was calculated for Chl *a* and T-P as followed,

$$TSI\ (Chl\ a) = 9.81 \ln (chl\ a) + 30.6$$
$$TSI\ (T\text{-}P) = 14.42 \ln (T\text{-}P) + 4.15$$

The results showed that maximum readings for both were more than 40 **(Table 3)**. For T-P (0.5 m) and for Chl a (20 m). This indicates that Lake Ikeda is a mesotrophic lake and not a eutrophic one.

**Table 3. Carlsons Trophic State Index (TSI).**

| Depth (m) | TSI (T-P) | TSI (Chl a) |
|---|---|---|
| 0.5 | 43.20 | 32.66 |
| 10 | 39.98 | 32.43 |
| 20 | 37.35 | 42.44 |

## 4. Discussion

Zooplankton community of Lake Ikeda is presently dominated by Cladocera, that differs from previous studies; previously Copepoda and Rotifera were found dominant (Baloch, 1995, 1998). Dominance of Cladocera is related to mesotrophic or eutrophic environments but not the oligotrophic ones (Byron *et al.*, 1983). Kurasawa (1975) studied several Japanese lakes. He concluded that copepoda dominate oligotrophic lakes, whereas Cladocera or Rotifera dominate eutrophic lakes. The amount of total phosphorus (T-P) that was usually found lower than 0.01 mg/l, presently it shows comparatively higher quantity (0.015 mg/l). This indicates that the lake is continuously changing its trophic status. Carlson's TSI revealed that Lake Ikeda is a mesotrophic lake however, appearance of a new cladoceran filter feeder *Daphnia galeata*, suggests that food availability in lake Ikeda is more than sufficient. Cladoceran abundance is believed to depend mainly on the level of available food and predation (Dawidowicz and Pijanowska, 1984). In Lake Ikeda no potential invertebrate predator is present. On the other hand copepods are considered more successful than cladocerans in food-poor environments (Allan and Goulden, 1980).

Relative lower copepod population suggests that it is not a food-poor environment and hence Cladocera are more successful. The rotifers are opportunistic in nature and appear and disappear within a very short period of time (Allan, 1976). The lower rotifer population at present might be part of their opportunistic occurrence.

It is obvious from the present studies that there is continuous change in species composition of Lake Ikeda and the process of eutrophication is prevailing in lake however, the lake is deep enough to retain the position of mesotrophic for longer period of time. In Lake Ikeda temporary eutrophication is reported following unusual heavy rains (Baloch, 1998). From these observations it can be concluded that Lake Ikeda is a mesotrophic lake and process of eutrophication is prevailing with a very slow rate.

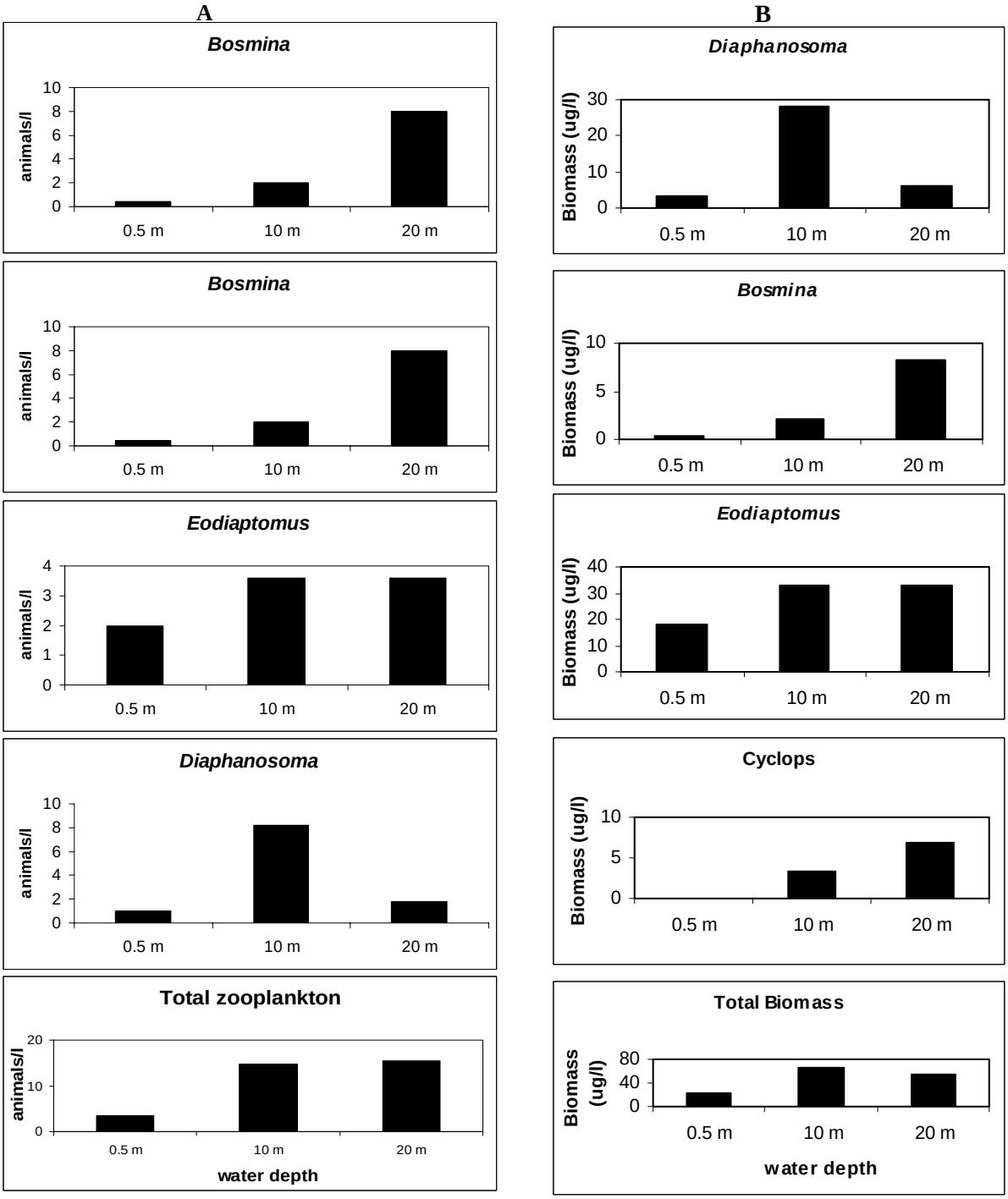



**Fig. 3. Vertical distribution of (A) zooplankton population and (B) zooplankton biomass in Lake Ikeda.**

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