Dormant Progagule Banks of Cladoceran Communites and Hatching Success from the Sedimentin China

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Abstract: The resources of cladoceran communitesin lakes in typical eutrophic shallow lakes in Chinawere investigated. Diapausing eggs of cladocerans were collected from the surface sediment of typical eutrophic shallow lakes and then hatched in the laboratory. The most common and dominant genera were *Bosmina* sp., *Ceriodaphnia* sp.,*Alona* sp.and*Moina* sp.The density of large cladocerans in the hatchlings was lower than the small cladocerans (Bosmina, Ceriodaphnia,Alonaand Moina). The distribution and abundance and species of Daphnia community were significantly influenced by TN and fish community.

1. Introduction

A portion of thesediapausing eggs will experiencea period of dormancy and then hatch as long as the climate gets favorable, while the otherdiapausing eggs remained will constitute the growing diapausing eggs library [1]. The diapausing eggs accumulated in this library was produced in different periods by various zooplankton animals that lived in different habitats and occupied different ecological niches, some of these eggs still have incubation capacity after decades or even hundreds of years of their production [2]. The research of diapausing eggs and diapausing egg library offers important applications in several fields,such as natural protection, diversity exploration, paleolimnology, taxonomy, evolutionary ecology, ecological biogeography and population and community ecology [3-4].

Previous studies have investigated the zooplankton communities in the thirty lakes in the middle and lower Yangtze River, finding that the density of large species of Daphnia is generally small, while small species of *Moina micrura* (*M. micrura*), *Diaphanosoma brachyurum* (*D. brachyurum*) and *B. coregoni*were the most common and dominant species [5]. In addition, Gao and Xu (2009), Wang

(2003) and Zheng (2009) [6-8] investigated Poyang Lake, Ou Jiang and Dianshan Lake respectively, showing that Daphnia is no longer the dominant species and that large zooplankton community has been declining obviously. Therefore, we studied the dormant crustaceancommunity from typical eutrophic shallow lakes in China. The aims of our work were to identify the eggs and investigate the hatching success, whichcould provide the basic informationfor large zooplankton community diversity in typical eutrophic shallow lakes in China.

2. Material and methods

2.1. Study site

Limnological characteristics of the studied lakes were shown as Table 1.

Table 1 Limnological characteristics of the studied lakes in China

Lake	Latitude	Longitude	Altitude(m)	Samples	Area(km^2)	Depth(m)
Dianchi	24°45′~24°57′	102°38′~102°42′	1887	7	309	5.3
Xingyun	24°18′~24°21′	102°45′~102°47′	1722	5	38.6	5.6
Chao	31°28′~31	117°20′~11	23	10	753	3.06

2.2. Sampling and sample processing.

Qualitative zooplankton samples were collected using a conical tow-net (diameter, 64 μm mesh), combining vertical hauls with horizontal hauls. Samples were washed in the net and fixed in 100% ethanol.

Diapausing eggs of zooplankton were collected within the surface sediments (0-5 cm), which were sampled using a Petersen grab to ensure that only the top-most layer of flocculent mud was taken. These samples were stored without fixation. Subsamples of surface sediment were firstly washed through a 1.25mm mesh metal sieve and then through a 200 μm mesh metal sieve. Subsequently, the residue was packaged respectively in dark at 4℃ in a week for later use.After the cold storage, quantitatively take out the mud sample to a 250ml beaker, add 200ml filtrated lake water (using 0.45μm filter membrane), and make hatch in the light incubator. Incubation experiment went on until no new individual hatchlings came. Incubation temperature was 24 ± 2 ℃, 40μmol/m^2·s and darkness14L: 10D[9-10].In the laboratory, hatchlings in the zooplankton samples were identified using a compound microscope with reference to Jiang and Du[11] and Shen [12] respectively.

Total phosphorus (TP), total nitrogen (TN) and sediment total organic carbon (STOC) were measured. The way of determination of total phosphorus in the sediment was called SMT [13]. Extraction of total nitrogen used the method of the persulfate digestion [14], and determination of total nitrogen in digestion solution was spectrophotometry. The column of total organic matter was supposed to be determined by the potassium dichromate method [15].

2.3. Statistical analysis.

Multivariate ordination techniques (using Cladoceran diapausing eggs abundance) were carried out using the software CANOCO 4.5[16].Descriptive statistics and Pearson and Spearman correlations for

environmental variables and biologic variations about hatchlings were calculated using SPSS (version 16.0) at 0.05 and 0.01 significance level.

3. Results

Diapausing eggs of cladocerans were collected from the surface sediment of the eutrophic shallow lakes and hatchling results were shown in Fig.1-Fig.2. Sediment incubation from Xingyun Lake were mainly dominated by copepods with the density of 39~422/m^2.There is only one site in Xingyun lake which hatchlings density of Ceriodaphnia quadrangula (Ceriodaphnia quadrangula) is up to 344 /m^2; the hatchlings density in other sampling sites were just 101 ± 15 /m^2. For the incubation of diapausing eggs in Dianchi, large cladocerans Daphnia hyalina and Daphnia pulex were detected in two sites (S-5# and S-7#).The most notable thing was the density of D. pulex from sediment incubation could reach up to 336/m^2 in the south of Dianchi lake near the Haikou site (S-7#).

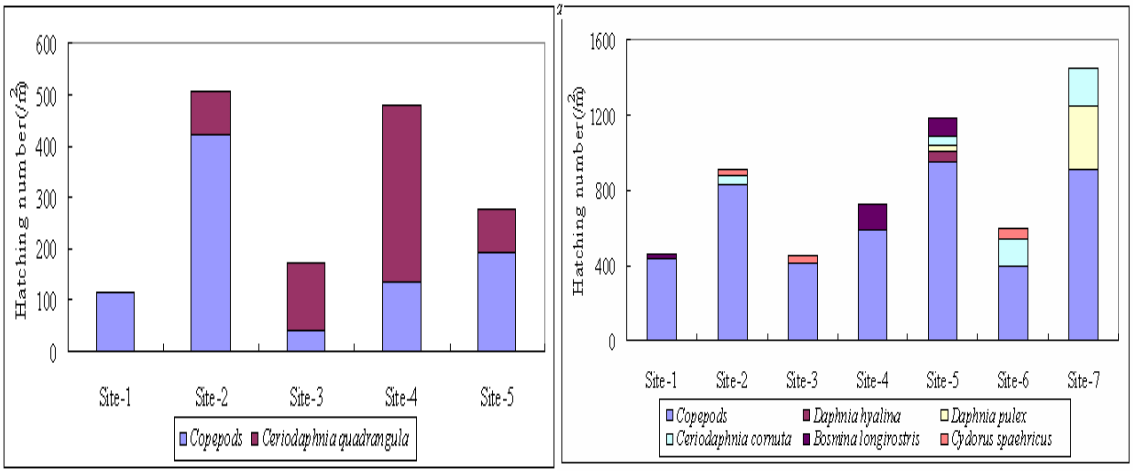

Fig. 1 Taxonomical composition of the resting egg collected in the sediment in XingYun Lake and Dianchi Lake (Left: Xingyun Lake; Right: Dianchi Lake)

The hatchlings of chaohu were shown in Fig2. Daphnia has been found in the sediment, but the dominant genera were small cladocerans. In Chaohu, there were five species of Daphnia in sediment hatchings, including *D.longispina*, *D. pulex*, *D. cucullata*, *D. hyalina* and *D.magna*. The small Cladocerans were dominant, in which *Bosmina* and *Daphniidae* were the most common species and accounted for about 20% ~ 30% of the hatchlings.

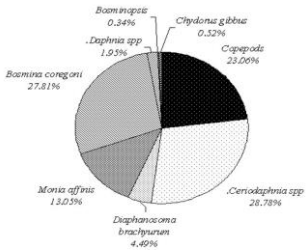

Fig. 2 Composition (%) of main species hatched from the sediment in Chaohu Lake

4. Dissusion

In this study, TN was significantly positively correlated with the distribution and species of the diapausing eggs by Pearson correlation coefficient sand probability levels between parameters of hatchlings and physico-chemical factors in lakes. The results indicated that TN may influence the abundance of the eggs in sediments.

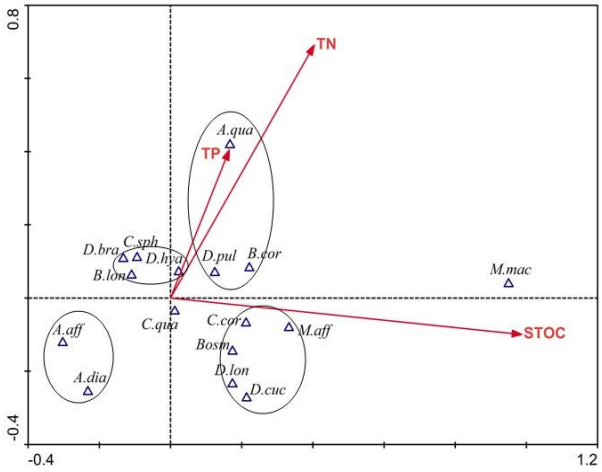

Fig. 3 CCA ordination diagram of 16 species of the Cladoceran

The CCA first ordination axis was significantly positively correlated with STOC, indicating that STOC was the mainly environmental factor in Cladoceran species distribution. According to the results of CCA, 16 Cladoceran species were divided into four groups (Fig. 3). *Alona affinis* and *Alona diaphana* were classified as group1, which was adaptive to low TN, TP and TOC environment. *Diaphanosoma brachyurum*, *Bosmina longirostris*, *Chydorus sphaericus*, *Daphnia hyaline* were classified as group 2, which lives well in the environment with high TN and TP but low STOC. *Alona quadrangularis*, *Daphnia pulex* and *Bosmina coregoni* as group 3 was adaptive to the environment with high TN, TP and TOC. The rest five species classified as group 4 was adaptive to the environment with high STOC but low TN and TP.

P. M. Mara-Barbosa *et al.* [10]found a large number of diapausing eggs produced by cladoceran and rotifer in the sediment of eutrophic lake, with the abundance ranging from $203.2\times10^3/m^2$ to $80\times10^3/m^2$.This may be caused by the fact that the distribution and incubation of diapausing eggs of cladoceran community in natural water body were easily affected by the biological disturbance and ecological restoration, for example, dredging, intercepting and renewing water.

In recent years, highly planktivorous fish stock along the middle and lower reaches of Yangtze River, the herbivorous zooplankton assemblage is characterized by small species and low density of large species. Fish communities from lakes in south western China were mainly composed of autochthonous fish species, accounting for 68%. The fish species composition and productions in southwest Lakes were different from those in the middle and lower reaches of Yangtze River, so they could affect the zooplankton in different ways, including size-structure of the community and the diapausing eggs distribution and abundance.

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