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研究简报

# 引水和疏浚工程支配下杭州西湖浮游动物的群落变化

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摘要　究了引水和疏浚工程支配下浅水、富营养化杭州西湖浮游动物群落的长期变化，包括浮游动物的优势种类组成、密度及生物量与水环境因子的相关分析。疏浚后的2003年调查中，西湖3个采样站的定量样品中共发现69种浮游动物，其中原生动物26种，轮虫27种，枝角类和桡足类各8种。Ⅰ站浮游动物年平均生物量从1990年的0.186mg/L上升到2003年的0.705mg/L，Ⅱ站和Ⅲ站分别从0.665mg/L和0.740mg/L上升到1.399mg/L和1.195mg/L。浮游动物数量组成中原生动物和轮虫平均占99%，并占78%的生物量。在1980～2003年期间，一些优势种类如砂壳纤毛虫（Tintinnoinea）、针簇多肢轮虫（*Polyarthra trigla*）和长额象鼻（*Bosmina longirostris*）等显著增加了它们的丰度和优势度；暗小异尾轮虫（*Trichocerca pusilla*）的优势度在引水后的1990～1995年增加了，但在疏浚后的2003年下降了；而20世纪80年代的一些优势种如毛板壳虫（*Coleps hirtus*）、螺形龟甲轮虫（*Keratella cochlearis*）和短尾秀体（*Diaphanosoma brachyurum*）等在3个采样站中失去优势种地位或消失。原生动物和轮虫生物量在营养水平较高的Ⅱ～Ⅲ站明显高于营养水平较低的Ⅰ站；长肢秀体（*Diaphanosoma leuchtenbergianum*）、长额象鼻、颈沟基合（*Bosminopsis deitersi*）和汤匙华哲水蚤（*Sinocalanus dorrii*）在营养水平较低的Ⅰ站具有较大的密度和生物量，而微型裸腹（*Moina micrura*）和粗壮温剑水蚤（*Thermocyclops dybowskii*）则在营养水平较高的Ⅱ～Ⅲ站具有较大的密度和生物量。西湖各类浮游动物在不同湖区形成不同的分布格局主要由引水水流和水体营养状态差异造成。1990～2003年期间，在采样站变异下，浮游动物中轮虫年平均生物量与水体年平均pH值和叶绿素a含量之间分别有极显著和显著的正相关关系，与水体透明度之间有极显著的负相关关系。引水后的1995年，与轮虫生物量最密切的生态因子是叶绿素a含量，而疏浚后水体碱性环境是影响轮虫生物量最密切的生态因子。

关键词　西湖；引水；疏浚；浮游动物组成；丰度和生物量变化
分类号　Q143,Q178

# Changes in the structure of zooplankton community in Lake Xihu(West Lake), Hangzhou after water pumping and dredging treatments

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**Abstract** he long-term changes of zooplankton, including in species composition, abundance and regression analysis between biomass and water environment have been studied at three sampling stations (from Ⅰ to Ⅲ) of Lake Xihu (West Lake), Hangzhou, a shallow eutrophic lake treated by water pumping and dredging. Station Ⅰ is located in the Xiaonanhu (drawing region), the bay of Lake Xihu, Station Ⅱ and Ⅲ are in the central lake and north-end of the lake (discharge region), respectively. Quantitative sampling of each group of zooplankton were taken monthly from each station in 1990, 1995 and 2003. The main purposes of this paper are to describe long-term changes in zooplankton communities of Lake Xihu, and to discuss the possible mechanisms of the change.
During the survey of 2003, 69 species of zooplankton were identified, among them 26 species we

re Protozoa, 27 Rotifera, 8 Cladocera and 8 Copepoda. From 1990 to 2003, the annual average density of zooplankton at Station Ⅰ from 1270 ind./L increased to 1583 ind./L, from 3229 ind./L to 11022 ind./L at Station Ⅱ and from 3161 ind./L to 7390 ind./L at Station Ⅲ, the annual average biomass at Station Ⅰ from 0.186 mg/L increased to 0.705 mg/L, from 0.665 mg/L to 1.399 mg/L at Station Ⅱ and from 0.740 mg/L to 1.195 mg/L at Station Ⅲ. 99% of abundance and 78.0% of biomass of zooplankton were protozoans and rotifers.

During 1990—2003, some of the dominant species of zooplankton, such as Tintinnoinea, Polyarthra Trigla and Bosmina longirostris increased their percentage in abundance remarkably, whilst the proportion of Diaphanosoma leuchtenbergianum was decreased at three stations, the proportion of Trichocerca pusilla was increased during 1990—1995 after water pumping treatment and declined in 2003 after dredging, Coleps hirtus, Keratella cochlearis and Diaphanosoma brachyurum, which were dominated in 1980s, have been disappeared from three stations in recent years.

The abundance of Protozoa and Rotifera at Stations Ⅱ and Ⅲ were higher than that at Station Ⅰ for their higher trophic level. Diaphanosoma leuchtenbergianum, Bosmina longirostris, Bosminopsis deitersi and Sinocalanus dorrii were more common at Station Ⅰ for its lower trophic level, whereas Moina micrura and Thermocyclops dybowskii were more popular at Stations Ⅱ and Ⅲ. After dredging treatment, Protozoa biomass only at Station Ⅰ was positively correlated with Chlorophyll-a concentration and CODMn. There was a significant positive relationship between Rotifera biomass and Chlorophyll-a concentration at three stations, biomass of Cladocera at each station was positively correlated with Chlorophyll-a concentration and CODMn, and biomass of Copepoda at Stations Ⅱ and Ⅲ was positively correlated with Chlorophyll-a concentration and CODMn.

During 1990—2003, the biomass of Rotifera had positive linear relationships with pH value and chlorophylla-a concentration, and a negative relationship with transparency in Lake Xihu. The most significant ecological factor affected on rotifers biomass was chlorophylla-a concentration after pumping water from Qiantang River in 1995, and the ecological factor was the pH value of Lake water after dredging in 2003.

The differences in water current and trophic level are responsible for the heterogeneous distribution of each part of zooplankton in Lake Xihu. The abundance of Protozoa and Rotifera has been increased rapidly, following the eutrophic process of the lake water.

**Key words** Lake Xihu _ water pumping treatment _ dredging treatment _ zooplankton composition _ change of abundance and biomass

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