Tracking eutrophication in Taihu Lake using the diatom record: potential and problems

Xuhui Dong[1, 2], Helen Bennion[2], Rick Battarbee[2], Xiangdong Yang[1], Handong Yang[2], Enfeng Liu[1]

1. Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences (NIGLAS), Nanjing 210008, P. R. China

2. Environmental Change Research Centre (ECRC), Department of Geography, University College London, London, WC1E 6BT, UK

Introduction

◆ Taihu Lake is the third largest freshwater lake in China, with an area of 2338 km² and an average depth of 1.98 m. It has been experiencing eutrophication problems for several decades (Fig.1).

Fig. 1 Pictures showing different water quality scenarios in Taihu Lake

◆ For effective lake restoration, scientists and aquatic managers need to know if, when and how much a lake has changed through time (Smol, 1992). However, monitoring records are sparse and short (<100 years).

◆ Diatoms (class *Bacillariophyceae,* Fig. 2), preserved in lake sediment cores, can be employed to reconstruct the history of lake eutrophication, due to their taxonomic distinction, good preservation, and their rapid response to environmental changes (Harding et al, 2005).

Fig. 2 Frustules of diatoms viewed in a light microscope (LM)

◆ Rose et al. (2004) observed poor diatom preservation in cores from Meiliang Bay. Furthermore, to date, our knowledge of diatom assemblages and their palaeo-limnological potential in Taihu Lake is rather poor.

Aims

◆ To compare the diatom distribution and preservation in the cores from the three bays, in order to evaluate potential for palaeoecological studies;

◆ To reconstruct the lake nutrient history based on diatom shifts and diatom-inferred total phosphorus.

This study provides the first attempt to investigate the problems and possibilities of using diatoms for palaeolimnological research in Taihu Lake.

Study area

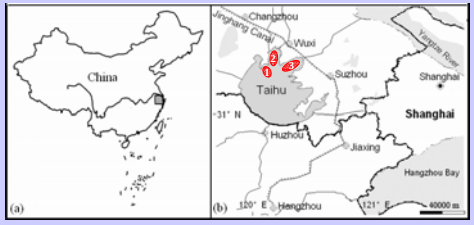


Fig. 3 Maps of the study area. (a) The location of Taihu Lake. (b) Surroundings of Taihu Lake and locations of three cores. 1-Mashan Bay; 2-Meiliang Bay and 3-Gonghu Bay

Methods

◆ Sampling and lab methods

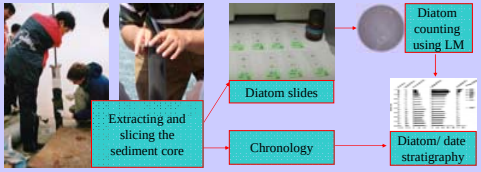


Fig. 4 Collection of sediment samples and lab-based analysis

◆ Diatom transfer function and reconstruction

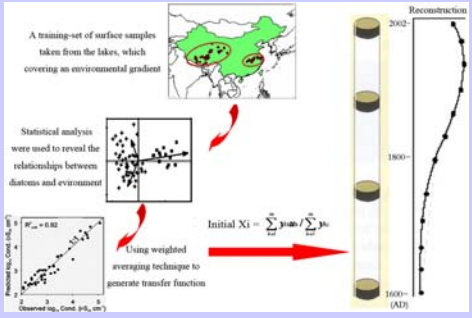
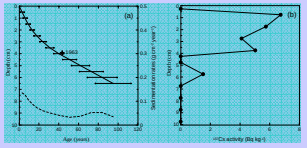


Fig. 5 Outline of the modern training set approach, development of quantitative diatom transfer functions and reconstruction of historical environmental condition

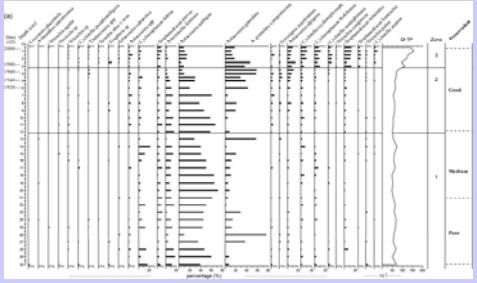
Results

◆ Chronology

Fig. 6 ^{210}Pb CRS depth-age model and the sedimentation rates versus time calculated using the CRS model (Appleby et al. 1978).



◆Diatom statigraphy, preservation and reconstruction

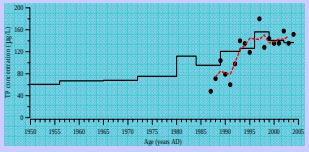


Due to the superior diatom preservation in the core from Mashan Bay, the fossil diatom record of this core and an established diatom total phosphorus transfer function (Yang et al, in press) were used to reconstruct the nutrient history of Taihu Lake.

Fig. 7 *Diatom stratigraphies of the cores from Mashan Bay (a), Meiliang Bay (b), Gonghu Bay (c); their preservation status is shown. In Fig 7-a the curve of DI-TP are the reconstructed TP.*

◆ Validation of the DI-TP

Fig. 8 Comparison of measured annual mean TP (filled circles) and DI-TP (step line). Monitoring data were smoothed using a 3-point-running average in red line (Data were from Taihu Laboratory for Lake Ecosystem Research)



Conclusions

◆ This study illustrates that there is considerable spatial and temporal variation in diatom distribution and quality of preservation in Taihu Lake. However, at present the mechanisms and processes causing the different dissolution remain unclear.

◆ Fossil diatom assemblages in Mashan core exhibit a shift at 3.5 cm (~1980) from *Aulacoseira ambigua, A. granulata* and *Asterionella formosa* to taxa associated with highly nutrient-rich waters (*Cyclostephanos - Cyclotella - Stephanodiscus*). Diatom-inferred TP concentrations indicate that prior to 1980 TP concentrations were stable, with values of 40~50 µg/L. Since 1980 a marked increase in DI-TP occurred with values increasing from 75 µg/L to 157 µg/L in the late 1990s.

◆ The close agreement between measured TP and diatom-inferred TP values indicates the potential of using diatoms as a palaeolimnological indicator. However due to the complex hydrological, sedimentological and biological conditions in Taihu Lake, more work is required to understand the mechanisms of diatom distribution and preservation.

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Contact: Xuhui Dong Email: xuhui.dong@ucl.ac.uk