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Distinguishing Lake Types of East Taihu Lake and West Taihu Lake by Biological Markers*

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Abstract: *The methods and analytical results for distinguishing lake types of East Taihu Lake and West Taihu Lake by biological markers were dealt in this paper.*
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1. Introduction

Taihu Lake, one of the largest fresh water lakes in China, is located in 31° 30' N, 120° 30' E (Sun Shuncai, *et al.*). Usually it is divided into two parts: the West Taihu Lake and the East Taihu Lake. The West Taihu Lake, in which blue algae are the dominant species, is an algae-type lake; the East Taihu Lake, which is covered by the vascular plant, is a macrophyte-type lake (Li Wenchao, Sun Shuncai, *et al.*).

In point of production biology, both algae and higher plants are primary producers. They use light, chemical energy and inorganic matters to form their organic bodies. The continuous enrichment of nutrients enhances the productivity of algae or macrophytes. The intense proliferation of algae and macrophytes in water bodies is known as eutrophication. Shallow lakes usually exhibit two general different status of the food-web structure: primary producers dominated by algae—algae-type lakes and primary producers dominated by macrophytes -- macroghyte-type lakes (Shu Jinhua). In addition, the index of C/N is also often used to distinguish lake types (Wang Sumin). In this paper, the saturated hydrocarbons of surface layer sediments from the East Taihu Lake and the West Taihu Lake will be analyzed. The distribution range of carbon numbers, the major peak and L/H etc. of the two lakes will be studied. The saturated hydrocarbons of blue algae and vascular plants will also be analyzed.

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2. Samples and Experiment

2.1 The collection of the samples

The sediment samples of the East Taihu Lake were collected from the center of the water body. The sediment samples of the West Taihu Lake were collected in the site of SSE of Maji Mountain.The blue algae from the West Taihu Lake, and the vascular plants from the East Taihu Lake were also collected. All the samples were collected in November 1995.

2.2 Experiment

2.2.1 The analysis of saturated hydrocarbons

Sediment samples were dried in the air and sieved (100 meshes) to remove large particles of plant debris. The plant samples were cut to about 2 mm long. Extraction was carried out in asoxhlet (500 m1; (2:1) CH_2C_{12}/MeOH) for 72 hours. The sulphur was removed by activated copper. The extracts were fractionated on an activated silica/ alumina column, the saturated hydrocarbons were washed by petroleum ether.

The saturated hydrocarbons were analyzed by GC-MS instrument (HP5890 capillary gas chromatograph-HP5989A quadrupole mass spectrograph). The operating conditions were: HP-5 fused-silica capillary column (30m x 0.25mm), high-pure He carrier gas; gradient temperature: 70 → 300 °C, at 4 °C · min^{-1}; ion source temperature: 250 °C and electron energy: 70 ev.

2.2.2 The analysis of total organic carbon (TOC), total nitrogen (TN)

The content of total organic carbon (TOC) was determined by potassium biochromate volumetry (Yu Tianren, *et al*); Owing to the content of the inorganic nitrogen was little, the total nitrogen (TN) was used instead of total organic nitrogen. TN was determined by the method of persulphate-UV-VIS spectrophotometry (Qian Junlong).

3. Results and Discussion

The original organic matter of the sediment have two types, one is from lower plants such as microorganisms, blue algae; the other is from some vascular giants and terrestrial giants. The distribution characteristics of the saturated hydrocarbons in different organism are different. The algae often have major peaks in C_{15} or C_{17}, but the abundance of high carbon number is small. For example, in the green algae the abundance of nC_{17} is dominant (about 36-95 % of the saturated hydrocarbons content). Higher plants are characterized by a modal distribution of C_{23}-C_{33} homologs maximized at C_{27}, C_{29}, C_{31} or C_{33} with odd-to-even predominance, so the major carbon peak (C_{max}) and its distribution model of the homologous compounds such as normal all<ane and fatty acid in sediment have important indicating significance. The major carbon peak in the range of C_{24}-C_{13} often indicates that the original organic matter is mainly from higher plants, and the lake is often a poor trophic one. When the major carbon peak is C_{15} or C_{17}, it indicates that the

original organic matter is mainly from lower plants, and the lake often is a eutrophic one. In addition, the relative ratio of lower weight components to higher weight components (L/H) is also a useful index-- a higher ratio value of L/H often indicates predominate input of algae and microorganisms etc.[1)]

3.1 The analysis of saturated hydrocarbons

The hydrocarbon of the surface sediment of the East Taihu Lake and the West Taihu Lake were analyzed. The blue algae from the West Taihu Lake and the emerged plants from the East Taihu Lake were also analyzed. The distribution model of normal alkane of these samples was shown as

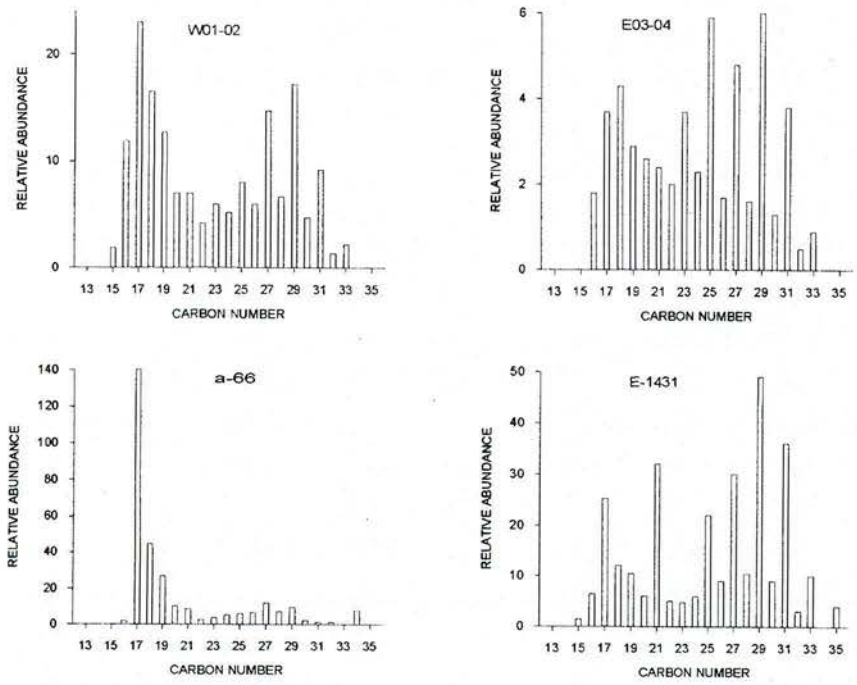

Fig. 1 *The distribution* model of normal alkane of the surface sediment of the East Taihu Lake (E03-04) and the West Taihu Lake (W01-02), blue algae in the West Taihu Lake (a-66) and emerged plant in the East Taihu Lake (E-1431)

From Fig.1 we can find that the distribution range of the carbon number of the normal alkane in the surface sediments in the West Taihu Lake is C_{15}-C_{33}, the major peak is C_{17}, the L/H is 1.04, C_{31}/C_{17} is 0.40, the odd to even predominate index (OEP) is 1.65, the ratio of pristane to phytane (Pr/Ph) is 0.80. According to the hydrocarbon total ion chromatography of the blue algae in the

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1) Zhang Gan, The lipids composition of the sediments of Gucheng Lake and its palaeoclimatical and palaeoenvironmental signifance, Doctoral thesis, 1995

West Taihu Lake, we can find that its range of the carbon number distribution is C_{16}-C_{24}, the major peak is C_{17}, the value of L/H is 4.85, C_{31}/C_{17} is 0.01, OEP is 1.55, Pr/Ph is 2.55. All these references were shown as Tab. 1. Comparing surface sediment with blue algae, the following conclusion can be drawn: the mainly original organic matter of the sediment in the West Taihu Lake is lower plants (blue algae). It is a eutrophic lake, and an algae-type lake.

From fig. 1 we can find that the distribution range of the carbon number of the normal alkane in the surface sediments in the East Taihu Lake is C_{16}-C_{33},the major peak is C_{17}, C_{29}. The value of L/H is 0.63, C_{31}/C_{17} is 0.95, OEP is 3.38, Pr/Ph is 0.59. According to the total ion chromatogram of the saturated hydrocarbon of the aquatic plants in the East Taihu lake, we can find that its range of the carbon number distribution is C_{16}-C_{33} the major peak is C_{29}, the value of L/H is 0.42, C_{31}/C_{17} is 1.44, OEP is 3.22, Pr/Ph is 1.17. All these references were also shown as Tab. 1. Comparing surface sediment with emerged plant, the following conclusion can be drawn: the mainly original organic matter of the sediment in the East Taihu lake is from vascular plants. It is a poor trophic lake, and a macrophyte-type lake.

Tab. 1 The references of the hydrocarbon of the surface sediment of the West Taihu Lake and the East Taihu Lake, blue algae in the West Taihu lake (a-66) and emerged plant in the East Taihu Lake (E-1431)

	Carbon range	major peak	Pr/Ph	OEP	pr/C_{17}	ph/C_{18}	C_{31}/C_{17}	L/H
West Taihu Lake	C_{15}-C_{13}	C_{17}	0.80	1.65	0.74	1.13	0.40	1.04
East Taihu Lake	C_{16}-C_{33}	C_{17}, C_{29}	0.59	3.38	0.56	0.83	0.95	0.63
Blue algae	C_{18}-C_{34}	C_{17}	2.55	1.55	0.73	0.89	0.01	4.85
emerged plant	C_{15}-C_{35}	C_{29}	1.17	3.22	0.67	1.21	1.44	0.42

3.2 The analysis of total organic carbon, total organic nitrogen and C/N

We usually judge the source of the original organic matter of the lake sediments and lake types by TOC, TON and C/N. Study shows (Wang Sumin): The C/N ratio value of plankton is about 6, C/N of higher plant is about 14-26, even above 30. The marked difference of the composition of TOC and TON in different organic matter provides us a useful method to study the various lake environment. The contents of TOC, TON and C/N of surface sediments in the West and the East Taihu Lake were determined. In the East Taihu Lake, TOC is 0.51%, TON is 0.039 %, C/N is 13.08; In the West Taihu Lake, TOC is 0.66 %, TON is 0.083 %, C/N is 7.95. We can find the compositions of TOC and TON in two lakes are different. The East Taihu Lake is a lake that has relative higher content of carbon and lower content of nitrogen, C/N is 13.08, therefore its original organic matter of the sediments is mainly from vascular plants in shallow water. The West Taihu Lake is a lake that has relative higher carbon content and higher nitrogen content, C/N is only 7.95, therefore its original organic matter of the sediments is mainly from blue algae which is the dominant species in the West Taihu lake, a eutrophic lake.

4. Conclusion

In this paper, the saturated hydrocarbons of surface layer sediments in the East Taihu Lake and the West Taihu Lake have been analyzed. The distribution range of carbon numbers, the major peak and L/H *etc*. are different in the two lakes. The dominant species in the West Taihu Lake is blue algae and in the East Taihu Lake is vascular plants. Their saturated hydrocarbons have also been analyzed. Finally, the common index of C/N has also been used. As a conclusion, the West Taihu Lake is an algae-type lake and the East Taihu Lake is a macrophyte-type lake. Being a conjoint site of the interaction between atmosphere, hydrosphere and biosphere, the lake sedimentary record differs from other geological record in its abundant biosphere information, and it is complicated. The result shows that biological markers can indicate lake types effectively, and it can purify the feature of biological composition in water. It will be a latent index in recovering the evolutionary history of lake environment.

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