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Natural and Artificial Change in Primary Productivity for 200 Years Recorded in the Coastal Lagoon Sediment

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Abstract – To examine the effect of recent human activity on coastal lagoons, we analyzed CNP concentrations and ?^{13}C and ?^{15}N of three core sediments collected from L. Shinji to trace both natural and anthropogenic effects on the coastal lagoon productivity for these 200 years.

I. Introduction

Estuarine environment including coastal lagoons constitutes an important transition zone between the land and the sea. It is enriched by the oceanic and continental inputs and is amongst the most productive aquatic ecosystems. Coastal lagoons, one of the typical estuarine environments, are used intensively by man, and receive the by-products of inland human activities. The effect of human activity on coastal lagoons has accelerated considerably in recent years, and the impact on these productive and economically important environments has become a major concern.

Lake Shinji in central part of Japan is nowadays a eutrophic estuarine lagoon, where historical documents describing the nature of the lagoon are available since 733 A.D. However, chemical property of L. Shinji, including nutrient concentration of the lake water, is only available for these 30 years. Information on the onset of anthropogenic eutrophication as well as change in primary productivity of the lagoon caused by climatic factors is critical to control anthropogenic eutrophication effectively.

Organic carbon (C), total nitrogen (N), and total phosphorus (P) concentrations as well as carbon and nitrogen stable isotope ratios (?^{13}C and ?^{15}N, respectively) are often used to detect eutrophication signals in the sedimentary records. They are also used to reconstruct natural environmental change.

Present study analyzed CNP concentrations and?? ^{13}C and ?^{15}N of three core sediments collected from L. Shinji to trace both natural and anthropogenic effects on the coastal lagoon productivity for these 200 years.

II. Materials and methods

A. Sediment sampling

Every two undisturbed sediment cores were obtained at three sampling points in Lake Shinji (Fig. 1) in October 1994 using a sampler [1]. They were collected from the basin deeper than 4.3 m at L. Shinji, because the bioturbation by macro zoobenthos should be minimized by seasonal anoxia. One core was used for the ^{210}Pb measurement, and another was used for the determination of CNP concentrations, ?^{13}C and ?^{15}N.

Core sediment samples were cut at 2 cm intervals. They were freeze dried for nutrient and stable isotope analysis, and oven dried at 70℃ for ^{210}Pb analysis. Dried samples were ground with an agate mortar and pestle.

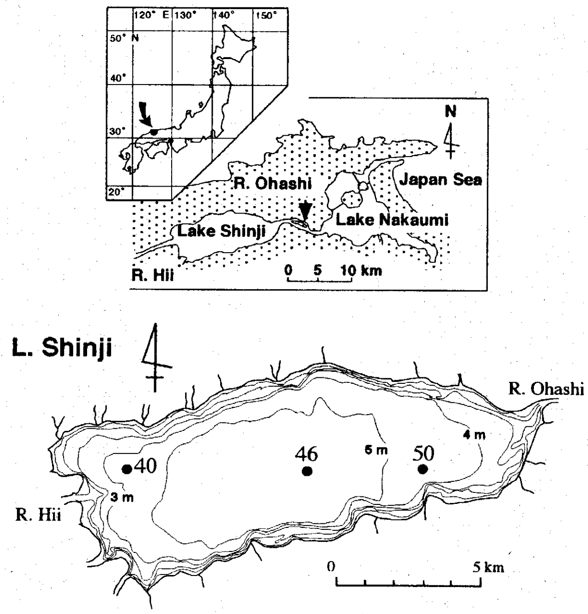

Fig. 1 Location of Lake Shinji and sediment sampling points (40, 46 50).

B. Analytical method

Organic carbon and nitrogen concentrations were determined using a Yanaco MT-5 CHN analyzer [2]. Total phosphorus was determined colorimetrically after digestion [3].

To determine stable isotope ratios, samples were combusted at 1020℃ in an elemental analyzer (Fisons Instruments EA1108), and the combustion products (CO2 and N2) were introduced into an isotope-ratio mass spectrometer (Finnigan Delta Plus) by using a He carrier. For the carbon isotope analysis, samples were combusted in a silver cup after being treated with drops of 1N HCl to remove inorganic carbon.

For the measurement of ^{210}Pb (T= 22.3 yr), samples were stored for a month to ensure secular equilibrium between ^{210}Pb and ^{214}Pb. The intensity of radioactivity was detected with ORTEC GWL-140230 and GWL-120230-S radioactivity of 46.5 keV and 352 keV were used to calculated the radioactivity of each nuclides. Cumulative mass (g cm^{-2}) was converted from percent water data using a sediment density of 2.45 g cm^{-3}. The constant initial concentration sedimentation model was used [4], and a liner regression of unsupported ^{210}Pb versus cumulative mass was used to provide sedimentation rate in g cm^{-2} yr^{-1}. The age at a given sediment depth was estimated by dividing the cumulative mass by the sedimentation rate, and expressed in A.D.

III. Results

C and N concentrations of core 50 were higher before 1850 than recent decades. N concentrations of core 46 was also higher before 1840 than present. P concentrations of these cores decreased towards past, while it was higher from 1830 to 1880 than 1880 to 1980 for core 40 (Fig. 2).

?^{13}C decreased gradually towards present for all three cores, while ?^{15}N decreased towards present for cores 40 and 46 (Fig. 3).

Atomic ratios of N:P and C:N showed similar patterns for all three cores (Fig. 4). Before 1900, these ratios of core 50 were higher than cores 40 and 46, and these two cores showed similar values. After 1940, ratios for core 40 were higher than cores 46 and 50, and these two cores showed similar values.

Unlike N:P and C:P, C:N before 1840 were higher for cores 40 and 50 than core 46. The values for three cores were similar from 1860 to 1900, and the ratio of core 40 became higher than other cores since 1920.

We will discuss the past productivity, nutrient condition and so on based on the results of horizontal distribution of CNP concentrations, ?^{13}C and ?^{15}N in surface sediment of present L. Shinji obtained from another survey..

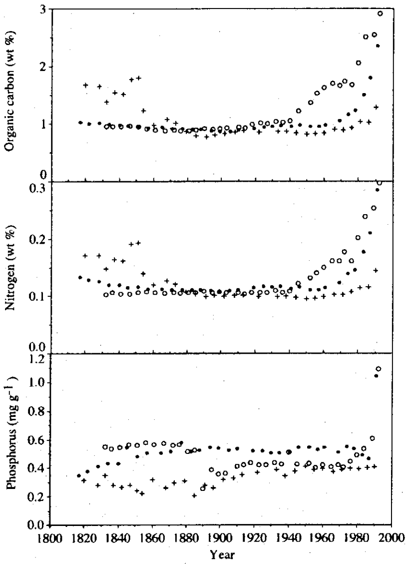

Fig. 2. Carbon, nitrogen and phosphorus concentrations of sediment cores of 40 (○), 46 (●), and 50 (+).

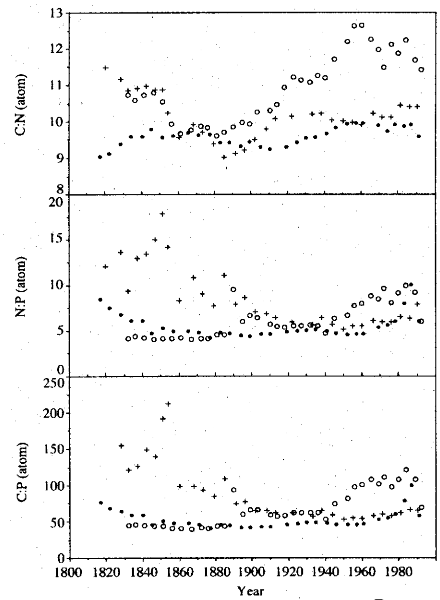

Fig. 4. C:N:P ratios of sediment cores of 40 (○), 46 (●), and 50 (+).

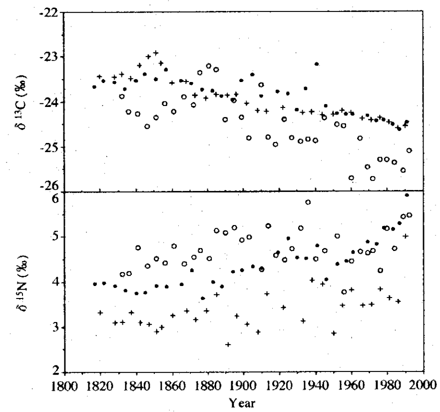

Fig. 3. ?^{13}C and ?^{15}N of sediment cores of 40 (○), 46 (●), and 50 (+).

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