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Holocene history of the diatom assemblages of the sediments from the mouth of the Samondo-gawa river along the northern coast of the Osaka Bay

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The sediments collected by Dr. MAEDA from a caisson at the mouth of the Samondo-gawa river were studied to clarify the sedimentary environment by diatom assemblage analysis. 1. The Osaka Bay Formation can be divided into the Nanko Bed and the Umeda Bed, which is subdivided into three units. 2. Based upon the ecological categories of diatoms, the sediments are classified in three diatom zones named A to C in ascending order. Diatom Zone A roughly corresponds to the Nanko Bed and is dominated by fresh-water assemblages of diatoms. From the fact that marine species increase in number downwards in Diatom Zone A, it can be assumed that the raising of the sea level occurred toward the period about 30,000 years BP at the Samondo-gawa site. 3. Diatom Zone B_1 corresponds to Molluscan Assemblage I reported by MAEDA (1978). An intertidal assemblage of diatoms appears prior to that of mollusca in the progress of Holocene transgression. Because Diatom Zone B_1 is dominated by *Nitzschia granulata*, the sea was very shallow at the horizons between -24 m and -21.8 m. 4. Diatom Zone B_2 (-21.8 m to -11.5 m) corresponds to Molluscan Assemblage II by MAEDA. Because littoral or neritic diatoms appear, it appears that sea became deeper at this horizon. 5. Diatom Zone C (-11.5 m to -9.5 m) corresponds to Molluscan Assemblage III. The change from the sub-intertidal assemblage to the intertidal one was caused by the regression of sea level at the period between 2,500 and 1,500 years BP.

Key Index Words: *diatom zone; freshwater species; holocene transgression; marine species; molluscan assemblage; Osaka Bay; Samondo-gawa; sedimentary environment.*

The past environmental changes are reconstructed mainly from the information obtained by geomorphological, the biological and the chronological investigations. ISEKI (1976) reviewed the investigations for the geomorphological environment, for the fluctuation of sea level and for the development of landforms during the Holocene period. MATSUSHIMA and OHSHIMA (1974) and MATSUSHIMA (1978) studied the littoral molluscan assemblages during the Holocene transgression along the Tokyo Bay and the Sagami Bay. MAEDA (1976, 1978) also determined the past sea level changes based upon the molluscan assemblages along the northern coast of the Osaka Bay.

The Mizoro-ga-ike Research Group (1976) investigated a history of the Mizoro-ga-ike in the Kyoto Basin based upon pollen and diatom analyses. The diatom assemblages were analysed by HASEGAWA (1968) in the Kanto Plain and UTASHIRO *et al.* (1975) in Kurashiki City in order to ascertain the sea level changes and the highest sea

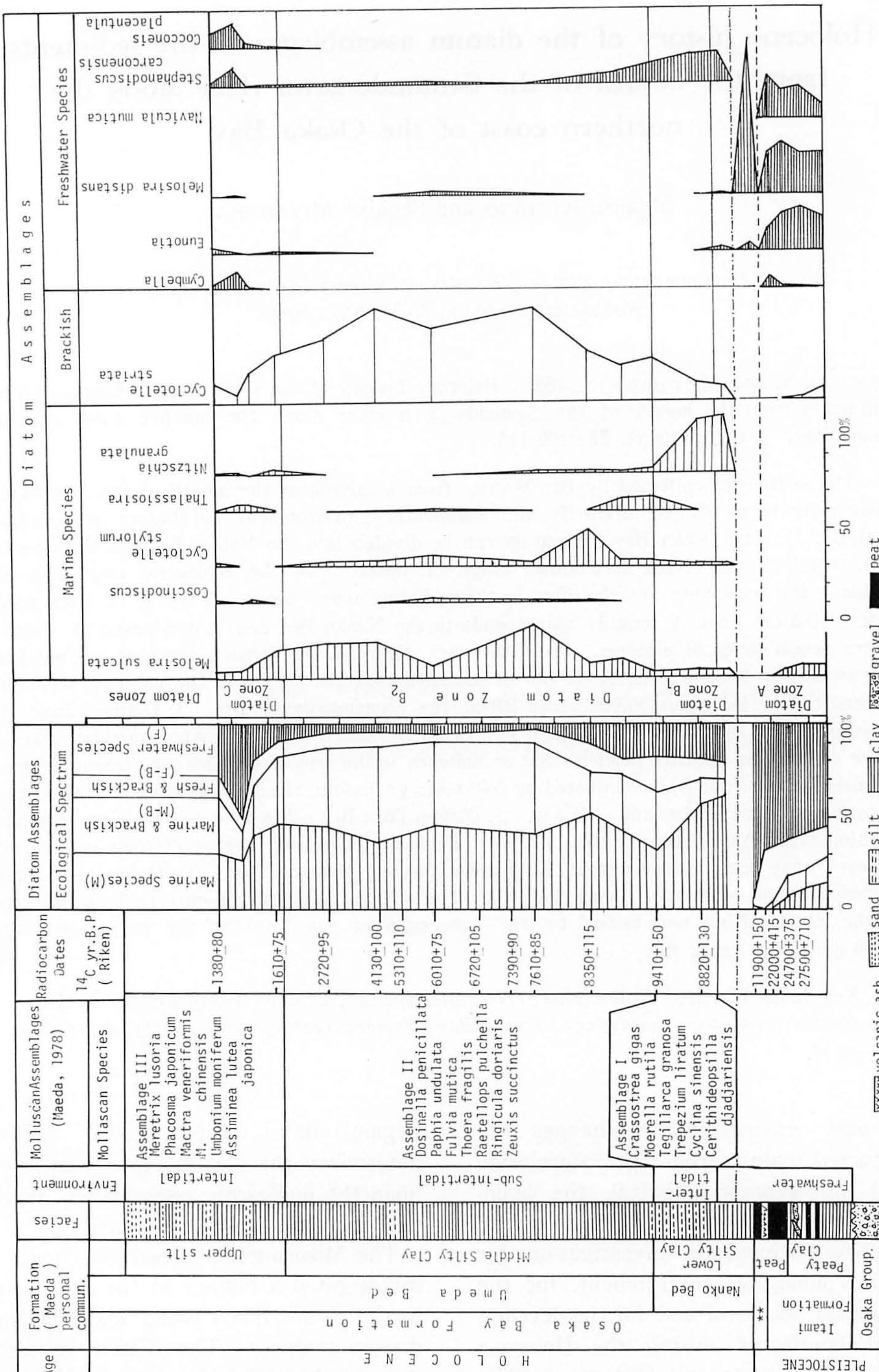

Fig. 1. Stratigraphy, columnar section, molluscan assemblages, radiocarbon dates and diatom diagrams of the sediments from the Samondo-gawa river along the northern coast of Osaka Bay.

level of Holocene transgression. YASUDA (1978) investigated the history of environmental changes and human activities around the Uriudo site in Osaka Prefecture. He reconstructed the paleo-geographical sequence from the Paleo-Kawachi Bay, via the Paleo-Kawachi Lagoon toward the lagoonal lowland based upon the geomorphological, the archaeogeological and the palynological evidences. MORI and HORIE (1975) studied the diatoms in a 200 meters core sample from Lake Biwa-ko.

The present work forms a part of studies to reconstruct the paleoenvironment during the Holocene along the coast of Osaka Bay. In the present paper the diatom assemblages were analysed in order to ascertain the sedimentary environment already reconstructed by evidence of molluscan assemblages (MAEDA 1978).

Materials and Methods

The sediments were collected by Dr. Maeda from a caisson used to build the foundation of bridge piers of the Tatsumi-bashi from February to June in 1972. The Tatsumi-bashi is situated near the mouth of the Samondo-gawa river along the northern coast of the Osaka Bay in Japan. For the diatom analysis, samples of approximately 1 g were taken at proper intervals of sediment, boiled with 15% hydroperoxide, and treated with conc. hydrochloric acid. A suitable amount of the cleaned and washed materials was dried and mounted with pleurax. The identification of diatoms was made by means of photomicrographs. About two hundred frustules of diatoms were counted in each sample, along a transect chosen at random and the relative abundance of each taxon is shown as a percentage of the total.

Stratigraphy

The stratigraphy of the sediments at the Samondo-gawa site is shown briefly in the 2 nd to 4 th columns of Fig. 1 and was described by MAEDA (personal communication) as follows:

The lowermost unit of this sediment belongs to the Osaka Group, composed of blue sand and gravel.

The Itami Formation is divided into two units:

a) blue green sand, clay and dark brown peaty clay about 2 cm thick.

b) dark brown peat; lower peat 40 cm thick, middle volcanic ash 50 cm thick and upper peat 20 cm thick. The upper part of this bed may be separated from the Itami Formation on the basis of the radiocarbon dates described below.

The Osaka Bay Formation can be divided into three units.

a) lower silty clay (Nanko Bed); the lower part consists of humaceous silty clay containing *Phragmites* sp. and freshwater sediments; the upper part consists of laminated dark brown clay containing many marine shells such as *Crassostrea gigas* and *Cerithideopsilla djadjariensis*, which imply the beginning of Holocene transgression at this site.

b) middle silty clay (the lower part of Umeda Bed); all consist of marine silty clay containing abundant marine shells indicating the sediments typically formed in an inner bay.

c) upper silt (the upper part of Umeda Bed); the lower part consists of silty clay and fine sandy silt upward, containing marine shells indicating an inner bay sediments.

Radiocarbon Dates

Seventeen samples from the Samondo-gawa site have been dated by Dr. HAMADA. Sixteen of them are shown in the 6 th column of Fig. 1. The other one is of -9.7 m and shows a radiocarbon age of 1370 ± 80. The radiocarbon dates suggest that the upper peat of the Itami Formation shows a radiocarbon age of $22{,}000\pm415$ years BP* and the upper continuation of the same peat bed shows an age of $11{,}900\pm150$ years BP. Dr. MAEDA has not yet given

* BP=before present=before 1950

any name for the bed younger than Itami Formation and older than 10,000 years BP. Consequently, the authors consider that there is an unnominated bed between the Nanko Bed above and the Itami Formation below.

Molluscan Assemblages

The molluscan fossils from the Umeda Bed at the Samondo-gawa site are studied and summarized by MAEDA (1978) as shown in the 5 th column of Fig. 1. MAEDA's description for the molluscan assemblages are as follows in ascending order. Assemblage I has characteristics indicating the environment of the intertidal zone of an inner bay. He pointed out that it shows the beginning of Holocene transgression at this site. Assemblage II has characteristics indicating the center of an inner bay. This assemblage is considered to have been formed at the period of the high level of the sea. Assemblage III indicated the sandy area of an inner bay. Such an assemblage was found in two horizons at this site, one at a depth of −22 m and the other at about −10 m below the present sea level. The assemblage at −22 m is confined in a very thin stratum indicating a short period in the rise of sea level. Another assemblage of −10 m imbedded in a sandy stratum indicating the leading edge of a coastal delta, which shows that sea was very shallow at that time at this site.

Diatom Assemblages

According to the results provided by many authors (HUSTEDT 1930, 1959, 1961-1966; PATRICK and REIMER 1966, 1975), most taxa of diatoms are able to be grouped into categories of salinity, i.e. marine species (M), marine and/or brackish (M-B), fresh and/or brackish (F-B) and freshwater species (F). Based upon these categories the diatoms found in the sediments at the Samondo-gawa site can be classified in three Diatom Zones which named A to C in ascending order. Diatom Zone B is divided into Subzones based on an occurrence of *Nitzschia granulata*.

In Diatom Zone A (−27 m to −24 m), being dominating by *Melosira distans*, *Navicula mutica*, *Eunotia* spp. and *Cymbella* spp., the ratio of freshwater species is more than 50% and increases up to 93% at −24.5 m depth.

In Diatom Zone B (−24 m to −11.5 m) freshwater species are dominated by *Stephanodiscus carconensis* and its ratio is less than 20%. On the other hand, marine species increase up to about 50% and the ratio of marine (M), marine and/or brackish (M-B) reaches nearly 85% at around −15 m depth. Diatom Zone B is divided into Diatom Subzone B_1 (−24 m to −21.8 m) and Diatom Subzone B_2 (−21.8 m to −11.5 m). In Diatom Subzone B_1, diatoms are dominated by a marine species *Nitzschia granulata* and a freshwater species *Stephanodiscus carconensis*. Diatom Subzone B_1 is roughly correlated with Molluscan Assemblage I and Diatom Subzone B_2 with Molluscan Assemblage II reported by MAEDA (1978).

In Diatom Zone C (−11.5 m to −9.5 m), being dominated by *Cocconeis placentula*, *Stephanodiscus carconensis* and *Cymbella* spp., the ratio of freshwater species is about 50%. Diatom Zone C roughly corresponds to Molluscan Assemblage III by MAEDA (1978).

Discussion

The radiocarbon dates suggest that the lowermost part of the sediments at the Samondo-gawa site shows an age of about 30,000 years BP. From the fact that marine species increase in number downwards in Diatom Zone A, it can be assumed that the rising of the sea level occurred toward the period about 30,000 years BP. Pollen analysis tells us that mean annual temperature at the period between 33,000 and 29,000 years BP was about 3-4°C lower than that of the present in northern Japan (NAKAMURA *et al.* 1960). This warm period was immediately followed by a cold glacial period around

2,0000 years BP, when the mean annual temperature was 7-8°C lower than that of the present. Corresponding to this warm temperature a high sea level around 30,000 years BP has been expected in the coastal area in Japan. YASUDA (1978) points out that a series of radiocarbon dates places this warm period in the Würm glacial age between 33,000 and 29,000 years BP, suggesting the possibility that it corresponds to the Denekamp Interstadial (HAMMEN *et al.* 1971) in the Netherlands.

The genus *Eunotia* is commonly found in stagnant waters and *Melosira distans* is characteristic of more or less humaceous lakes. From the fact that Diatom Zone A is dominated by the above mentioned taxa, *Eunotia* and *Melosira distans*, it can be considered that there were many lowland freshwater marshes around the Samondo-gawa site and the sea level was very low at the period around 10,000 years BP.

According to MAEDA (1978) the beginning of the Holocene transgression, confirmed by the intertidal assemblage of mollusca, starts at −23.4 m, which horizon shows an age of 8,820 years BP. In the present paper, only four frustules of diatoms were detected at −24.0 m, as if some remarkable events or environmental changes took place. Many marine species of diatoms appeared at −23.8 m, which horizon consists chiefly of humaceous silty clay containing *Phragmites* sp. but no marine molluscs and belongs to the lower part of lower silty clay of the Nanko Bed. From the above mentioned evidence, it can be assumed that an intertidal assemblage of diatoms appears prior to that of molluscs in the progress of Holocene transgression.

It is considered that sea was very shallow at the horizon between —24 m and —21.8 m, because Diatom Zone B_1 is dominated by *Nitzschia granulata*, which is frequent on sandy shores in England (HENDY 1964). This consideration agrees with the opinion that sea level rose slowly at the period between 8,800 and 8,000 years BP (MAEDA 1978).

On the other hand, Diatom Zone B_1 is dominated by *Stephanodiscus carconensis*, which is one of the most noticeable phytoplankers in the Lake Biwa-ko ever since the last 250,000 years (MORI and HORIE 1975) and at present time (NEGORO 1960). MORI and HORIE (1975) stated that *Stephanodiscus carconensis* decreased at Sc. 1 Point of a 200 meter core sample from the Lake Biwa-ko and referred the period after Sc. 1 Point to the post-glacial time. From the above mentioned facts, *Stephanodiscus carconensis* found in Diatom Zone B_1 at the Samondo-gawa site is regarded as a phytoplankter which drifted from the Lake Biwa-ko, so that this site was connected with the Lake Biwa-ko through the Paleo-Yodo-gawa at this period.

In Diatom Zone B_2, the dominant species of marine diatoms changes from *Nitzschia granulata* in a sandy shore habitat, via *Cyclotelle stylorum* in a littoral habitat, to *Melosira sulcata* in a littoral or in neritic habitat in accordance with the changes of the molluscan assemblages, from intertidal to sub-intertidal zones reported by MAEDA (1978).

In Diatom Zone C (—11.5 m to −9.5 m), a decrease of *Melosira sulcata* of littoral or neritic species and an apperance of *Nitzschia granulata* on sandy shore habitat as well as an apperance of the intertidal assemblage of mollusca are found. It is assumed that these changes were caused by the regression of sea level at this period between 2,500 and 1,500 years BP. On the other hand, the ratio of freshwater species increases up to 50%, being dominated by an alkaliphilic species *Cocconeis placentula*, and a planktonic spcies *Stephanodiscus carconensis* which drifted from the Lake Biwa-ko. From these facts, it can be considered that the Samondo-gawa site was located near the fringe of the lobated delta of the Paleo-Yodo-gawa.

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熊野　茂・宮原幸子：大阪湾左門殿川口における完新世珪藻遺骸群集の変遷

左門殿川川口の潜函より前田 (1978) の採取した堆積物の珪藻分析を行なった。

大阪湾累層は南港層と梅田層に，梅田層は更に2層に細分される。堆積物の珪藻遺骸群集の特徴より，大阪湾累層は下部より上部へ A, B, C の珪藻遺骸群集帯に分けられる。

珪藻群集帯Aでは淡水性珪藻が優占し，南港層にほぼ対応する。珪藻群集亜帯 B_1 は浅い海または渚に生育する潮間帯群集を含み，前田 (1978) の貝類群集Ⅰに対応する。完新世海進に伴って珪藻群集の変化は貝類群集の変化に先行する。珪藻群集亜帯 B_2 では浅海性珪藻の比率が増加し，前田の潮間帯下貝類群集Ⅱに対応する。珪藻群集帯Cは潮間帯貝類群集Ⅲに対応し，淡水性珪藻が増加し再び海が浅くなったことを示す。(657 兵庫県神戸市灘区六甲台町1－1　神戸大学理学部生物学教室)

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案　内

第1回国際藻学会議 First International Phycological Congress

第1回国際藻学会議が1982年8月8-14日にカナダ東海岸のニューファウンドランドの St. John's にあるニューファウンドランド・メモリアル大学 Memorial University of Newfoundland で開催される。

海藻・淡水藻，大形藻・微細藻，およそ藻と名のつくものを研究するすべての人々の参加が期待される国際会議の第一回で，特別講演として次の3つ，シンポジウムとして次の12のテーマが取上げられる予定。

特別講演：

- 8月9日　1. R.T. Wilce: Arctic benthic phycology: Where we have been and where we have to go. 2. O. Moestrup: Algal phylogeny from the ultrastructural viewpoint. 3. K. Lüning: Photoperiodism in algae.

シンポジウム：

- 8月10日　1. Algal hormones. Convenor: R.C. Starr, 2. Freshwater Algae and Water Quality. Convenor: L.R. Mur, 3. Species Relationships and Distribution Patterns in the Phaeophyta. Convenor: A.R.O. Chapman, 4. The Dinoflagellate Cell Covering. Convenor: J.D. Dodge,
- 8月12日　1. Intra- and Intercellular Transport in Algae. Convenor: J. Willenbrink, 2. Algae-grazer Interactions. Convenor: T.A. Norton, 3. Life Histories and Taxonomy of Rhodophyta. Convenor: M. Guiry, 4. Nuclear and Cell Division from an Ultrastructural Viewpoint. Convenor: G. Leedale,
- 8月13日　1. Osmoregulation in Algae. Convenor: J. Hellebust, 2. Polymorphism and Taxonomy of Desmids. Convenor: C.E.M. Bicudo, 3. Genetics of Macro-Algae. Convenor: J.P. Van der Meer, 4. Plastids and the Cell Cycle. Convenor: Mme. Lefort-Tran.

ファーストサーキュラー入手希望者は下記に申込むこと。

The Secretariat, First International Phycological Congress, c/o Department of Biology, Memorial University of Newfoundland, St. John's, Newfoundland, Canada AIB 3X9

なおこのファーストサーキュラーには申込用紙がついているので，これに必要事項を記入して8月31日まで事務局に送ると，セカンドサーキュラーを10月頃受取ることができる。

(千原　光雄)