Chapter 5

Analysis of Pollen and Diatoms in the Mawaki area, Noto Peninsula, During Holocene: A microscopic Perspective of the Mawaki Environment

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Abstract

Microfossil assemblage within the Holocene coastal deposits provides important information on environmental issues in and around archaeological sites. Pollen analysis reveals vegetation change and climate phenomena, while, diatom analysis yields data on the water ecosystem in and around archaeological sites. Preliminary data from the core samples provided insight into the environmental changes around the Mawaki site, such as changes in sea-level (one cycle of transgression to regression) and vegetation.

5.1 Introduction

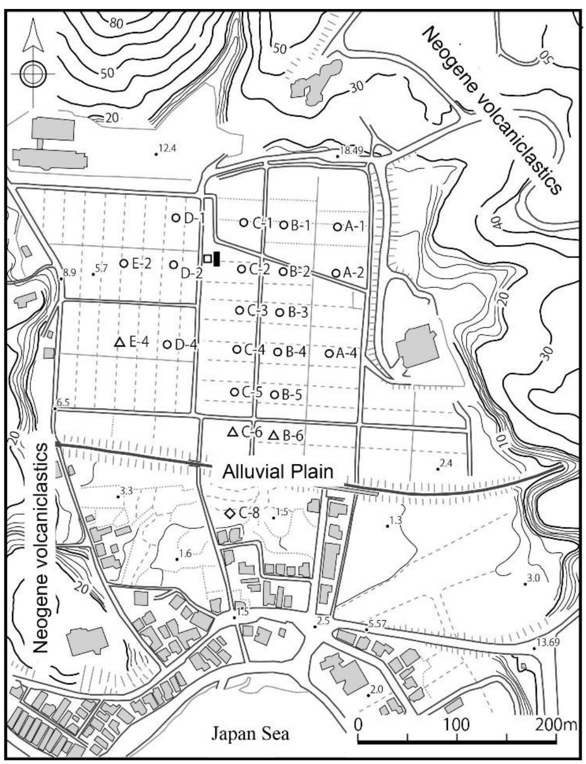

__Figure 5.1__ Borehole and geoslicer locations around the Mawaki archaeological site. Open circle: drilling in 1997 & 1998, open triangle: drilling in 2002, open rhombus: drilling in 2005, solid rectangle: geoslicer coring.

Pollen analysis and botanical data are very important to understand the climatic environment on the basis of the reconstruction of vegetation in and around surrounding area. Additionally, diatom species lives in a wide range of aquatic conditions, as well as in planktonic and benthic habitats. Therefore, diatom assemblage of the discrete horizons is indicative of the associated environment at that time (Lowe and Walker, 1997; Nakamura, 1967, etc), and both analyses provide important information for the reconstruction of the archaeological environment. This section introduces the example from the Mawaki site.

5.2 Methods and Analytical Samples

5.2.1 Pollen Analysis

Pollen grains and spores are frequently dispersed in very large number in order to maximize the opportunities for successful pollination. Many accumulate on the ground or in water bodies, and some are subsequently incorporated and fossilized in sediments. Extraction, identification and counting of these preserved fossil grains form the basis of pollen analysis. Most pollen grains and spores are small; few exceed 80 to 100 μm in diameter, with the majority falling in the size range of 25 to 35 μm.

Samples containing fossil pollen and spores can be taken from the exposed sections by means of coring. Samples must be sealed air-tight and are usually stored in a cool place. This protects them from contamination by pollen circulating in the air. In the laboratory, following dispersal, sieving, and chemical flotation (density separation), samples are chemically treated in a variety of ways to concentrate pollen grains. Lignins and cellulose can be reduced in volume, if not entirely removed, by oxidation and accetolysis. Mineral grains may be removed by digestion in hydrofluoric acid, separation via differential centrifugation, or floating the organic detritus. The residues containing the pollens and spores may be stained with an organic dye such as safranin which enhances the surface detail of some grains and then mounted on to glass slides on a suitable medium such as glycerine jelly. Counting is then performed at magnifications of 100× to 1,000×, depending on the detail required for identification purposes. By traversing the slide in a systematic way, the identifiable pollens and spores can be counted until a sufficient number for interpretation has been reached. This should be high enough (e.g., 300-500 grains) to account for most of the variations in the spectrum of pollen assemblage. Identifications, which in generally can easily made up to family and genus level but less frequently to the species level, is based on distinctive exine characteristics using pollen keys, collections of photographs and laboratory reference material derived from modern pollen samples.

Where samples have been taken from a stratified sequence of sediments, such as a lake or peat sequence, an analysis of the pollen content of a single horizon will reveal a mixture of pollen types, collectively termed the pollen assemblage (pollen spectrum). Analysis of a series of horizon may show changes in pollen content which may, in turn, indicate temporal changes in vegetation cover in the area adjacent to the site. These changes are usually depicted graphically in the form of pollen diagrams which are based either on percentage values or on pollen concentration data, the latter sometimes being termed as 'absolute pollen diagrams'. Percentage pollen diagram usually take two forms. In some cases a pollen sum is selected for each level, and individual pollen and spore types are then expressed as percentages of that sum.

The interpretation of a pollen diagram is the most difficult part of pollen analysis, as it requires knowledge of pollen production and dispersal, source and deposition, preservation and the relationship between fossil pollen and former plant communities. Only when these factors have been carefully evaluated can be inferences made about former vegetation cover and, by implication, former climatic conditions and environments.

First, not all plants produce the same quantity of pollen. Second, it is necessary to know something about the source of fossil pollen in a body of sediment. It is important to establish whether plants were growing on the bog surface or within the lake basin, around the margins of the site, in the immediate vicinity, or some distance away. Moreover, it is necessary to know some aspects of the mechanisms involved in the transport of pollen from its source to the eventual point of deposition. Third influencing factor is the nature of pollen deposition. Different settling velocities of pollen in lakes and ponds, coupled with the disturbance of sediment on the lake or bay floor, either by currents or burrowing organisms, can lead to complications in the fossil record. Equally misleading is the occurrence of redeposited or secondary pollen that has been washed into the lake by stream flow, overland flow, solifluction or collapse of the basin edge sediments, and the subsequent redistribution or material across the lake floor. These grains will clearly be of an age different from that of those arriving at the lake surface from the atmospheric pollen rain. Although they can often be distinguished from primary pollen by signs of exine deterioration, they are potential sources of confusion in the interpretation of the biostratigraphic record.

As a result, pollen stratigraphy was applied to following reconstructions: Local vegetation reconstructions, regional vegetation reconstructions, and space-time reconstructions. Analytical samples for pollen analysis were used from core samples of C-line drilling cores.

5.2.2 Diatom Analysis

Diatom remains have proved extremely useful as indicators of local habitat changes, particularly in both shallow and deep marine deposits, but also in lake sediments. The analysis of diatom flora has revealed a wide range of paleoenvironmental issues, such as changes in the water chemistry, reconstruction of past lake level and sea-level variations and the disturbance of the ecosystem by human activities (Lowe and Walker, 1997; Ando, 1990; Asai and Watanabe, 1995; Hustedt, 1937-1938; Krammer and Lange-Bertalot, 1986-1991; Kosugi, 1986, 1988; Lowe, 1974, etc).

Diatom valves are best preserved in fine grained sediment since they can be easily damaged or destroyed in coarse-grained deposits. Samples for analysis can be obtained from vertical exposures in shallow water marine or estuarine deposits, though more frequently they are extracted from sediment cores obtained from lake, shelf seas or the deep ocean. Diatom are not susceptible to oxidation or microbial degradation, but cores for diatom analysis are usually sealed air-tight to prevent drying out of the sediment, which can lead to fracturing of the valves. Diatom frustules may be separated from the sediment matrix by a variety of laboratory procedures. Organic matter is removed by oxidation, the most common methods being digestion in H_2O_2 or in a mixture of potassium dichromate and sulphuric acid, while carbonates and certain other salts can be dissolved by heating gently in dilute hydrochloric acid.

Diatom valves are light and easily transported, and thus in estuarine sediments, for example, there is often a complex admixture of marine, brackish and freshwater forms, while lake muds may contain diatoms derived not only from the lake ecosystem, but also from inflowing streams and catchment soils. Freshwater diatoms often occur in marine sediments. Selective destruction of diatoms is another potential source of error, with complete or partial dissolution of the frustules under pressure at great depths or alkaline conditions. Also, reworked diatom frustules can sometimes be detected. Despite these problems, diatom analysis has proved to be a particularly valuable technique for environmental reconstructions.

As a result, individual diatom species can be classified on the basis of their salinity preferences as salinity is a major factor controlling distribution. Using the specific diatom assemblage data, we can consider the aquatic environments on the basis of the salinity data such as marine, brackish and freshwater water mass, and related geographical environments.

Analytical samples for diatom analysis were used from core samples of C-line drilling cores and horizon of dolphin bone occurrence.

5.3 Reconstruction of Vegetation and Water Environment Around the Site

5.3.1 Pollen Assemblage and Interpretation of Vegetation

This section is mainly the result of pollen assemblage (Photo 5.1) from boring sample C-2 at Mawaki site (Figure 5.1 and Figure 5.2), and the result at other boring samples is shown in Figures 5.1, 5.3, 5.4, and 5.5).

The pollen assemblage from C-2 core samples is divided into four pollen zones of C-2 U-I, C-2-U-II, C-2-U-III and C-2-U-IV in ascending order.

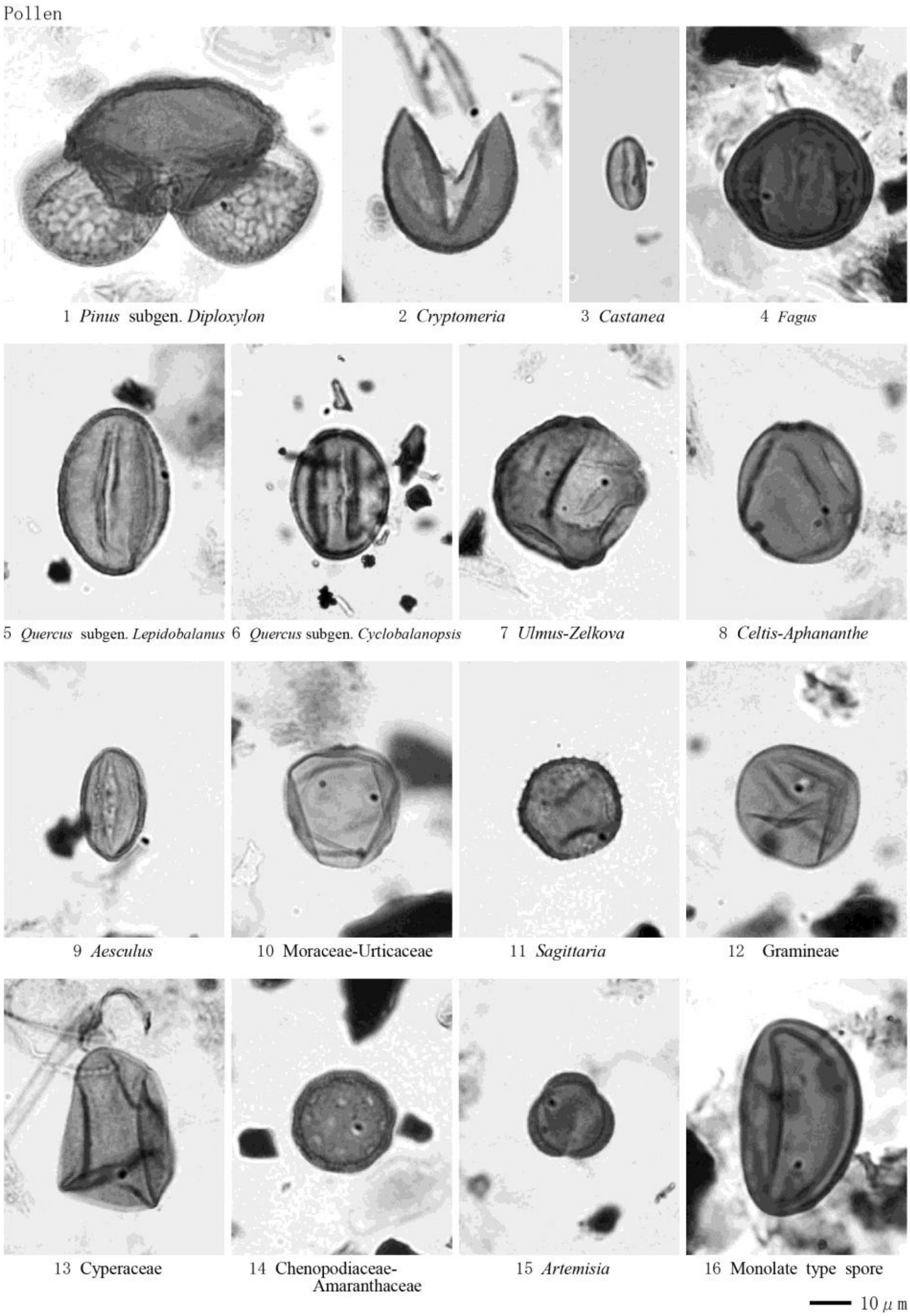

Photo 5.1 *Representative photos of pollen grains from the Mawaki Site.*

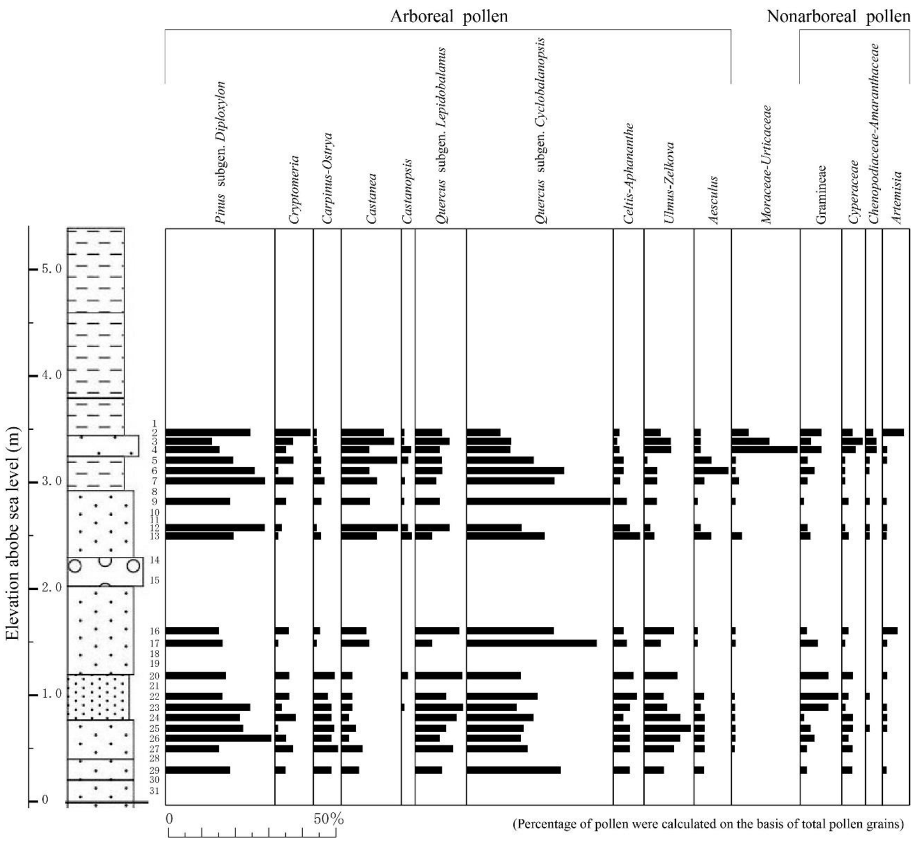

Figure 5.2 *Pollen assemblage from boring sample C-2.*

C-2-U-I zone (sample No. 18-20): Percentage of arboreal pollen is high, and Quercus (Cyclobanopsis) and Pinus are mostly occupied, and associated with broad leaf trees of Quercus (Lepidobalanus), Ulmus - Zelkova, Celtis - Aphanante, Carpinus - Ostrya, Castanea, Aesculus and Cryptomeria. Abundance of grass plant pollen is low and most of those grass pollen are Gramineae family.

C-2-U-II zone (sample No. 8-17): This zone is characterized by an increased percentage of Castanea pollen.

C-2-U-III zone (sample No. 5-7): This zone is characterized by an increased abundance of Aesculus pollen.

C-2-U-IV zone (sample No.2-4): This zone is characterized by the decreased abundance of Quercus and increased abundance of Ulmus - Zelkova, Moraceae, Ulticacerae, Gramineae, Cyperaceae, Chenopodiaceae and Amaranthaceae.

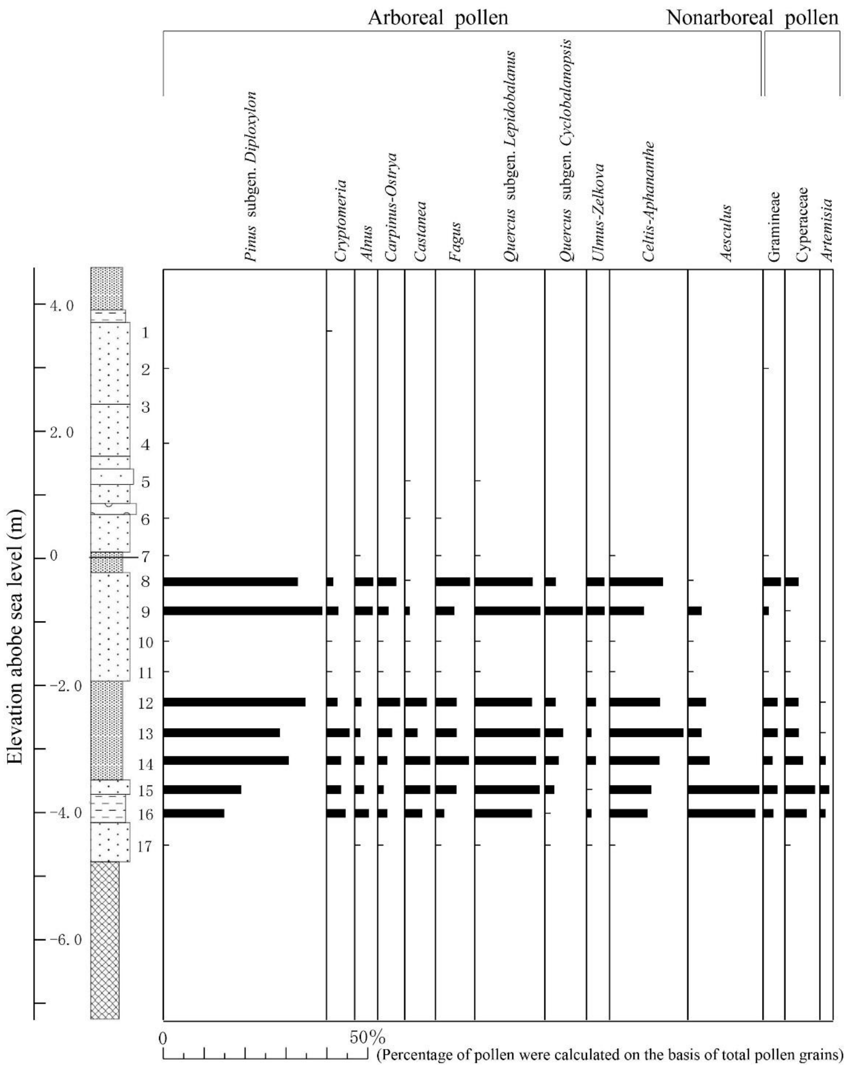

Figure 5.3 *Pollen assemblage from boring sample C-3.*

Surrounding area of Mawaki region was covered by Quercus and Pinus tree vegetation, and Pinus trees were distributed in the rock area along the shoreline and Aesculus (horse chestnut) were living along the valley. Castanea trees were distributed in and around the site, and Quercus and Celtis were present during the late and latest Jomon period. Castanea and Aesculus were the main eatable fruits for people. In the latest Jomon period, the Aesculus plant was distributed in the newly emerged humid area in front of the archeological site. Low abundance of Cryptomeria indicates a little snow near the site, and this is one of the reasons why the Mawaki archaeological site may have been used for habitations.

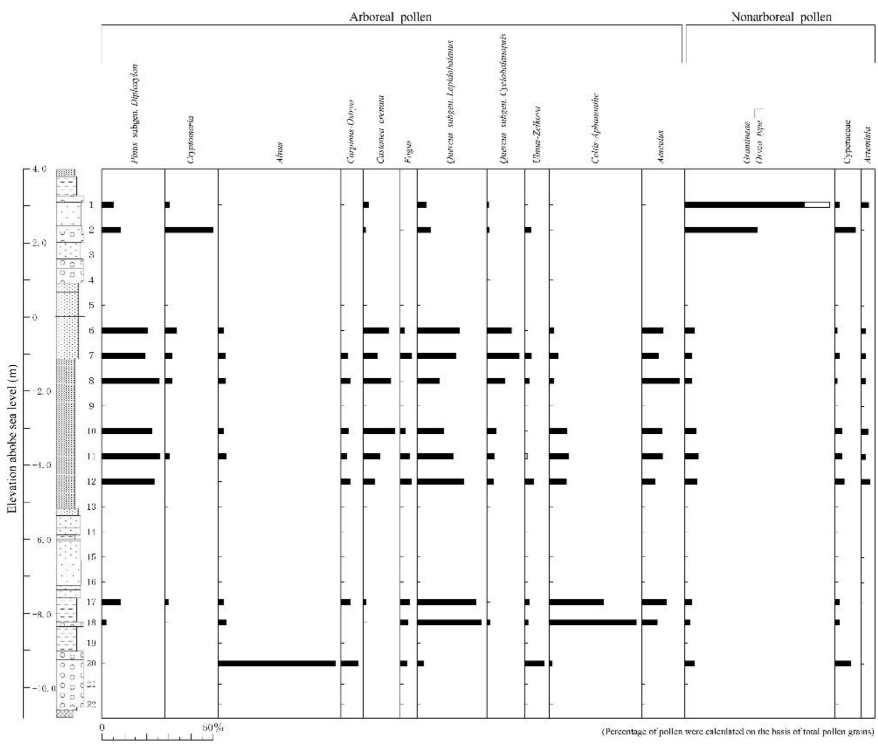

Figure 5.4 *Pollen assemblage from boring sample C-4.*

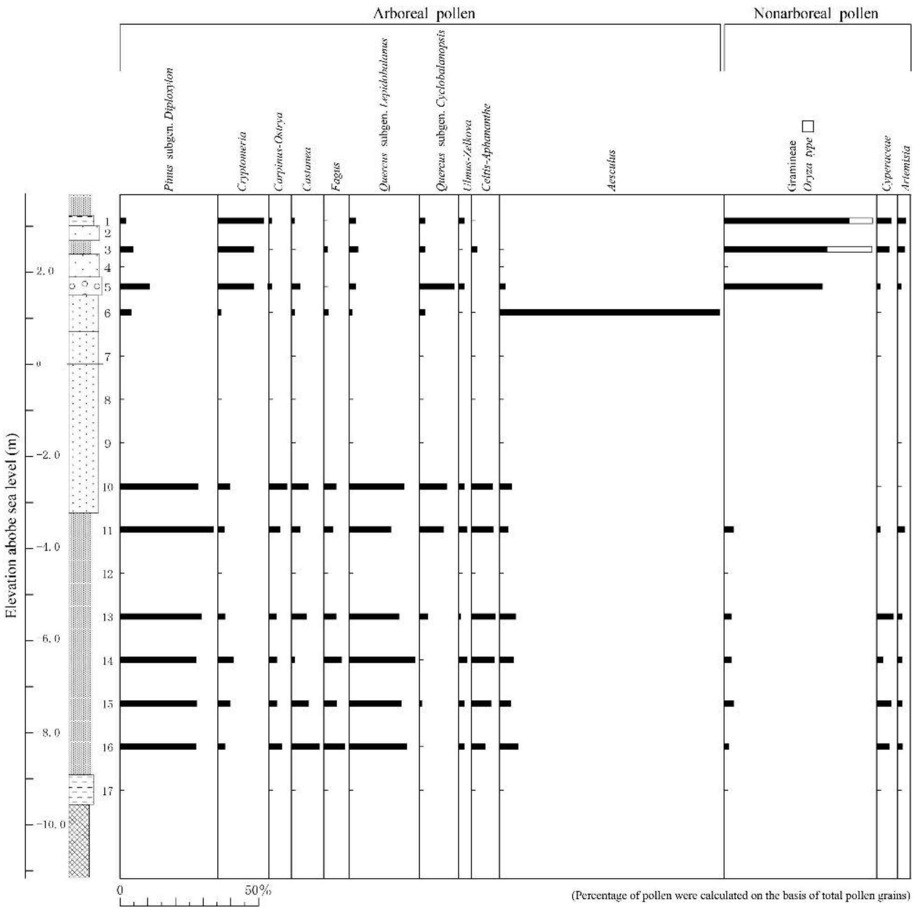

Figure 5.5 *Pollen assemblage from boring sample C-5.*

The castanopsis group in the excavated area in 1998, having detected rather much amounts, planted in drier condition and the abundance within the marine sediments. Abundance of the Pinus group-pollen was reflected in marine sediments rather than in any other environment, and their abundance was influenced by the local vegetation at the steep slope and rock outcrops or along the shoreline.

5.3.2 Vegetational Change in and Around Mawaki Site in Space and Time

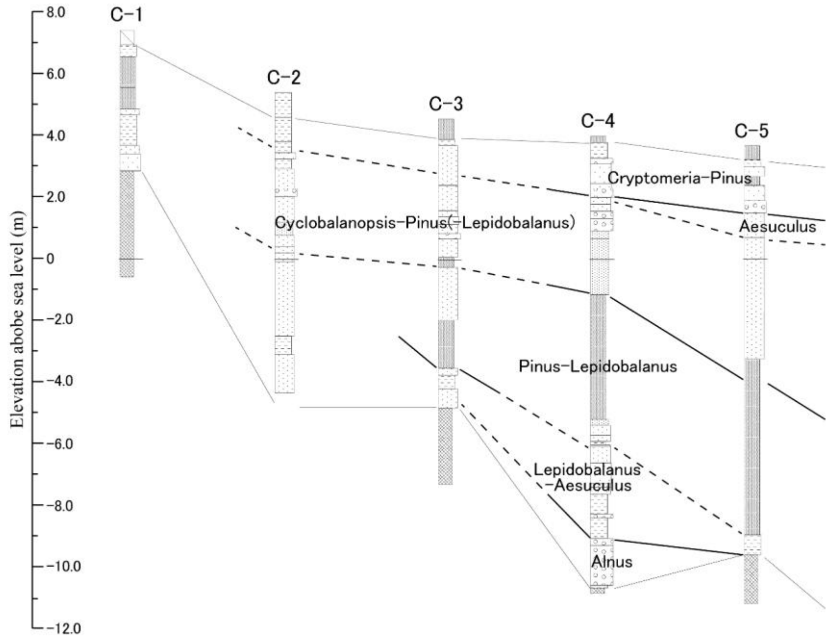

Figure 5.6 *Correlation among cores along the C-Line by pollen assemblage.*

Spatial distribution of pollen assemblage is shown along the C-Line (C-2 - C-5) in Figure 5.6. On the basis of lithological continuity, distribution of marine sediments was thicker from the hill to shoreline side. The lowest part of sedimentary sequence was composed of sandy sediments. Though the abundance of pollen grains was small, the pollen assemblage here was composed of mainly Alnus pollen. This indicates that this horizon includes sediments influenced by humic land condition. The pollen assemblage indicated a forest composed of broad-leaved deciduous trees such as Qercus, Aesculus (horse chestnut) within the clay and silty sand units (units B and C). Abundance of pollen grains was very high here. Those are composed of Lepidobalanus-Aesculus assemblage, Pinus-Lepidobalanus assemblage and Cyclobanopsis-Pinus-(Lepidobalanus) assemblage in ascending order. Abrupt changes to uppermost part were recognized to include Cryptomeria and Pinus, which were influenced by human activity. Cultivated soil covers unconformably the sedimentary sequence during Jomon period.

5.3.3 Diatom Assemblage and Environmental Change

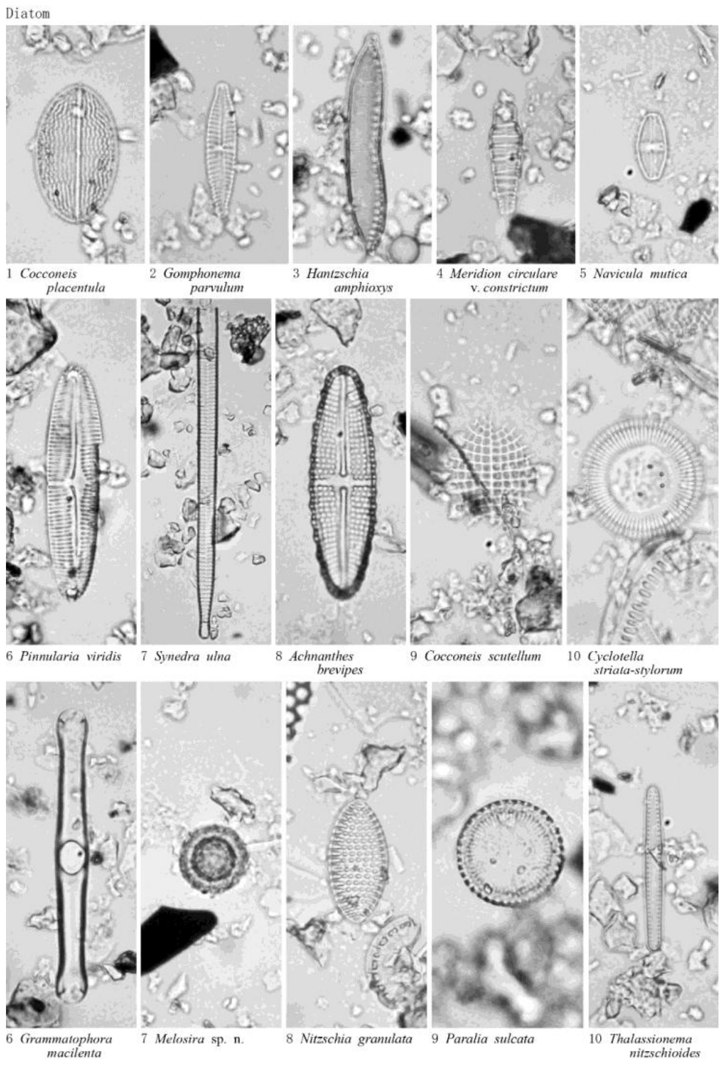

Photo 5.2 *Representative photos of diatom grains from the Mawaki Site.*

Figure 5.7 shows the result of diatom analysis (Photo 5.2) and correlation among C cores from hill side to shoreline side. Abundance of the diatom frustules grains was small in the lower part of sequence. In the middle part of sequence of boring core sediments, *Palaria sulcata* group diatoms were found. The data represent the marine environment. In the sequence of C-2, the boundary between marine environment and marshy environment was located at about 3 m above present sea level.

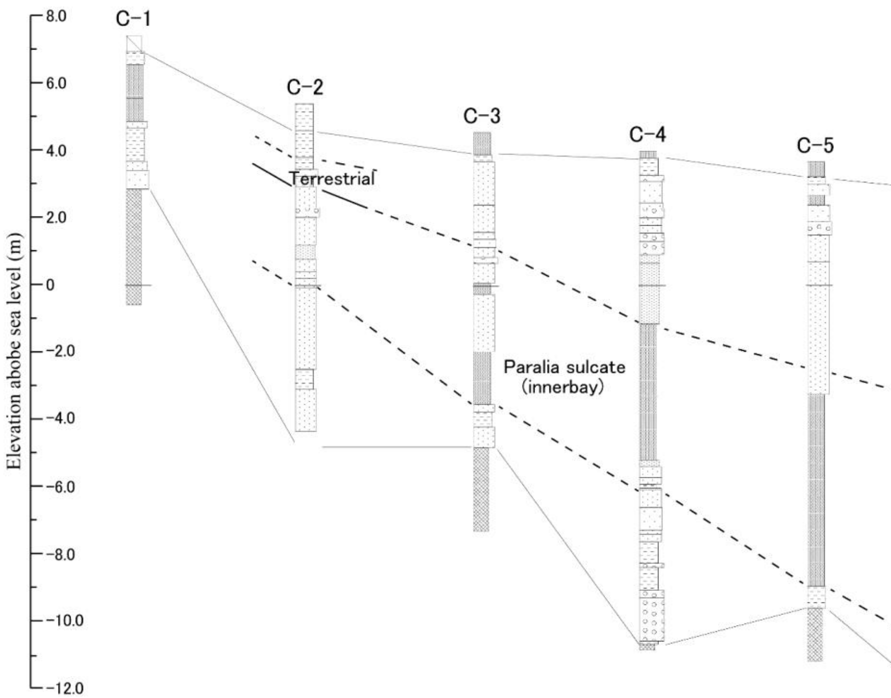

Figure 5.7 *Correlation among cores along the C-Line by diatom occurrence.*

Diatom assemblage of the sediments related with dolphin bone occurrence at the excavation site of the altitude of 3.6~4.3 m above sea level was analyzed. Composition was characterized by occurrence of terrestrial diatom and freshwater diatom associated with marine environment diatom such as *Navicula mutica* in the upper part, *Hantzschia amphioxys* and *Navicula munica* in the middle part, and *Grammatophora oceanica*, *Hantzschia amphioxys* and *Navicula munica* in the lower part. Horizons of sediments with dolphin bones were characterized by a sedimentary environment along the shoreline based on the diatom assemblage data.

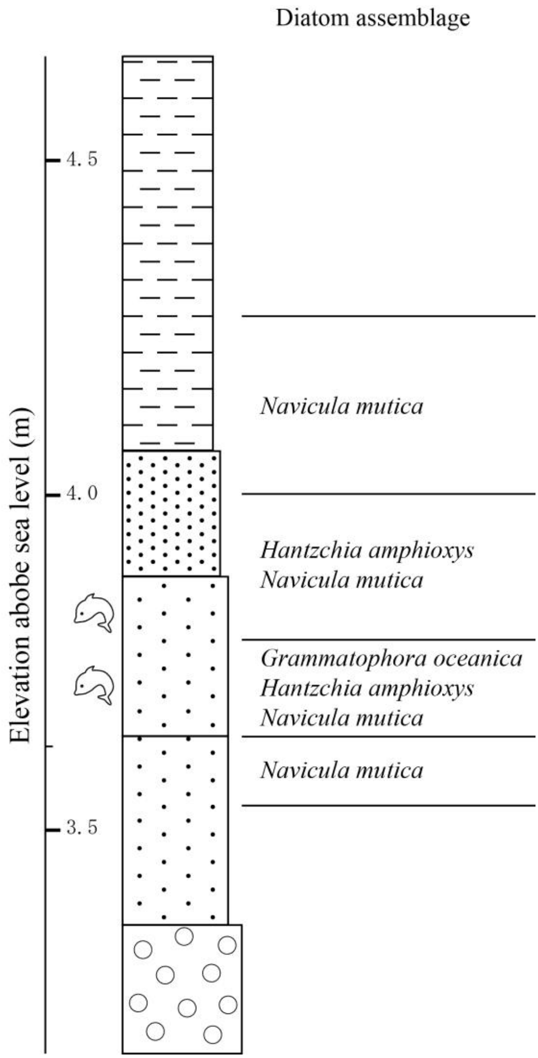

Figure 5.8 *Diatom assemblage of sediments at the southwest from the excavation site.*

5.4 Conclusive Remarks

Surrounding area of Mawaki region was covered by Quercus and Pinus forest vegetation, and Pinus trees were distributed in the rock area along shoreline side and Aesculus (horse chestnut) were living along the valley. Castanea were distributed in and around the site, and Quercus and Celtis were living during late and latest Jomon period. Castanea and Aesculus were main the eatable fruits for people.

In the latest Jomon period, Aesculus plants were distributed in the newly emerged humid area in front of archeological site.

Low abundance of Cryptomeria indicates a little snow near the site, and this is one of the reasons why the Mawaki archaeological site may have been used as a dwelling area during the Jomon period.

Preliminary data of pollen and diatom within the core samples provided insight into the environmental changes around the Mawaki site, such as changes in sea-level (one cycle of transgression to regression) and vegetation.

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