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Abstract - The vegetation in western Japan since the last interglacial are summarized based on more than sixty pollen records including long cores covering the last interglacial, the whole last glacial and the Holocene. In the interstade (isotope stage 3), the late glacial and the Holocene, the vegetational differences between the coastal areas of the Japan Sea and the Pacific Ocean are recognized. Changes of the warm current in the Japan Sea probably caused the vegetational differences of the both areas.

I. Introduction

Japanese vegetation history has been affected by not only global scale climate changes but also changes of the Kuroshio warm current in the Pacific Ocean and the Tsushima warm current in the Japan Sea. Therefore, the comparison of the vegetation changes between the Pacific and the Japan Sea coasts is important for making clear the process of the establishment of the vegetation in Japan. Recently, several pollen records covering the last interglacial, the whole last glacial and the Holocene are also, available from the western Japan. In this paper, the differences in vegetation between the coastal areas of the Japan Sea and the Pacific Ocean since the last interglacial in western Japan are summarized based on mainly Takahara & Takeoka (1992), Takahara (1994), Takahara & Kitagawa (2000) and Takahara et al.(2000) [1-4].

II. Vegetation zones in western Japan

The areas below about 500-600 m are situated in the warm-temperate zone. Almost all the lowland area is covered by agricultural field as rice paddies. The climax vegetation of the hillslopes in the area is warm-temperate evergreen broad-leaved forest, but most modern vegetation has been changed to secondary forests dominated by Japanese red pine (*Pinus densiflora*) and deciduous oaks (*Quercus serrata*) or plantations of Japanese cedar (*Cryptomeria japonica*) and Japanese cypress (*Chamaecyparis obtusa*). The mountain area above 500-600 m altitude is the cool-temperate zone. On this area, deciduous broad-leaved forests composed mainly of beech (*Fagus crenata*) and oak (*Q. crispula*) are dominant. Beech forests in the Sea of Japan area include Japanese cedar with relatively high frequency. On the other hand, fir (*Abies homolepis*) and beech are mainly components of the forests in the Pacific Ocean area. Uppermost part of the mountain area above 1600 m include the subalpine coniferous forests composed by fir (*Abies veitchii*), spruce (*Picea jezoensis* var. *hondoensis*), hemlock (*Tsuga diversifolia*) and birch (*Betula ermanii*).

III. Vegetation changes since the last interglacial

The last interglacial period

Isotope stage 5e : The last interglacial pollen record are available in Lake Biwa [5], Kurota lowland [3], Kamiyoshi Basin (Takahara *et al*., unpublish data & [4]) in western Japan. Forest vegetation were composed of evergreen oaks, *Crypotmeria japonica*, fir and hemlock with *Largerstraemia* that is distributed in the southwestern Island and China at present. Also, this warm temperate forests included beech (*Fagus crenata*) which grows in the cool temperate zone at present. The combination of climatic factors during the last interglacial is considered to be different from that during the Holocene.

The last glacial period

In the period from 90 to 60 kyr BP (substage 5b, 5a and stage 4), vegetation histories of the both areas are very similar. Temperate conifer forests, composed primarily of *Cryptomeria japonica*, were predominant in 90 to 70 kyr BP (substage 5b and 5a), conifer forests composed of pinaceous trees dominated from 70 to 60 kyr BP (stage 4), and cool-temperate deciduous broad-leaved forests dominated around 60 kyr BP. However, during the interstade (isotope stage 3) from 60 to 30 kyr BP, Cupressaceae trees became dominant in the inland area (Kamiyoshi Basin and Lake Biwa) whereas *Cryptomeria japonica* were dominant in the coastal area of the Japan Sea (Kurota Lowland). The difference in vegetation between the both areas became more distinct between 45 and 30 kyr BP (in the latter half of isotope stage 3). That is, Cupressaceae trees were predominant in Kamiyoshi Basin, associated with *Sciadopitys verticillata* and deciduous oaks, while *Cryptomeria japonica* was dominant in Kurota Lowland, associated with cool-temperate deciduous broad-leaved trees such as *Fagus crenata* and deciduous oaks. The dominance of *Cryptomeria japonica* in the interstade has been recognized in Oofuke moor [6], Lake Mikata [7] and Yamakado Moor [8], which are located in the coastal area of the Japan Sea. The difference in vegetation between both areas suggests that the climate in the inland area

differed from that in the coastal area of the Japan Sea during the period from 60 to 30 kyr BP (especially between 45 and 30 kyr BP).

The full-glacial period

Isotope stage 2 : In the early full-glacial period from about 25000 to 18000 years BP, Pinaceae and *Betula* pollen were dominant with *Cryptomeria* and *Ulmus-Zelkova* at Lake Mikata and with *Cryptomeria* and broad-leaved trees such as *F. crenata*, *Quercus* (*Lepidobalanus*), *Carpinus-Ostrya* and *Ulmus-Zelkova* at the Iwaya site. In this stage, *Cryptomeria japonica* and cool-temperate deciduous broad-leaved trees were relatively abundant around the Kurota Lawland. Therefore, the Mikata district probably had a relatively wet climate in this stage, within the cold and dry full-glacial.

In the late full-glacial period (Last Glacial Maximum) from 18000 to 16000 years BP, pinaceous conifer forests consisted of *Abies*, *Tsuga* (*T. sieboldii* and *T. diversifolia*), *Picea*, and *Pinus*, with *Betula* trees showed the maximum development and *C. japonica* and *F. crenata* declined in the coastal area of the Japan Sea.

Pinaceous trees continued to be prominent in the forest in the early half of the late-glacial period from 16000 to 12000 years BP in the coastal area of the Japan Sea, but began to decline in about 13500 years BP. The increase of *C. japonica* pollen at about 16000 years BP, indicates the occurrence of small stands of *C. japonica* and the beginning of the wet climate in the late-glacial period.

In the latter half of the late-glacial period, after 12000 years BP, pinaceous conifer forests declined and were replaced by cool-temperate deciduous broad-leaved forests composed mainly of *F. crenata*, *Quercus* (*Lepidobalanus*), *Aesculus turbinata*, *Pterocarya rhoifolia* and *Carpinus* trees in the coastal area of the Japan Sea. The cool-temperate deciduous broad-leaved forests dominated by *Fagus crenata* were simultaneously established in areas below 600 m altitude in the coastal area of the Japan Sea. *Cryptomeria japonica* also began to increase there. Such a conspicuous change in the vegetation was caused by climatic amelioration, the climate becoming warmer and wetter. On the other hand, in the Pacific Ocean and inland areas, pine and deciduous oak have been the dominant taxa since the full-glacial [9].

The Holocene

In the early postglacial (10,000-8,000 years BP), in the coastal area of the Japan Sea below 800 m was dominated by cool-temperate deciduous broad-leaved forests composed mainly of *F. crenata* and *Quercus* (*Lepidobalanus*). Also, *C. japonica* considerably increased below 500/600 m. At about 10000 years BP, there was a temporary flow and at 8000 years BP an abundant flow of the Tsushima warm current into the Sea of Japan [10-11]. The inflow of the Tsushima warm current into the Japan Sea is considered to have caused abundant snowfall and high precipitation that made *Cryptomeria japonica* forests develop in the coastal area of the Japan Sea.

The Pacific Ocean and the inland areas were covered with *Quercus* (*Lepidobalanus*)-dominated deciduous forests. Around 6,000 years BP, *C. japonica* became the most dominant species in the forests below 600 m, and cool-temperate deciduous broad-leaved forests developed above 600 m. At this time, lucidophyllous (evergreen broal-leaved) forests composed mainly of *Quercus* (*Cyclobalanopsis*) and *Castanopsis* had already been established in the southernmost part of the Pacific Ocean area, and began to develop below 600 m in the inland area. Lucidophyllous forests in the coastal area of the Japan Sea developed after about 6,000 years BP, later than those in the Pacific Ocean area. After 4,000 years BP, lucidophyllous forests spread in all areas below 600/700 m and *Cryptomeria japonica* forests also developed from lowland to the mountainous areas the coastal area of the Japan Sea. Secondary forests of *Pinus densiflora* that reflect human disturbance of the original vegetation, began to increase around 1,500-1,200 years BP near old cities such as Kyoto, Osaka and Nara and around 1,000-700 years BP in mountainous areas at some distance from these cities.

To clarify vegetational responses to global climate changes, We need more detail studies on the influence of changes of the Kuroshio warm current in the Pacific Ocean and the Tsushima warm current in the Japan Sea on the vegetational differences between the both areas.

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