Climatic Changes and the Development of Jomon Culture in Japan

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INTRODUCTION

The Japanese Jomon culture started around 13,000 BP[1] and continued for more than 10,000 years. This Neolithic culture was mainly based on hunting, fishing and gathering activities, though there was some primitive agriculture. The Jomon age is divided into six periods: Initial period (*Sousouki*), 13,000–10,000 BP; Earliest period (*Souki*), 10,000–7,000 BP; Early period (*Zenki*), 7,000–5,500 BP; Middle period (*Chuki*), 5,500–4,300 BP; Late period (*Kouki*), 4,300–3,200 BP; and Latest period (*Banki*), 3,200–2,300 BP.

According to previous pollen analyitcal studies, the author notes four marked periods represented by abrupt climatic and cultural change. The dates of these periods are as follows: 13,000–12,500 BP; 8,500–8,000 BP; 5,500–5,000 BP; and 3,500–3,000 BP. The influence of climatic change on the development of Jomon culture in these four marked climatic periods will also be discussed in comparison with other Asian areas, such as China and the Middle East. It is a cause of regret that because of insufficient data a complete comparative study of climatic change between Asia and Japan remains impossible. However, we can also recognize four important dates that are common in climatic change and the cultural development of Asia. The location of the sites of pollen analysis discussed in this report is shown in Fig. 1.

THE GEOGRAPHICAL SETTING IN JAPAN

1 A heavy snow fall country

Heavy snow fall along the Japan Sea coast is a characteristic climatic phenomenon of Japan, and one of the major differences from the climate of China and Middle East. The maximum snow depth in winter in the Hokuriku district of central Japan reaches more than 3,000 mm. The warm Tsushima current plays an important role in

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[1] Dates in this report are based on radiocarbon years B. P. (before 1950 A.D.).

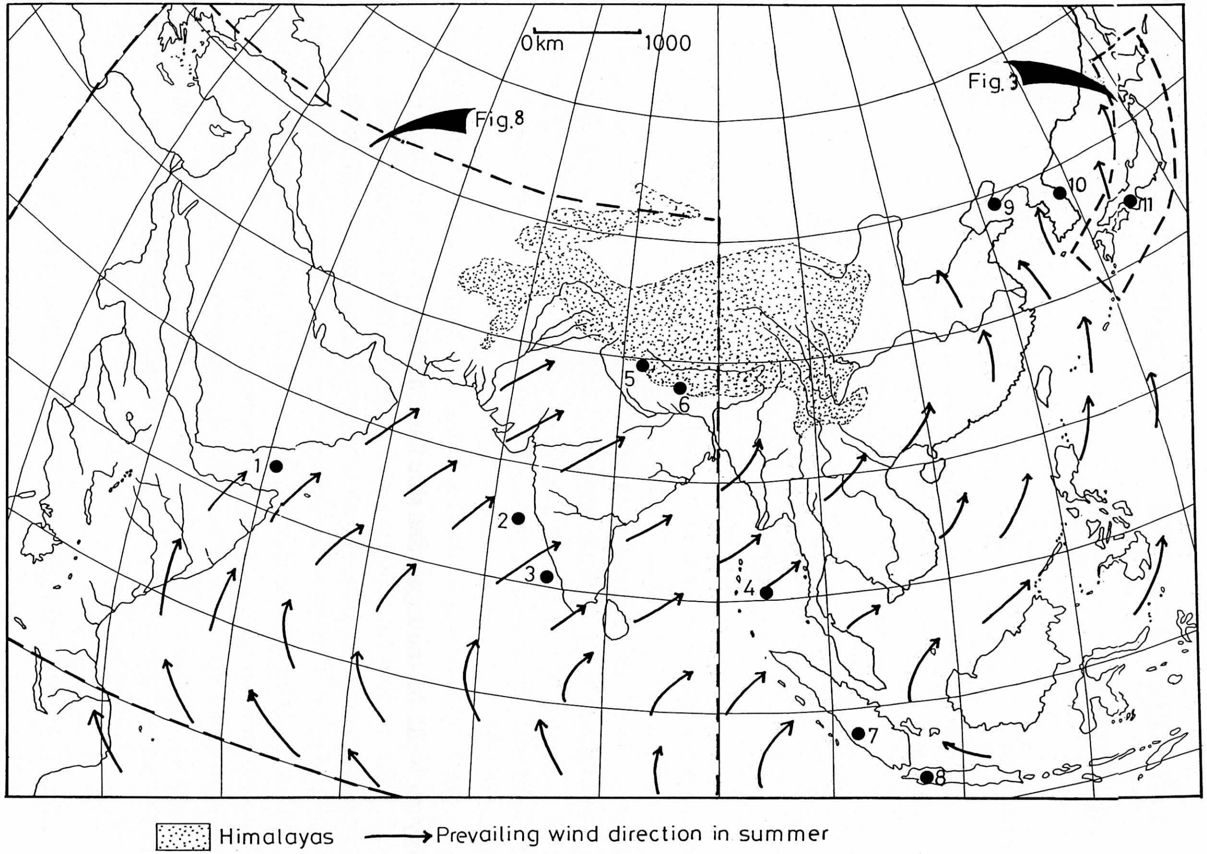

Fig. 1. Map showing the sites of pollen analyses discussed in this report.

1: MD76135 (Van Campo *et al.*, 1982), 2: MD76131 (Van Campo, 1986) 3: MD76194 (Van Campo, 1986), 4: MD77169 (Fontugne *et al.* 1986) 5: Lake Rara (Yasuda and Tabata, 1988), 6: Kathmandu valley (Igarashi *et al.*, 1988), 7: Danau di Atas Swamp (Stuijts *et al.* 1988), 8: Situ Bayongbong (Stuijts *et al.* 1988), 9: Liaoning district (Laboratory of Quaternary Palynology and Laboratory of Radiocarbon, Kweiyang Institute of Geochemistry, Academia Sinica, 1978), 10: Lake Yunnang Yasuda *et al.*, 1980), 11: Furuichi moor (Yasuda, 1978)

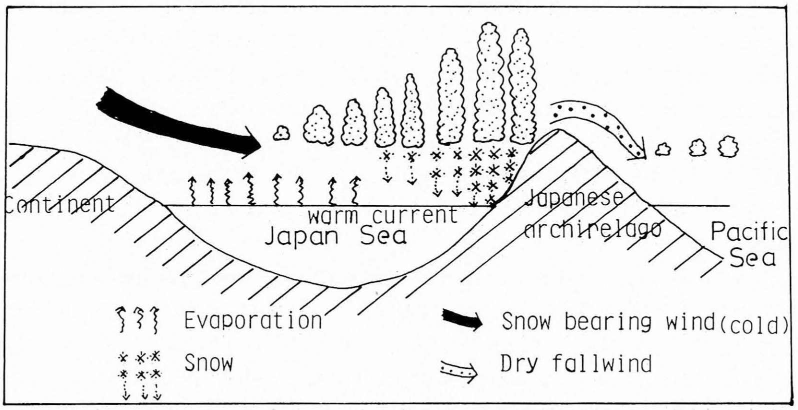

Fig. 2. A schematic map of the heavy snow fall mechanism.

the creation of the heavy snow fall along the Japan Sea coast. Fig. 2 is a sketch of the heavy snow fall mechanism. The surface temperature of the Japan Sea, warmed by the Tsushima current in winter, is about 10°C., while the air temperature near the surface cooled by the cold northwest monsoon from the Siberian anticyclone falls to minus 10°C.. This wide temperature range between the warm water surface and the cold air causes active evaporation, producing a large amount of fog. The fog is carried by the northwest monsoon towards the Japanese archipelago, and develops into large cumulo-nimbus clouds. These large clouds produce a heavy snow fall on the Japan Sea side. Heavy snow fall on the Japan Sea side has a marked effect on the distribution of the present vegetation. For example, the current distribution of the mixed forests of *Cryptomeria japonica* with *Fagus crenata* occur in the area which receives over 300 mm of precipitation during the three winter months. The distributional area of the mixed *Cryptomeria japonica* with *Fagus crenata* almost corresponds to the districts of heavy snow fall. On the other hand, the distributions of *Tsuga* coincides with the light snow region. There are two types of *Tsuga* in Japan, *T. diversifolia* and *T. sieboldii. T. Diversifolia* grows in the subalpine and cool temperature zones, while *T. sieboldii* grows in the warm to cool temperature zones. Both species occur on the Pacific Ocean side of Japan, being adapted to a dry climate and unstable soil conditions. These fluctuations in snow fall have influenced the vegetational changes of the Japanese archipelago.

THE BEGINNING OF JOMON CULTURE AND THE CLIMATIC CHANGES AROUND 13,000–12,500 BP

1 Climatic and cultural changes around 13,000–12,500 BP in Japan

Recent palynological studies have revealed dramatic changes in Japan's snow fall during the transition between the Pleistocene and Holocene. Because the sea level was more than 80 m lower than the present level, the Tsushima warm current could not enter the Japan Sea during the maximum period of glaciation. The climate during this period, especially from 25,000 to 15,000 BP, was very dry. A cold and dry climate prevailed throughout Japan. The mean annual temperature in Hokkaido was 9°C. lower than the current mean, 7–8°C. lower in central Japan, and 6–7°C. lower in Kyushu, while annual precipitation was less than a third of the present level (Yasuda 1990a). After 15,000 BP, this cold and dry climate became warmer, and the temperature rose quickly. However, precipitation did not begin to increase until 13,000–12,500 BP.

Fagus crenata is one of the main elements of the cool temperate broad-leaved forests of Japan. Its presence indicates maritime climatic conditions as it is more sensitive to precipitation than temperature, especially in winter. *F. crenata* cannot flourish in a dry, cold winter climate, because frozen soil damages the roots and interrupts growth, even though the cumulative annual temeprature, or warmth index (Yasuda and Narita 1981), implies favorable conditions. Snow cover protects from frost damage as it maintains soil temperature above freezing point during winter. In early spring snow cover also shelters young buds from the cold air. It is considered that snow fall provides suitable conditions for the growth of *F. crenata.*

Fig. 3 shows the fossil pollen map of *Fagus* since the last period of maximum glaciation. Below 40°N., along the Japanese archipelago, after 13,000 BP *Fagus* pollen increased, suggesting climatic amelioration and increasing snowfall. The area south of 40°N., along the Japan Sea coast, corresponds with the districts that currently endure heavy snow fall. North of 40°N., however, *Fagus* pollen did not increase until 8,000 BP, after which it was able to expand northwards. This regional distribution indicates that with increasing snow fall the cold and dry climate began to ameliorate around 13,000 BP, and the development of maritime conditions, around 8,000 BP, suitable for the growth of *F. crenata* suggests the establishment of heavy snow fall.

On the other hand, the drier climate continued along the Pacific Ocean side of the Japanese archipelago. In a pollen diagram of Furuichi moor (34°33′30″N., 135°36′30″E., 25 m in altitude) (Yasuda 1978b) in Habikino city, Osaka Prefecture, the horizon dating from 13,000 to 10,000 BP was characterized by the high frequency of *Pinus Haploxylon, Picea, Abies, Quercus Lepidobalanus, Carpinus, Ulmus-Zelkova* and *Betula,* while the frequency values of *Fagus* register only a few percent. The climate during this period on the Pacific Ocean side was too dry for *Fagus* because of the light snow fall.

The L zone from 13,000–10,000 BP of the Furuichi moor is sub-divided into four sub-zones, i.e. from the lowerst zones La, Lb, Lc, and Ld (Yasuda 1978b). The Lc sub-zone is characterized by the decrease of *Picea, Abies* and *Pinus Haploxylon,* and the increase of temperature broad-leaved trees such as *Quercus Lepidobalanus, Carpinus* and *Ulmus-Zelkova,* which suggests climatic amelioration. Radiocarbon dating suggest that this warm period of the late glacial period lasted from 12,000–11,000 BP, and corresponds with northern Europe's *Allerød* Interstadial.

In the Ld sub-zone, *Picea, Abies, Tsuga* and *Pinus Haploxylon* increased once more and the temperate broad-leaved trees decreased, indicating a climatic deterioration that correlates with the *Younger Dryas* period in northern Europe.

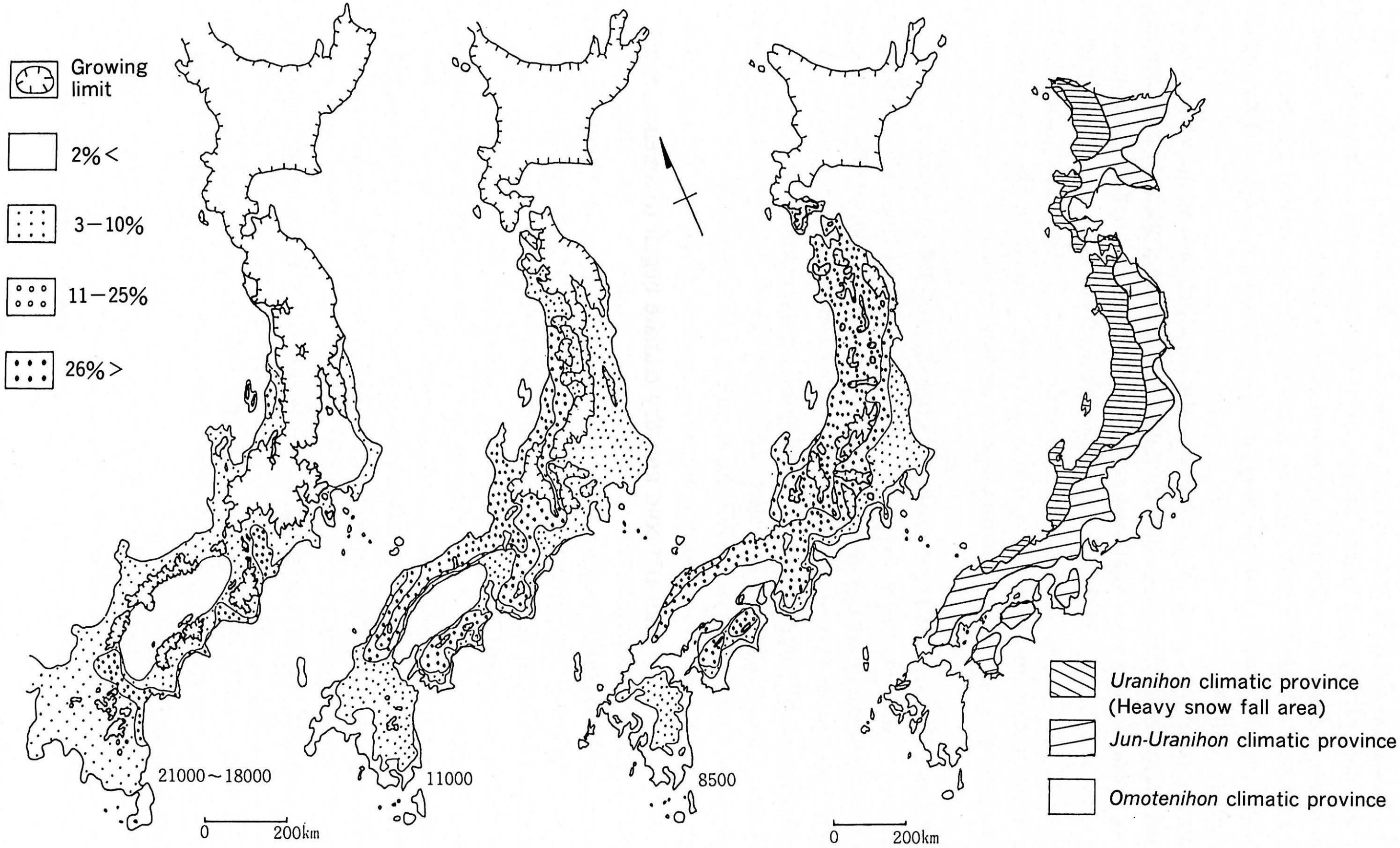

Fig. 3. Fossil pollen maps of *Fagus* during 21,000-18,000 yr BP, 11,000 yr BP, 8,500 yr BP and climatic divsion of the Japanese archipelago (Yasuda, 1992).

The oldest pottery, together with micro blades, has been found at the Fukui-dokutsu site in Nagasaki Prefecture in northern Kyushu. This pottery was decorated with micro linear clay projections and is called *Sairyusenmon* pottery. Charcoal collected from the horizon containing the *Sairyusenmon* pottery has been dated at 12,400±350 BP and 12,700±500 BP (Serizawa 1974). Kato (1988) has pointed out that the new micro blade culture which produced the pottery technology had probably expanded from southern China.

As mentioned above, post-13,000 BP climatic amelioration in Japan resulted in a significant increase of snow falls. This climatic change encouraged the development of temperate broad-leaved trees such as beech and oak, which produced a considerable crop on nuts. It is supposed that the pottery was used for cooking,. and in particular the boiling of nuts from the temperate broad-leaved forests. The post-13,000 BP climatic amelioration brought about a revolutionary change in the development of Japanese culture, which led to the new age of Jomon culture.

2 Climatic and Cultural Changes around 13,000–12,500 BP in Asia

The climatic transition from the cold and dry climate of the glacial period to the warm and moist climate of the Holocene began around 15,000–12,000 BP in China's north Shandong plain (Yu *et al.* 1991). The climate became warmer and grassland, mainly composed of *Artemisia* and Chenopodiaceae, decreased, while dark coniferous trees, such as *Pinus, Picea* and *Abies*, increased. Wang Jian (1989) has indicated that the temperature in the Beijing region around 12,000 BP was about 4–5°C. lower than present temperatures, and the region was marked by the appearance of broad-leaved trees. In the Huaibei plain of Anhui, steppe or desert steppe, composed of *Artemisia* and Chenopodiaceae, decreased after 12,000 BP and mixed forests of coniferous and deciduous broad-leaved trees expanded (Jin 1991). The pollen diagram of the lower reaches of the Yangtze River indicate the increase of evergreen broad-leaved trees after 12,000 BP (Zhang 1985, Xi and Sun 1988).

Fig. 4 shows the pollen diagram of Lake Yunnang (38°13′ N., 128°35′ E., O m in altitude) (Yasuda *et al.* 1980) in Sokucho city, on the eastern coast of the Korean peninsular (Fig. 1). Because of the high frequency values for *Picea, Abies* and *Larix*, the pollen diagram suggests the development of a cold and dry climate around 15,000 BP. Frequency values for the temperate broad-leaved trees such as *Quercus, Carpinus* and *Juglans* are very low, while *Fagus* is totally missing. These low values for temperate broad-leaved trees continued until 10,000 BP. On the Japan Sea side of the Japanese archipelago, *Quercus* started to expand around 15,000 BP. and *Fagus* developed after 13,000 BP., while on the Korean peninsula the development of temperate broad-leaved forests occurs after 5,000–3,000 years, much later than that of the Japanese archipelago.

The time lag between Japan and Korea in the development of temperate broad-leaved forests was caused by the differing amounts of snow fall. The continuing cold and dry winters in the Korean peninsular impeded the growth of temperate broad-leaved trees.

The results of oxygen isotopic and pollen analyses of a core (MD 73135) taken from

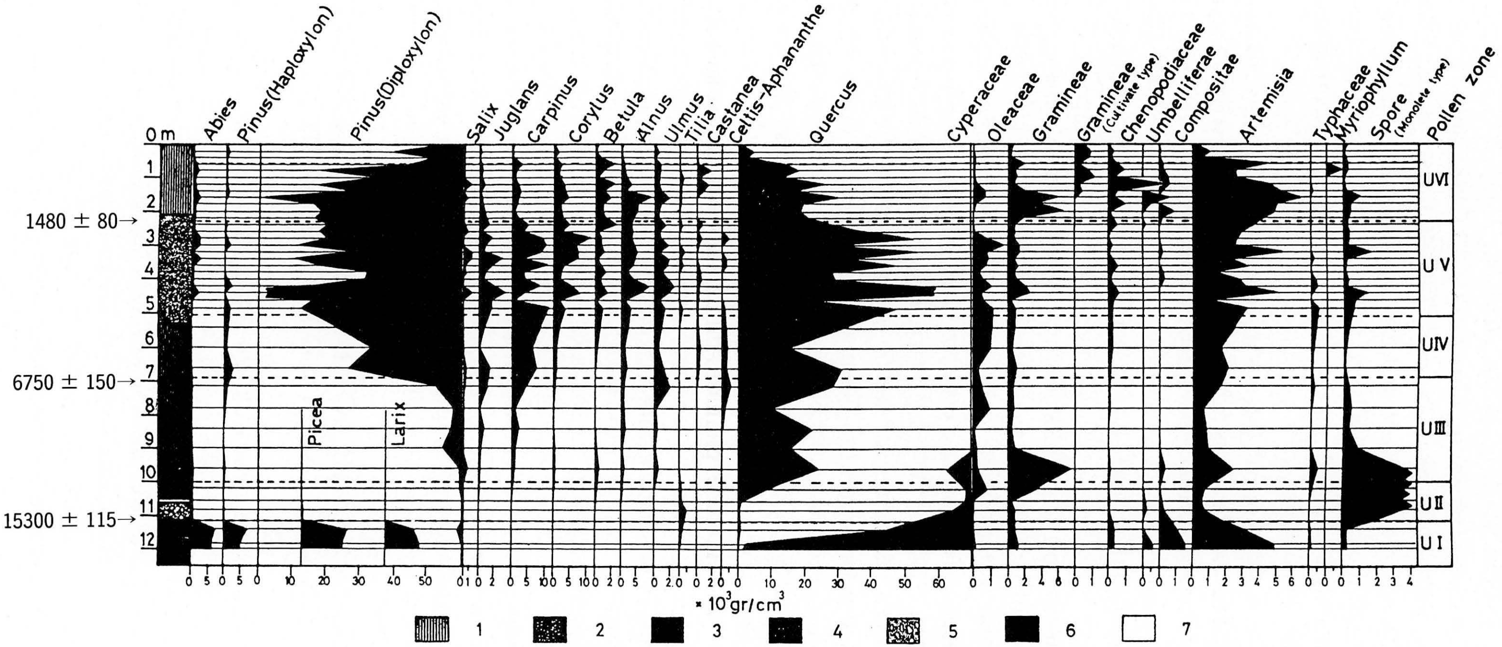

Fig. 4. Pollen diagram from Lake Yunnang in Sokucho City, Korea (Values expressed as absolute number per cm³) (Yasuda, *et al.* 1980).
1 Dark grey gyttja, 2 Dark brown highly humified gyttja mixed with shell, 3 Green grey weakly humified gyttja, 4 Muck mixed with sand and gravel, 5 Grey clay, 6 Grey gravel, 7 Dark brown peat.

the bottom of the Arabian Sea (Fig. 1) (14°26′ 6″N., 56°31′ 3″E.) have revealed the reactivation of the southwest monsoon after 12,000 BP (Van Campo *et al.* 1982). East African lake levels, including Lakes Victoria, Rudolf (Owen *et al.* 1982), Nakuru (Butzer *et al.* 1972), Mahoma, Ziway and Shala (Gillespie *et al.* 1983), rose after 12,500 BP and attained their maximum levels around 8,000 BP. These rises were caused by very heavy rainfall brought about by the reactivation of the southwest monsoon which began around 12,500 BP.

Evidence of massive flooding of the River Nile during the late glacial and early Holocene, again due to very heavy rainfall, was discovered in a core taken from the bottom of the Mediterranean Sea off southern Crete. Rossignol-Strick (1982) found two sapropel formations, dated 11,800–10,400 BP and 9,000–8,000 BP, from the KS52 core and concluded that these layer were formed under the influence of the River Nile.

The argument for the post 12,500 BP reactivation of the southwest monsoon is also supported by the results of pollen analysis of the MD76131 (15°31′ N., 72°34′ E., 1,230 m in depth) and MD76194 (10°28′ N., 75°14′ E., 1,222 m in depth) cores taken from the Indian Ocean (Fig. 1) (Van Campo 1986). Carbon isotopic analysis of the MD77169 core (10°12′ 5″N., 95°03′ E., 2,360 m in depth) from the bottom of the Andaman Sea showed low ^{13}C values for 12,700 BP, a result of the significant contribution from terrigenous organic carbon. Fontugne and Duplessy (1986) have concluded that this increased terrestrial contribution was a product of the strengthened southwest monsoon and possibly, as a consequence of the warm and wet climate, the melting of the ice caps in the Himalayas.

Results of the MD77169 core from the Andaman Sea are consistent with the pollen analytical results obtained from the Kathmandu valley in east Nepal (Igarashi *et al.* 1988) and Lake Rara in western Nepal (Yasuda and Tabata 1988). The rise of water levels in Inner Mongolia and the increased post-13,000 BP precipitation in Japan, might have been closely linked to the reactivation of the southwest monsoon.

Around this 13,000–12,500 BP watershed the new cultural ecosystem appeared in Asia. The beginnings of Jomon culture in the Japanese archipelago is one of the peculiar cultural features in the human adaption during the transition from the cold and dry climate of the Glacial period to the warm and moist climate of the Holocene.

THE ESTABLISHMENT OF JOMON CULTURE AND CLIMATIC CHANGE AROUND 8,500–8,000 BP

1 Clmatic and cultural change around 8,500–8,000 BP in Japan

The climatic epoch between 13,000 and 8,000 BP was a transitional period from a cold and dry continental climate to a warm and moist maritime climate. This transitional period ended in 8,000 BP and a maritime climate developed throughout the Japanese archipelago. In Hokkaido deciduous broad-leaved forests, mainly composed of *Quercus*, rapidly expanded after 8,000 BP (Igarash 1986).

The incursion of the Tsushima warm current into the Japan Sea is clear from the foraminiferal, diatom and O16/O18 analyses of cores taken from the floor of the Japan Sea (Oba 1983, Koizumi 1989).

According to the results of these analyses, the full-scale entrance of the Tsushima warm current occurred around 8,000 BP. This date corresponds with the expansion of *F. crenata* forests to the north of 40°N. coinciding with the development of the maritime climate.

Recently Japanese archaeologists have discovered an important cultural break around 8,000 BP. Nishida (1989) has pointed out that Jomon culture's basic tools appeared as early as in 8,000 BP, and suggests the establishment of life style adapted to the maritime climate and an ecosystem of broad-leaved forests. These cultural developments should be considered as the fruits of the warm and moist climate.

Evidence for a short cold period around 7,000 BP, observable through fluctuating African lake levels (Owen *et al.* 1982, Gillespie *et al.* 1983, and Hassan 1986), is rarely found in Japanese pollen diagrams. However, a pollen diagram from Ebetsu city in Hokkaido (Ono and Igarashi 1991), and the fluctuations of the Tsushima warm current (Fig. 5) (Koizumi 1989, and 1994) reveal such a temporary cold epoch.

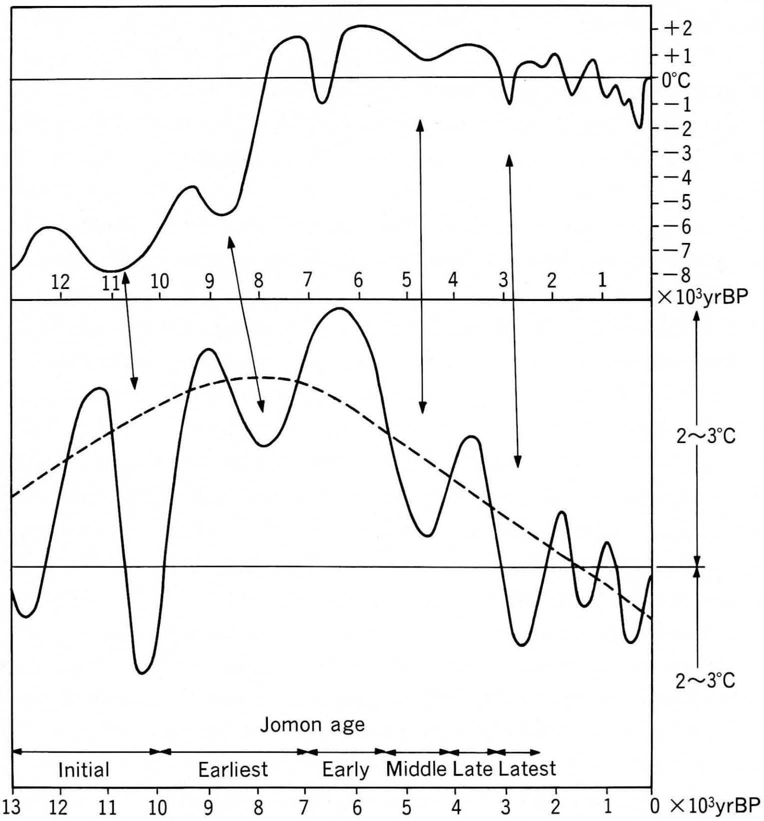

Fig. 5. The temperature fluctiations for the last 13,000 years in China (Sun *et al.*, 1991) (upper) and the oscillations of Tsushima warm current in Japan (Koizumi, 1994) (lower).

Recent studies of the annual varve clay from Lake Suigetsu in central Japan point to clear regression and climatic deterioration around 7,000 BP (Fukuzawa 1994). In Lake Suigetsu the regression becomes more marked with the eruption of the Kikai caldera volcano in Kagoshima Prefecture.

After this temporary climatic deterioration, the Japanese climate became warm again. Mean annual temperature between 6,500 and 5,500 BP was about 2–3°C. higher in north Japan and 1–1.5°C. higher in southwest Japan than the current annual mean (Yasuda 1983). During this 'Climatic Optimum' the climate of north and east Japan was both warm and dry. The climate of the Japan Sea side was particularly dry because of increased snow fall. On the other hand, hit by heavy rain and numerous typhoons the climate of southwest Japan was warm and moist. *Fagus crenata* forests arrived in Hokkaido in 6,000 BP (Ono and Igarashi 1991) and evergreen broad-leaved forests covered the lowlands of southwest Japan. In the pollen diagram from the Torihama shell mound site (Yasuda 1979), *Quercus Cyclobalanopsis* and *Castanopsis*, the main elements of the evergreen broad-leaved forests, increased after 6,000 BP. The sea-levels were some 0–5 m higher than current levels (Umitsu 1991) and the shoreline retreated more than 50 km in the 'Jomon transgression'. A neolithic maritime culture developed along the sea coast and large numbers of Jomon shell mound sites were created.

2 Climatic and cultural change around 8,500–8,000 BP in Asia

A warm and moist climate was also established by 8,500–8,000 BP in China and the Middle East. In Loess Plateau in northern China coniferous trees such as *Picea, Abies, Tsuga* and *Pinus* increased rapidly after 8,000 BP, and mean annual temperature rose more than 5°C. (Sun 1991). At the same time northern China's north Shandong plain was covered by a dense mixed forest of *Pinus* and *Quercus* (Yu *et al.* 1991).

Separate research in China has concluded that throughout the whole country this epoch was the warmest and wettest ever. The Laboratory of Quaternary Palynology and Laboratory of Radiocarbon, Kweiyang Institute of Geochemistry, Academia Sinica (1978) has discovered, based on a palynological result from the Takushan formation in Liaoning Province which showed high frequency values for broad-leaved trees such as *Quercus, Alnus, Juglans* and *Carpinus*, that the mean annual temperature between 8,000–5,000 BP was some 3–5°C. higher than current levels. The pollen diagram from the GG81 core, from the Zhujiang Delta in southern China, indicates the development of subtropical forests, around 8,000 BP, that were mainly composed of Evergreen *Quercus, Castanopsis* and *Elaeocarpus* (Liu *et al.* 1991).

Similar climatic changes were also reported in the pollen diagrams from Southeast Asia (Fig. 1) (Stuijts *et al.* 1988). Pollen diagrams from Danau di Atas (00°30′ S., 100°30′ E., 1,065 m in altitude) in west Java indicate a sharp decline in *Dacrycarpus* and *Dacrydium*, and the rapid increase of *Altingia* and *Engelhardia* after 12,400 BP. The decline of *Dacrycapus* and the increase of *Altingia* and *Engelhardia* was caused by the rise in temperature. In the Situ Bayongbong horizon, dated at 10,000 BP, there is a sharp decline in *Engelhardia* and an increase in *Castanopsis*, which suggests the

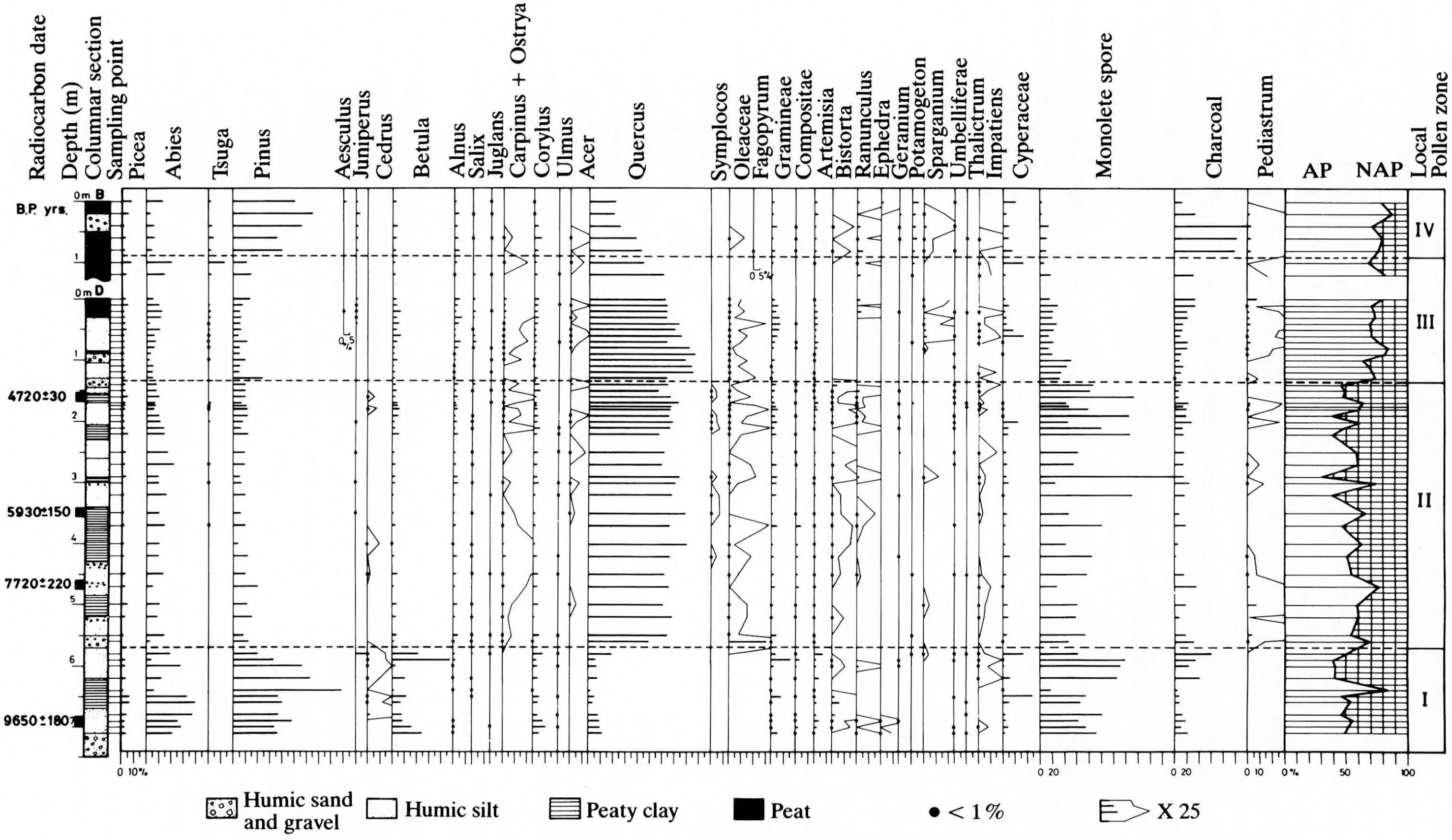

Fig. 6. Pollen diagram from Lake Rara in western Himalayas (Yasuda *et al.*, 1988).

development of a warmer climate. In the pollen diagram from the same site while *Quercus* becomes dominant, *Dacrycarpus*, a relic of the glacial period, disappears almost completely by 8,000 BP.

Fig. 6 shows a pollen diagram from Lake Rara (29°34′ N., 82°05′ E., 3,000 m in altitude) in west Nepal (Yasuda and Tabata 1988). In this pollen diagram *Quercus* pollen increases rapidly after 8,000 BP, which suggests the development of a warm and moist climate in the Himalayas.

In the vegetational history of the Middle East, 8,000 BP is also the most important period for the rapid expansion of forestation (van Zeist and Bottema 1991). After 8,000 BP arboreal vegetation, mainly composed of *Pinus* and *Quercus*, expanded considerably.

It can be said that 8,500–8,000 BP was one of the most important dates in the Holocene climatic history of Asia, indicating the establishment of the warm and moist climate.

MATURE JOMON CULTURE AND CLIMATIC CHANGE AROUND 5,500–5,000 BP

1 Climatic and cultural change around 5,500–5,000 BP in Japan

Around 5,500 BP the warm climate came to an end, climate deterioration started, with the nadir of cold epoch around 4,500 BP. The pollen diagram from the Noda peat layers in Chiba Prefecture in the Kanto district (Sakaguchi 1987) show a temporary, but sudden, increase in *Picea, Abies* and *Pinus Haploxylon* around 4,500 BP. A similar result was obtained from the Ohjinodai site in Kanagawa Prefecture, again in the Kanto district (Yasuda 1991b). In the pollen diagram from the Ohjinodai site (35°21′ 30″N., 139°16′ 30″E., 37 m in altitude) there is a sudden increase in *Cryptomeria* together with *Picea* and *Tsuga* in the horizon dated at 4,600 BP. Diatom analysis also indicates the increased influence of water flow at this time. In the Kanto district the sea coast regressed more than 40 km on the Kanto plain (Kosugi 1989).

This temporary coastal regression was repeated in the Hokkaido, Hokuriku, and Tokai districts (Yasuda 1990a). Consequently, the abundant bay side sea products environment was replaced by an expanded barren and swampy lowland.

During this cold epoch many Jomon sites were concentrated further inland, in these places especially the Chubu and the western Kanto districts, which were covered by thick volcanic ash suited to the growth of *Quercus* and *Castanea* forests. The sea coast environment, rich in sea marine products, deteriorated with the increasingly cold climate, and the Jomon people may have moved inland in search of nuts and acorns. This concentration of population increased information exchange and witnessed the development of new technologies for the intensive use of nuts and acorns. The cultivation of miscellaneous cereals may have also begun. The population of the inland area increased during this Middle Jomon period. The number of Jomon sites in Nagano Prefecture in central Japan increased twofold (Fig. 7). Numerous religious clay

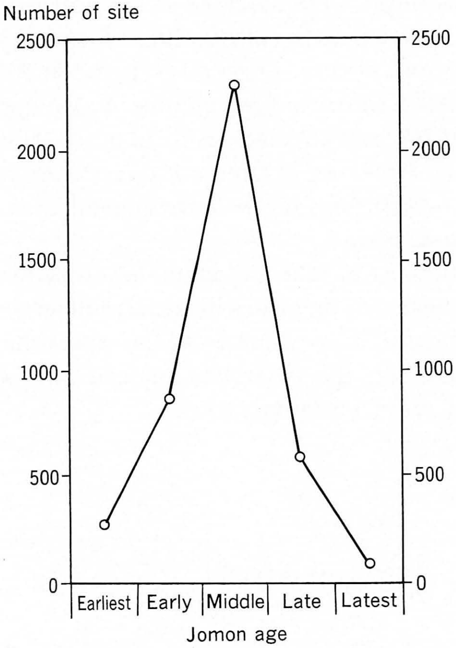

Fig. 7. Concentration of the archaeological sites to the Central Japan at Middle Jomon period (Yasuda, 1987).

figurines (*Dogu*) were also made during this Middle Jomon period, indicating the development of a spiritual culture.

2 Climatic and cultural change around 5,500–5,000 BP in Asia

Between 5,500–5,000 BP the climate of China became much drier. This climatic change was first reported by the pollen analytical studies of the southern Liaoning district by the Laboratory of Quaternary Palynology and Laboratory of Radiocarbon, Kweiyang Institute of Geochemistry, Academia Sinica (1978). More recently similar climatic deterioration has been reported for the Loess Plateau in northern China (Sun *et al.* 1991) and for the Huaibei Plain in Anhui (Jin 1991). Both studies discovered that around 5,000 BP the climate became drier and there was a temperature drop. However, no remarkable temperature fall was discovered.

During the reign of the first emperor of the Shang Dynasty there was a serious drought which lasted for seven consecutive years.

In Japan, as noted before, after 5,500 BP the climate deteriorated and coastal regression occurred. However, after 5,500 BP while the Japanese climate became wetter the climate in China became drier. While there is a close correspondence between temperature increase and decrease in China and Japan, humidity fluctuations were reversed. In China a dry climate dominated during the cold epoch and a wet climate appeared in the warm epoch, while in Japan a cold climate was accompanied by a wet climate.

Similar reversals in humidity were observed in the northern and southern parts of the Middle East. Fig. 8 summarizes the fluctuations of lake and marsh levels in eastern Africa, the Middle East and Greece. From 6,000 to 5,500 BP lake levels in the Nile basin rose, which suggests a warm and wet climate. Lakes appeared even in the Arabian desert (McClure 1976), and the lake levels in Syria (Niklewski and Zeist 1970) also showed higher levels. However, in Greece and on the Anatolian plateau, lake and marsh levels were low, which suggests the development of a dry climate during the 'Climatic Optimum' warm period.

After 5,500 BP fluctuations of lake and marsh levels showed a complete reversal. Water levels in the Nile basin fell and lakes in Arabian desert completely disappeared, suggesting the development of a dry climate. At the same time, lake and marsh water levels rose in Greece and on the Anatolian plateau and wet edaphic conditions developed, suggesting a cool and damp climate.

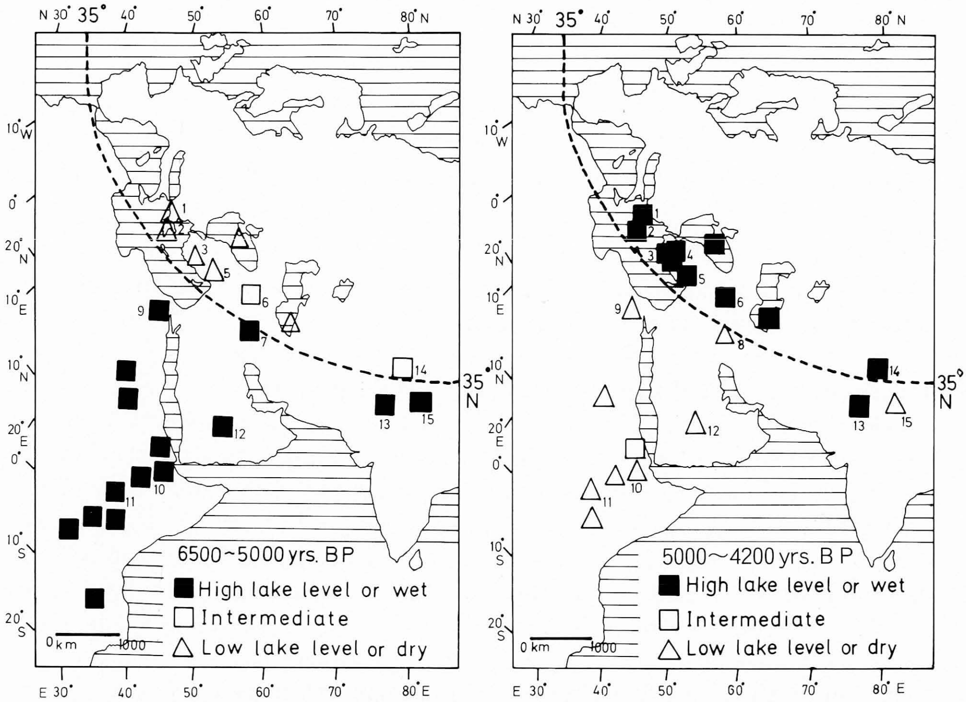

Fig. 8. Fluctuations of the lake and moor levels during 6,500-5,000 years BP (left) and 5,000-4,200 years BP (right). The detail of the references see Yasuda 1988a and Yasuda 1989

1:Korone Marsh (Yasuda *et al.*, 1987) 2:Hotusa Marsh (Yasuda, 1988a) 3:Beysehir Lake (Bottema *et al.*, 1984) 4:Civril Marsh (Yasuda, 1988a) 5:Aci Lake (Bottema *et al.*, 1984) 6:Van Lake (Zeist *et al.*, 1978) 7:Zeribar Lake (Zeist, 1967) 8:Mirabad Lake (Zeist, 1967) 9:Moeris Lake (Hassan, 1986) 10:Ziway and Shala Lakes (Gillespie *et al.*, 1983) 11:Turkana Lake (Owen *et al.*, 1982) 12:Salt Lake in Arbian Desert (McClure, 1976) 13:Salt Lakes in Rajasthan Plain (Singh *et al.*, 1972) 14:Buthapathri Moor (Dodia *et al.*, 1884) 15:Rara Lake (Yasuda *et al.*, 1988)

Other sources of the fluctuations of the lake levels are based on Street *et al.* (1976, 1979), Chepalyga (1984)

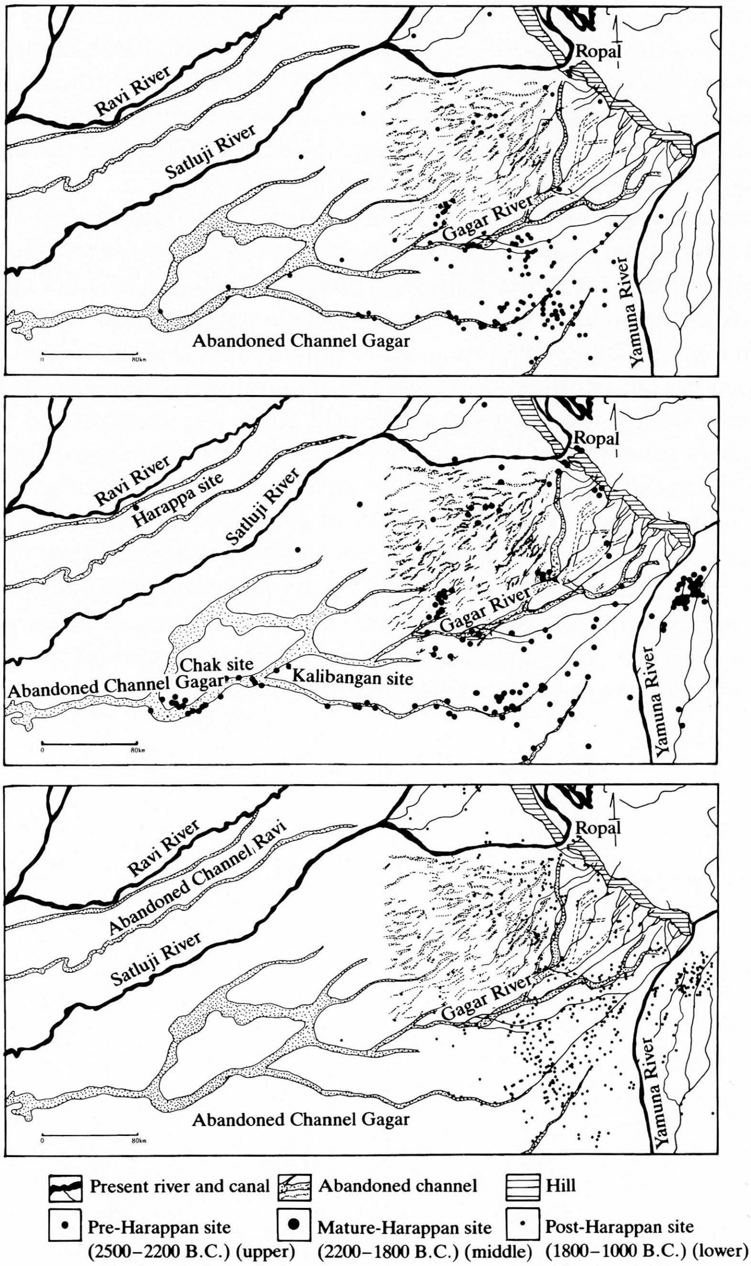

Fig. 9. Distribution map of the archeological site during Pre-Harappan period (2,500-2,200 B. C.) (upper). Mature-Harappan period (2,200-1,800 B. C.) (middle) and during Post-Harappan period (1,800-1,000 B. C.) (lower) in northwest India (Yasuda 1989)

It can thus be said that the climatic tendencies, especially humidity, were completely opposite in the northern and southern part of the Middle East. The boundary between these two zones was close to 35°N.. From 6,500 to 5,500 BP the northern Middle East was characterized by a dry and warm climate, while the southern Middle East was warm and damp. On the other hand, between 5,500 and 4,000 BP, the former was subject to a cool and moist climate while the latter was dry.

This climatic change around 5,500–5,000 BP had a great influence on the birth of the ancient civilizations (Yasuda 1991). The area south of 35°N., where the Egyptian, Mesopotamian and Indus civilizations were born, were affected by a dry climate after 5,500 BP. With the onset of this dry climate people started to concentrate along the Nile, Euphrates, and Indus Rivers in order to obtain water (Fig. 9). It can be assumed that the peoples concentrating along these rivers after 5,500 BP were graziers, who had previously been living dispersed on the arid plain. The concentrated population along the rivers increased information exchange between graziers and farmers, who originally lived in the valley plain, and developed demand and labor supply. This may have been an important element in the birth of ancient civilization.

Similar phenomena have occurred in Japan. Numerous Jomon sites were concentrated inland because of the deterioration of the sea coast environment. Climatic change around 5,500–5,000 BP caused population concentration in Japan and the Middle East (Fig. 10). This concentration was an important element in the development of Middle Jomon culture and the ancient civilizations.

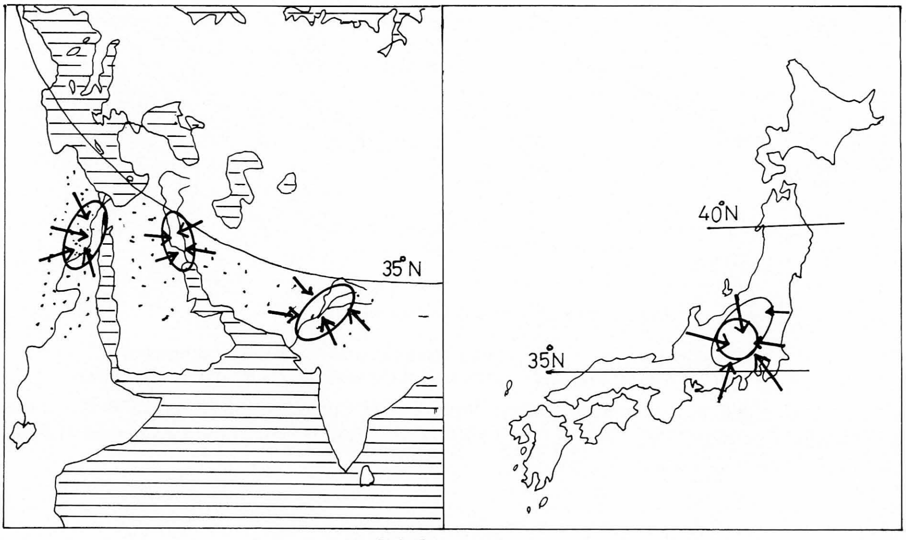

Fig. 10. A schemmatic map of the migration of people in the West Asia and Japan at 5,000 years BP.

THE DECLINE OF JOMON CULTURE AND CLIMATIC CHANGE AROUND 3,500–3,000 BP

1 Climatic and cultural change around 3,500–3,000 BP in Japan

After 3,500 BP a cold and wet climate dominated. Numerous palynological results in Japan indicate a climatic deterioration between 3,500 and 2,500 BP (Yasuda 1978a, and 1993). The climate also became wetter, especially as a result of increased snow fall. Mean annual temperature might have been 2–3°C. lower than the current mean. Sakaguchi (1983) named this cold period the 'Latest Jomon cold stage.' The analysis of sediment taken from Kawasaki city (Nakai *et al.* 1988) indicates the rapid increase of terrigenous organic carbon at the sea coast, which suggests regression and an in-

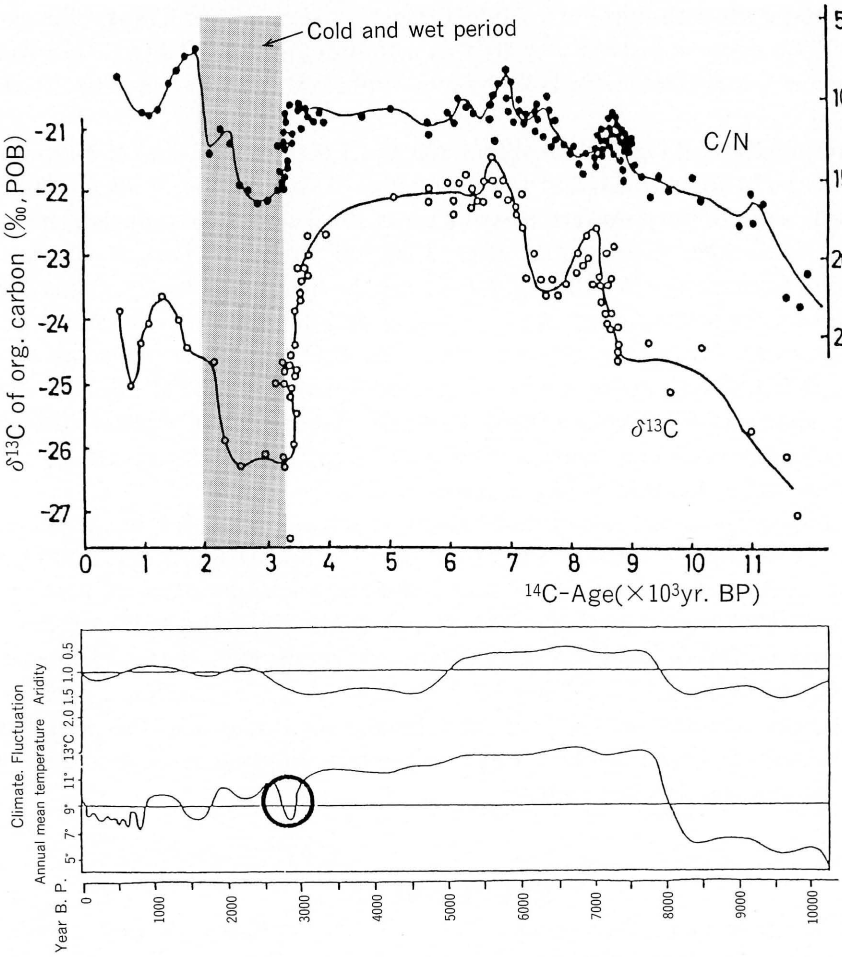

Fig. 11. The δ^{13}C and C/N variations of the core from Kawasaki city in Japan (Nakai, 1989) (upper) and climatic change in Liaoning district in China (lower) (Laboratory of Quarernary Palynology and Laboratory of Radiocarbon, 1978).

crease of precipitation after 3,500 BP (Fig. 11). At the end of this cold and wet period Jomon culture collapsed. Following the decline of Jomon culture new people arrived in the Japanese archipelago bringing with them rice paddy cultivation.

2 Climatic and cultural change around 3,500–3,000 BP in Asia

Temperature change on the northern slope of Mount Changbai indicate that after 3,000 BP China's climate became much colder and drier. A cold phase between 3,500 and 3,000 BP is also recorded from the results of pollen analysis of the Loess Plateau in northern China. Sun *et al.* (1991) have called this cold epoch the 'Early Chou Dynasty cold epoch.'

Recent palaeobotanical studies (Yasuda 1987b, Toyama and Nakayama 1990) have shown that around 3,000 BP rice cultivation had already begun in northern Kyushu: this was during the 'Latest Jomon cold stage.' The propagation of rice culture to Japan corresponds with the 'Early Chou Dynasty cold epoch' in China. The author (Yasuda 1992) suspects that the new arrivals who brought rice paddy field cultivation to Japan were 'boat-people', displaced by social upheaval caused by climatic deterioration.

A corresponding cold epoch between 3,500 and 3,000 BP is also clear from pollen analysis of the Mediterranean and Levant regions (Yasuda 1993). Pollen analysis of the El Rouj basin in northwestern Syria (Yasuda 1993) shows the sudden decrease of *Centaurea* and other Compositae after 3,200 BP and the rise of *Typha* and Cyperaceae. Bottema and Woldring (1990) found the B.O. phase was characterized by the sudden decline of *Centaurea* and Compositae and the rapid increase of tree pollen such as *Quercus*, *Pinus*, *Juglans* and *Olea*. This B.O. phase was found in several results of pollen analysis in the Mediterranean and Levant regions. The sudden decline of Compositae and *Centaurea* around 3,200 BP indicates that climatic conditions became much cooler. The increase of *Typha* and Cyperaceae indicates the expansion of wet lands and a decrease of hot summer weather.

Archaeological evidence shows that there was severe destruction at the center of Mycenaen civilization toward the end of the Late Helladic IIIB (around 1,200 B.C.). Many archaeological sites were abandoned and there was an influx of new people (Betancourt 1976) from the north. The author (1993) has suggested that the cold climate around 3,200–3,000 BP caused migration of people from the northern parts of the Balkan peninsular which delivered a fatal blow to the Mycenaean civilization in the Greek Peloponnese (Fig. 13). Thus, the climatic deterioration of this period caused a population movement in the Mediterranean area and East Asia and had a great influence on cultural developments.

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