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Human responses to the Younger Dryas in Japan

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ABSTRACT

The effect of the Younger Dryas cold reversal on the survival of Late Glacial hunter-gatherers in the Japanese Archipelago is evaluated, through a synthetic compilation of ^{14}C dates obtained from excavated Late Glacial and initial Holocene sites (332 ^{14}C dates from 88 sites). The estimated East Asian monsoon intensity and vegetation history based on the loess accumulations in varved sediments and pollen records in and around the Japanese Archipelago suggest an abrupt change to cool and dry climate at the onset of Younger Dryas, coupled with the Dansgaard-Oeschger Cycles as recorded in Greenland. The chronometric placement of sites based on an assessment of ^{14}C dates show that the site numbers decrease from the Bølling-Allerød to Younger Dryas and increase from the Younger Dryas to Preboreal. However, human population dynamics inferred from a site distribution analysis was little changed from the previous Bølling-Allerød and to the following Preboreal. Moreover, hunter-gatherers consistently employed ceramic pottery technology since its emergence prior to the onset of Younger Dryas, while the quantity of ceramic vessels that were undermined during the Younger Dryas dramatically increased at the onset of the Holocene, implying that a substantial change in hunter-gatherer socioeconomy occurred *after* the end of Younger Dryas.

Keywords: Younger Dryas, Bølling-Allerød, Preboreal, East Asia, Japanese Archipelago, pottery technology

1. **Introduction**

A central issue in studying prehistoric hunter-gatherer society is to discuss whether and how extent paleoclimatic oscillations affected human adaptive responses. The interglacial-glacial cycles originally predicted by Milankovitch are now proven to coincide with fluctuations in oxygen-isotope signatures (δ^{18}O values), recorded in ice cores and marine and terrestrial sediments (e.g., Dansgaard et al., 1993; Hays et al., 1976; Kawamura et al., 2007; Wang et al., 2008; Yuan et al., 2004). In East Asia, recent studies on the oxygen-isotope signatures in cave stalagmites in China (e.g., Sabano and Hulu Caves) have traced millennium-scale fluctuations climatic records reliably furnish climatic frameworks within which changes and variability in adaptive strategies of human societies are legitimately concerned. In developing the relationship between environmental conditions and variability in human adaptations, the Younger Dryas cold reversal, dated to 12,900 – 11,600 cal. B.P. (11,000-10,000 B.P.), gives an appropriate chronometric framework. There are several advantageous characteristics in employing the Younger Dryas. The first advantage is that the Younger Dryas is a short climatic episode, but long enough for exploring changes in human societies at the Pleistocene/Holocene transition. An abrupt climatic transition from the previous Bølling-Allerød interstadial and its abrupt termination at the end of the Pleistocene (Alley et al., 1993; Wang et al., 2001) give the prospect that this millennium climatic event could have had a substantial effect on socioeconomy of hunter-gatherer societies. The second reason is that archaeological records are abundant for the Late Glacial, especially after the end of the Last Glacial Maximum (LGM) around 17-16,000 B.P. It was during the Late Glacial when hunter-gatherers came to settle various regions in the worldwide (e.g., Gamble, 1993; Goebel et al., 2008; Hoffecker et al. 1993; Straus, 1996). Because hunter-gatherer archaeological records at the regional scale come to be highly visible in the Late Glacial, it is worthwhile to make a comparison of archaeological records at the regional scale. Among the other geographic locations in East Asia, because of the large number of excavated sites in late Upper Pleistocene (ca. 35,000-10,000 B.P.), the Japanese Archipelago now can provide sufficient data sets to evaluate the impact of Younger Dryas to human adaptations. The third reason is on the emergence of complexity in hunter-gatherer societies. The Late Glacial archaeological records in the Far Eastern Asia in and around the Japanese Archipelago witnessed a variety of technological innovations, notably pottery and bow and arrow technologies (see Fig. 4.). Among the debatable topics including how technological innovation contributed to changes in hunter-gatherers lifeways including on the beginning of sedentary lifeway (e.g., Nishida, 1986; Pearson, 2006), the beginning of broad-spectrum subsistence strategies (e.g., Aikens and Akazawa, 1996) and the introduction of horticultural economies with rice domestication (e.g., Bleed and Matsui, 2010; Matsui and Kanehara, 2006), the emergence of pottery technology is a big question in world prehistory (e.g., Clark, 1969; Ikawa-Smith, 1976; Rice, 1999). It will give a new avenue toward an understanding of evolution in social complexity at the cultural transition from the Paleolithic to the Neolithic, through the clarification of how new technologies changed ways of resource exploitations that in turn altered variability in archaeological records (e.g., Cohen, 1998; Keally et al., 2003; Kuzmin, 2006; Yasuda, 2000).

Given these environmental and archaeological backgrounds of the Late Glacial, the present paper addresses the question as to whether and how the Younger Dryas impacted hunter-gatherers in the insular environment of Japan, situated in the mid to high latitudes of the Northern Hemisphere. Since the Japanese Archipelago is isolated from the Continental East Asia, it is an independent geographic entity that can serve as a natural regional framework, but its internal geographic variability is high because of elongated extension and diverse landscapes. Thus, regionally diverse geography needs to be seen as something that potentially influences the adaptive variability of hunter-gatherers. In this sense, it is reasonably hypothesized that adaptive variation in hunter-gatherer lifeways is expected and that variability in the Late Glacial archaeological records was affected by both macro-climatic condition (i.e., the Younger Dryas cold reversal) and ecological diversity at the regional scale. The Japanese Archipelago serves as an ideal geographic entity for testing the hypothesis.

The main goal of this paper is to discuss changes in human occupations during the Younger Dryas in the Japanese Archipelago. This will be achieved through a synthetic compilation of currently available radiocarbon dates obtained from excavated archaeological sites, and comparison of dates among the three continuous periods of Bølling/Allerød, Younger Dryas, and Preboreal. The second goal is to see whether there were any socioeconomic changes at the transitions to the onset and at the end of the Younger Dryas. Since Pleistocene archaeological sites in the Japanese Archipelago are virtually sterile in osteological and botanical remains on which we can reconstruct human subsistence economy in resource exploitations, here we will assess socioeconomic change through an examination of foraging patterns at the regional scale by the analysis of site locations (i.e., latitudes and altitudes). Since the emergence of pottery is the notable technological innovation at the end of Pleistocene in East Asia, in employing the new data sets of artifact assemblages associated with radiocarbon dates, we also assess the issue as to whether and how the late Late Glacial hunter-gatherers maintained ceramic technology during the Younger Dryas. Results will illuminate aspects of the human technological and socioeconomic responses to the Younger Dryas, and further suggest implications as to how Late Glacial hunter-gatherers adapted in the insular environments of East Asia.

2. The environmental background of the Japanese Archipelago during the Younger Dryas

While the boundary of Japanese land is politically determined, it is the latitudinally long chain of islands, situated in the mid to high latitudes along the northwestern Pacific Rim. The main islands called Hokkaido, Honshu, Shikoku, and Kyushu, from north to south, extend along a northeast-southwest axis (see Fig. 3.). These four main islands are situated between 45 – 30°N, and 145 – 130°E. With the Japan Sea to the west, the archipelago stretches parallel to China, Korea, and Russian Far East. While the land bridge between the Korean Peninsula and Kyushu Island (southern Japan) disappeared by the end of Middle Pleistocene, the present masses of islands were shaped after the end of the LGM as rising sea level submerged the land bridges between southern Sakhalin Island and northern Hokkaido, and plains that had lain in between Shikoku and the western Honshu (e.g, Keigwin and Gorbarenko, 1992; Tada, 1999). By about 15,000 years ago, around the time when Bølling/Allerød interstadial began, the present shape of the Japanese Archipelago was nearly completed. Unlike the mainland of East Asia, the oceans that surround the archipelago (the Japan Sea to the west, and the Pacific Ocean to the east) affect the circulations of currents and East Asian monsoons that blow from the west (Igarashi and Oba, 2006). The geographic characteristics of the Japanese Archipelago stretching across the mid to high latitudes have created both comparable, but also unique climatic signatures from the global standards recorded in high latitudes around the Greenland. The varved sediments in Lake Suigetsu and Lake Tougouike (western Japan) have sequential records of the intensity of East Asian monsoon (Fukusawa, 1999). Fukusawa's (1999) pioneering study of varved sediments suggests that there was a Younger Dryas signature in the fluctuations of eolian loess originating from the Chinese Loess Plateau on the mainland of East Asia. His analysis of varved layers from the Lake Suigetsu has demonstrated that the cooling event at approximately 11,320 B.P. (Kitagawa and van der Plicht, 1998) may corresponds with the 100 year cooling event from 11,300 to 11,400 years ago recorded in the Greenland ice core (GISP 2) (Stuiver et al., 1995). Moreover, since illite and quartz grains that are transported as eolian loess by the Asian summer monsoon, Fukusawa (1999: 240-241) analyzed the quartz flux (mg/cm^2 yrs) in late fall to early spring varves in Lake Tougouike to estimate the paleoclimatic fluctuations in the mid latitudes, given the understanding that the amount of quartz grains in verved sediments reflects the moisture at the inner Asia. In correlating the oxygen isotope ratios in the GISP 2 (Stuiver et al., 1995), an abrupt increase of quartz flux that suggests the onset of dry and cold climate in inner Asia is 350 years earlier than the onset of Younger Dryas (Fukusawa, 1999: 241). This estimate is further supported by reconstructed changes in mean annual temperatures recorded in the pollen stratigraphy of Lake Suigetsu, western Japan (Nakagawa et al., 2005). The cool and dry climate during the Younger Dryas has been also recorded in the vegetation history. A recent synthesis of the pollen records (Takahara et al., 2010) from terrestrial and marine sediments in and around the Japanese Archipelago show that the vegetation changes were in response to the Dansgaard-Oeschger cycles registered in Greenland (Dansgaard et al., 1993). The pollen records obtained from Japan and Taiwan demonstrates that the Younger Dryas was characterized by the abundance of cold conifers and cool conifers relative to temperate deciduous broadleaf trees and an increase of upland herbs. Consistent with the sedimentary changes in varved layers, the pollen records from Lake Suigetsu show cold temperatures during the Younger Dryas (Nakagawa et al., 2005). Contrary to the vegetation, faunal community in the Younger Dryas has not been well reconstructed because of the lack of paleontological and zooarchaeological records. While a substantial absence of faunal remains in the Pleistocene archaeological sites in Japan makes it difficult to discuss human prey species, some paleontological records around the LGM have demonstrated that the two faunal communities inhabited in the Japanese Archipelago: the faunal group represented by Naumann’s elephant (*Palaeoloxodon naumanni*) and giant deer, and the group with mammoths (Akazawa 2005). The faunal group with Naumann’s elephant was originally migrated from the Continental Asia through land bridges during the middle Middle Pleistocene (ca. 400,000 – 300,000 B.P.), whereas the group with mammoths (also including bison and moose) first appeared in the Japanese Archipelago around 360,000 – 340,000 B.P., migrated from the northern land bridge (Takahashi and Izuho 2010). The group with Naumann’s elephant mainly inhabited in southwestern Honshu disappeared by the onset of LGM. In contrast, the faunal group with mammoths inhabited in Hokkaido during the LGM, but likely disappeared after the LGM, as climate started to become warmer in the post-LGM period (Iwase et al. 2010). Given the current understanding of paleontological records of the Late Pleistocene large mammalian community in the Japanese Archipelago, megafauna seem to be disappeared by the onset of Younger Dryas. Although there is no confirmative evidence of megamammal hunting in the Japanese Pleistocene sites, without having large mammalian community in the post-LGM landscapes, the largest terrestrial species targeted by humans in the Younger Dryas were presumably mid-bodied mammals notably represented by boars and sika deer, which were continuously preyed in the Holocene (e.g., Niimi 2010; Nishimoto 1991).

3. An evaluation of the Younger Dryas Sites

3.1 The sample and analytical procedure

Following the records in the Greenland ice cores (Stuiver et al., 1995), we employ as dates for Younger Dryas, beginning at 12,900 cal. B.P. and ending 11,650 cal. B.P. The sites falling in the range dated between 14,700 – 12,900 cal. B.P. are placed in the Bølling/Allerød, while those falling in the range dated to 11,650 – 8,500 B.P. are situated in the Preboreal. Table 1 lists the ^{14}C dates that are attributed to the terminal Pleistocene and the initial Holocene. The list has attributes including site names, regions, sampled locations, laboratory numbers, methods of radiocarbon dating, materials, δ^{13}C values, uncalibrated ^{14}C dates, calibrated ^{14}C dates, and references. Placement of archaeological sites in Younger Dryas was done through a critical evaluation of the published radiocarbon dates. Sources of ^{14}C dates were extracted from Kanomata (2007), summarizing dates from the published reports of the Late Glacial and initial Holocene in northern Japan. The ^{14}C dates for the study period were also extracted from Keally et al. (2003). In addition, the list of dates for the sites typologically attributed to the Initial Jomon Phase, recently dated by the National Museum of History and Ethnology (Onbe, 2007) was used. The radiocarbon dates listed in these references were gathered by referring to the relative ages constructed by a unique chronological scheme of Jomon pottery types, namely the Incipient and Initial Jomon periods (see Fig. 1.). The lithic assemblages without having the ceramic vessels are also included. Whenever it was necessary, we also used the dates published in site monographs.

In Table 1, we provide calibrated ^{14}C dates using the OxCal version 3.10 (Bronk Ramsey, 1995, 2001). Since many sites have yielded multiple ^{14}C dates, it was first necessary to determine as to whether the site retains reliable evidence for the purpose of this exercise. First, we assessed multiple ^{14}C dates from a single site to determine the chronozone for the site. In the first step, we assign specific chronozone to each date, based on the calibrated dates. The ^{14}C calibrated dates are shown with 68% confidence limits around the means. After assigning the chronozones, we examine whether the 68% confidence intervals overlap or not. If they are separated by multiple series of ^{14}C dates, we further examined whether the separate ranges of ^{14}C dates fall in mutually different chronozones or all fall in a single chronozone. If all series of dates fall in separate groups, but are assigned to be a single chronozone, we judge that site has credible dates and assigned it to that chronozone. If separated groups exhibit multiple chronozones, we judge that the chronometric placement of that site is undetermined, unless a majority of dates (> 60 %) fall into a single chronozone.

<Fig.1.>

<Table 1>

<Table 2>

3.2 Results

The calibrated ^{14}C dates with determined chronozones for sampled sites are summarized in Table 2. We examined 332 ^{14}C dates from 88 sites. A total of seven Younger Dryas sites are identified. It is only 8% of the total sample of dated sites (7/88). From north to south, these are: Hachazawa B (Tohoku), Takihata (Tohoku), Kannoki (Chubu [Central Japan]), Toya (Northern Kanto), Tako Minamihara (Northern Kanto), Kounoki (Tokai), and Obaru D (Northern Kyushu). The contextual backgrounds of the Younger Dryas sites summarized below are from the original site reports.

Hachazawa B: The date was obtained from the charcoal sampled from the bottom of the pit in Excavation Zone B. No cultural remains are associated.

Takihata: The charcoal dated for ^{14}C was obtained from the cobble concentration (cobbles are fire-cracked rocks). A cluster of potsherds (nail-pressed) and hand axes were recovered around the cobble concentration. A likely contemporaneous pit-house-like feature was located about 10m away from the cobble concentration.

Kannoki: A series of consistent dates were obtained from charcoals and soils sampled from pits (SK35, SK37, SK38) and burnt sediments (a hearth) (SF01). No descriptions of the features and associated artifacts are available in the report.

Toya: The site has numerous pit traps. The dated specimen was obtained from an organic remain left on the bottom of the pit trap. No culturally diagnostic artifacts are associated with the pit.

Tako Minamihara: The dated specimen was obtained from the organic remains left on the bottom of the trap-pit. No culturally diagnostic artifacts are associated.

Kounoki: The dates for the Younger Dryas were obtained from various features, including a pit house (SH220, SH234), pits (SK201, SK 213), and hearth (SZ215).

Obaru D: The dates for the Younger Dryas were obtained from various features, including a burnt pit house (SC003), another pit house (SC014, SC029), burnt sediments (SX051), and features located on the surface depression (#4001). A number of lithics and ceramics were recovered from the features. The upper structure of the burnt pit house was reconstructed from the locations of charred postholes.

These site contexts suggest that the hunter-gatherers in the Younger Dryas constructed pit houses, as identified in the Kounoki and Obaru D. Even though pottery was readily used in this period, it is notable that hunter-gatherers retained cobble concentrations that possibly functioned as cooking facilities (e.g., boiling, grilling).

The numbers of sites dated to the Bølling/Allerød and Preboreal are 21 and 36, respectively. Although some of them possibly fall into the Younger Dryas, a total of eight sites – Juno, Kamikuroiwa Cave Layer 6, Kariyagano, Kigano, Monzen, Ogakubo, Saishikada Nakajima (B), and Torihama shell midden – could not be assigned as to a specific chronozone because these sites have calibrated dates that cross the ranges of multiple chronozones. Our identification of sites to the chronozones in the Late Glacial demonstrates that site numbers decrease from the Bølling/Allerød to the Younger Dryas, and increase from the Younger Dryas to Prebreal (Fig. 2.). Because the duration of Younger Dryas – approximately 1,000 years – is shorter than the previous and following periods, duration of the three chronozones needs to be standardized in assessing site numbers. The mean site numbers per millennium (represented by gray bars in Fig. 2.) obscures the observed difference in site numbers among the three chronozones, while the number of the Younger Dryas sites is still the lowest among the three periods. This leads the question as to whether human population contraction occurred in the Japanese Archipelago during the Younger Dryas. In the following section (*3.3.*), we will further evaluate the extent of population dynamics in the Younger Dryas through an examination of site locations at the regional scale in the archipelago.

<Fig.2.>

Three sites exhibiting dates greater than 14,700 cal. B.P. fall into the range prior to the onset of the Bølling/Allerød interstadial. These are the Fukui Cave Layer III (northern Kyushu), Maeda Kochi site (Southern Kanto), and Odai Yamamoto I site (Tohoku, northern Honshu). All of these sites have pottery, suggesting that the Late Glacial hunter-gatherers employed pottery technology. The Fukui Cave Layer III has yielded pottery (linear-relief style) associated with wedge-shaped microblade industry (Hayashi, 1970; Serizawa, 1978). Our calibrated dates suggest that the Odai Yamamoto I site yielded pottery dating to 15,300 – 14,650 cal. B.P. This site had been credited for with having the earliest pottery industries in East Asia (Kuzmin, 2006; Nakamura et al., 2001), until an older pottery industry dated to 18,300 – 15,430 cal B.P. was discovered from the Yuchanyan Cave, southern China (Boaretto et al., 2009). Although the issue as to whether the earliest pottery technology occurred in the Japanese Archipelago either by local invention or diffusion from other regions in East Asia is debatable, it is notable that the Late Glacial hunter-gatherers developed pottery technology during the early phase of Late Glacial in East Asia, presumably during the colder Heinrich Event 1 (Denton et al., 2005), before the onset of the Bølling/Allerød and after the LGM. Putting the issue of the origin of pottery technology into the context of the effect of Younger Dryas on human socioeconomy, it is critical to concern as to whether already invented (or introduced) pottery technology was maintained in the technological inventories of hunter-gatherers during the Younger Dryas. We will examine this issue in section of *3.4.*

3.3 On the effect of the Younger Dryas on human foraging

Based on the dated sites that were sorted into the three chronozones, we examine as to whether hunter-gatherers changed their foraging areas in response to the Younger Dryas climatic regime. In order to evaluate a trend in foraging patterns of the late Late Glacial hunter-gatherers, here we test two hypotheses. The first hypothesis aims to answer the question as to whether the humans migrated from the north to the south under the cooler climatic conditions initiated at the onset of the Younger Dryas. As described above, cooler signatures recorded in pollen spectra in central Japan coincided with the Younger Dryas (e.g., Kumon et al., 2009; Takahara et al. 2010). If humans shifted their foraging areas toward the south, the Younger Dryas sites are expected to be distributed more southern area than the sites attributed to the Bølling/Allerød. The second hypothesis addresses the question as to whether hunter-gatherers changed their foraging strategies in response to changed seasonality in the Younger Dryas. Since the interpretation of changes in oxygen-isotope ratios in the Greenland ice cores has shown that the Younger Dryas is marked by considerably colder winters than during the preceding and succeeding chronozones (Broecker, 2006; Denton et al., 2005), as well as decrease in summer monsoons (Wang et al., 2001). With the increased seasonality with long winters and cool summers, plant productivity and abundance of species in mammalian community were diminished. The overall decline in biomass could have resulted in available resources for humans across landscape to become patchy. In this circumstance, it is expected that hunter-gatherers changed their foraging strategy to acquire resource patches that were expected to be more scattered on plains, lowlands, and lower terraces than high plains, and mountains. Given the rugged terrain of the Japanese Archipelago, foragers in the Younger Dryas were expected to shift their foraging areas toward lower elevations.

The first hypothesis is tested by a comparison of latitudes of site coordinates among the Bølling/Allerød, Younger Dryas, and Preboreal. Fig. 3. compares the latitudes of sites among the three chronozones. The sites are spread across the entire Archipelago, although the frequency of the Younger Dryas sites is lower and the geographic distribution is slightly more “centered” in the archipelago than in the previous and following periods. The Younger Dryas sites are distributed between 40 and 33 °N, and no sites are identified below 33 °N or above 41 °N. In plotting the site locations on the map of Japanese Archipelago (Fig.4.), sites attributed to the Younger Dryas are absent in Hokkaido and southern Kyushu. No sites in Hokkaido are even recognized during the Preboreal. Although current understanding is that pottery technology were absent during the Younger Dryas and Preboreal in Hokkaido until its resurgence around 8,000 B.P. (Sato et al., 2010), this would not necessarily indicate that Hokkaido was uninhabited for 3000 years between ca. 11,000 to 8000 B.P. Unlike the situation in China where the LGM sites are absent above 41 °N (Barton et al. 2007; Elston et al. 2010), humans inhabited Hokkaido at least since the onset of the LGM (ca. 21,000 B.P.) and more than 200 late Upper Paleolithic sites mostly characterized by microblade technology has been identified (Nakazawa et al., 2005). Late Glacial hunter-gatherers survived rigorous climatic condition in the LGM could have been capable in dealing with environmental circumstances in the Younger Dryas. Since a not small number of late Upper Paleolithic sites lack radiometric dates, we speculate that a portion of the Late Glacial sites with microblades can be attributable to the Younger Dryas. By the same token, no Younger Dryas sites in southern Kyushu (lower than 33 °N) could be the result of sampling error. A total of nine sites in southern Kyushu evenly falls into the Bølling/Allerød (N = 3), Preboreal (N = 3), and Undetermined (N = 3), although the sample size is so small that it is not allowed to examine non-randomness of site numbers among different chronozones. Conversely, if the pattern in latitudes of sites was not the result of sampling error, the observed limitation in site distribution suggests that the overall human population in the archipelago likely had contracted in some degree. Regardless of whether there is sampling error or not, no Younger Dryas sites distribute in regions lower than 33 °N and above 41 °N, implying that population contraction, if any, was not associated with directional human migrations. In other words, the kinds of human migrations that altered both regional and pan-regional population dynamics represented in the American Continents during the Late Glacial (e.g., Anderson and Gillam, 2000; Dillehay, 2000; Faught, 2008; Hamilton and Buchanan 2007; Rogers et al. 1991; Steele et al. 1998; Surovell, 2000), were unlikely to have occurred during the Younger Dryas in the Japanese Archipelago.

In testing the second hypothesis, we compared the altitudes of Younger Dryas sites with those of the Bølling/Allerød and Preboreal sites. Because the altitudes of sites are not normally distributed (Ryan-Joiner normality test: RJ = 0.881, N = 39, $p < 0.01$), the medians of altitudes were compared among the three chronozones. The median of attitudes for the Younger Dryas sites (65m) is much lower than those of the other (Bølling/Allerød = 184m, Preboreal = 173m).The non-parametric statistical comparison, however, failed to reject the null hypothesis that the altitudes of sites among the three chrnonozones are not different at the 5% level (Kruskal-Wallis Test: H = 2.59, df = 2, p = 0.274).This is because the sites located above 600 m above sea level (e.g., Kannoki and Seikosanso B in the montane area in Central Japan) were consistently occupied throughout the three periods of the Late Glacial. Even though the median of site elevations for the Younger Dryas is low, humans lived almost as widely across entire regions in Japan, regardless of altitudinal differences vis-à-vis the Bølling/Allerød and Preboreal. Thus, hunter-gatherers favored to move in lower elevations during the Younger Dryas, but no prominent sign of change in the overall patterns of site locations. This implies that change in foraging areas with respect to altitudinal movement was little.

<Fig.3.>

<Fig.4.>

3.4. The role of pottery technology among humans in the Younger Dryas

Fig. 5. illustrates the representative classes of stone tools and ceramic vessels, compared across the three regions (Kyushu, Kanto/Chubu/Tokai/Western Honshu, and Hokkaido/Tohoku), through the Bølling/Allerød, Younger Dryas, and Preboreal chronozones. In addition to ceramic vessels, a variety of chipped stone tools and groundstones were used since the Bølling/Allerød interstadial and variation of lithic tool assemblages was continuously observed among industries throughout the Younger Dryas and Preboreal. In association with the emergence of pottery, projectile points (arrowheads) are usually found in the lithic industry of the Bølling/Allerød. This suggests that hunter-gatherers employed bow and arrow technology with the pottery before the onset of the Younger Dryas. Numerous classes of groundstone artifacts (e.g., polished stone axes, anvils, hammerstones, saddle querns, grinding stones) that are ubiquitous in the Holocene Jomon sites were readily found from the final Late Glacial sites, notably those in the southern Kyushu (31 – 30 °N) (Pearson, 2006; Shinto, 1999).

As noted earlier, we examined how final Late Glacial hunter-gatherers maintained the earlier invention of pottery technology. If ceramics was identified as a technological inventory of the

Younger Dryas hunter-gatherers, it will suggest that humans have consistently employed this peculiar cooking utensil in their subsistence practice. If it was not, it will imply that humans radically changed their subsistence technology responded to new ecological circumstance in the Younger Dryas. In testing these expectations, we collected quantitative data on ceramic sherds from the late Late Glacial sites, assuming that the number of potsherds gives a gross estimate of the quantity of vessels that were consumed by site occupants. Since the variability and quantity of archaeological assemblages can vary depending on sample size (Grayson, 1984; Leonard and Jones, 1989), we examined the relationship between number of identified specimens (NISP) for ceramic sherds and trench size at excavated sites (m^2), followed by a comparison of quantities of potsherds among the three chronozones (i.e., Bølling/Allerød, Younger Dryas, and Preboreal). Although some lack of quantitative data of potsherds makes the sample size reduce to be 24, the logarithmic NISP (Ryan-Joiner normality test: RJ = 0.99, N = 24 p > 0.1) and logarithmic trench size (Ryan-Joiner normality test: RJ = 0.944, N = 24, p = 0.023) are not correlated (Pearson's r = 0.066, p = 0.758), suggesting that there is no sample-size effect on quantity of potsherds recovered from the sampled sites. Table 3 summarizes the basic statistics for the NISP of pottery compared among the three periods. Only two pottery assemblages (i.e., Kounoki and Takihata) are assigned to the Younger Dryas. The sample size is smaller than those of the previous and following periods. Also, the quantity of ceramic vessels for the Younger Dryas as represented by the NISP is notably smaller than those of the other periods. The median size of pottery assemblage in Bølling/Allerød is about 50% larger than those of the Younger Dryas, while the median size for Preboreal is four times larger than that of the Younger Dryas. Moreover, the maximum number of potsherds in the Preboreal is 66 times larger than that of the Younger Dryas. While pottery was the newly invented material first appeared in the archaeological records during the Bølling/Allerød, its quantity increased dramatically at the onset of the Holocene, suggesting that the use of pottery came to be a requisite among the hunter-gatherer societies since the beginning of the Holocene. This supports an earlier observation by Keally et al. (2003). A notable observation stemming from our data is that the frequency of use among ceramic vessels diminished during the Younger Dryas. Pottery was consistently maintained in the subsistence technology among the late Late Glacial hunter-gatherers, while its importance in technological inventories seems to have been smaller during the Younger Dryas.

<Fig. 5.>

<Table 3>

4. Discussion

Our synthetic evaluation of calibrated ^{14}C dates compiled from the excavated Late Glacial and initial Holocene sites in the Japanese Archipelago demonstrates a decrease in site numbers in the Younger Dryas. The effect of the Younger Dryas on the socioeconomy of the hunter-gatherers in Japan was investigated through the comparison of foraging patterns at the regional scale and the role of pottery technology among the three contiguous chronozones: the Bølling/Allerød, Younger Dryas, and Preboreal. Foraging patterns assessed by latitudes and altitudes of the sampled sites do not show a significant change in the Younger Dryas. The role of pottery technology in the Late Glacial and initial Holocene hunter-gatherer inventories was quantitatively assessed by the NISP of potsherds (i.e., number of pieces from ceramic vessels).

Use of pottery, beginning during the Bølling/Allerød, was undermined in the Younger Dryas, and resurged at the onset of the Holocene. Decreased site numbers during the Younger Dryas may be a signature of population contraction. However, the degree of population contraction was not large enough to create small isolated populations that in turn would have substantially reduced the number of active potters. Moreover, knowledge of pottery technology would have been firmly shared among the hunter-gatherer populations, presumably maintained for many generations during the Younger Dryas. Large social networks (Wobst 1974) through which verbal information and goods were circulated were probably maintained throughout the late Late Glacial (ca. 16–15,000 cal. B.P. and onward), as hunter-gatherers started to exploit various small resource patches (e.g., aquatic resources, nuts and geophytes in forestry environment, particularly in Honshu, Shikoku, and Kyushu) that were more densely distributed than those of the LGM.

The present data are insufficient to broach the big question about how the emergence of sedentary lifeways was related to the technological innovations and broad-spectrum subsistence economy in hunter-gatherer societies. While the incompleteness of dietary data makes it difficult to reconstruct the subsistence economy of the Late Glacial hunter-gatherers, the first obvious signature of broad-spectrum has been seen in the intensive exploitation of aquatic resources that left large shell middens since the beginning of Holocene (e.g., Aikens and Akazawa, 1996; Nunn et al., 2006). Since the Natsushima shell midden (southern Kanto), known as the earliest shell midden in Japan (Sugihara and Serizawa 1957) was now likely fallen in 11,500 – 9000 cal. B.P. (Habu 2004; Kudo 2004), it is plausible that the emergence of shell middens on the Japanese Archipelago was during the Preboreal. This phenomenon occurred simultaneously with the quantitative increase of ceramic vessels, may have been the cultural consequence of a systemic change in human resource exploitations and foraging patterns. However, pottery production and use did not come to be large-scale for 4500 years of the Bølling/Allerød and Younger Dryas until the onset of Preboreal, while the mean site numbers did not increase dramatically at the transition from Younger Dryas to the Preboreal (Fig. 2.). This may suggest that the increased quantity in ceramic vessels in the Preboreal sites was not an outcome of rapid demographic change in the beginning of the Holocene. Rather, we suggest that an increased reliance on pottery could be the consequence of changes in human foraging strategies. We also think that the presence of shell middens may not necessarily be a rapid response to widening human diet breadth and population increase at the onset of Holocene. Potential foraging areas for pursuing terrestrial mammals after the end of LGM gradually decreased as the transgression of shorelines towards inlands submerged the Pleistocene plains to shape present rugged and narrow coastal plains on the Japanese Archipelago. Besides the decreased foraging areas, since mobility of mid-bodied terrestrial mammals (e.g., boar, sika deer) was lower than that of the Pleistocene large-bodied mammals inhabited on the lower plains (e.g., bison, giant deer, moose, reindeer), cost induced from searching the terrestrial games ("searching costs" *sensu* Stephens and Krebs [1986:17]) would have decreased as well. This made humans repetitively forage on particular segments on the Holocene landscapes, but face to spend energy and time to exploit various small patches including low-ranked resources with low caloric returns (e.g., shellfish, geophytes) and high handling cost (e.g., deciduous acorn with toxic tannin). In some regions where coastal plains were small (e.g., Tohoku, northeastern Honshu), hunter-gatherers could have crossed over both coastal (e.g., estuaries, marshes, lagoons) and inland (e.g., valleys, hills, mountains) areas to exploit various resource patches. Decreasing foraging territories and widening prey choices occurred after the Younger Dryas would have eventually led hunter-gathers to be sedentary that in turn accelerated rate of innovation to produce a variety of ceramic vessels served for cooking and storage. Having recognized the increased biogeographic diversity in the Japanese archipelago after the end of Younger Dryas, this scenario only delivers a general framework of changes in foraging strategies and prey choices, which future investigations into the archaeological records at micro-regional scale will evaluate.

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Captions

Fig. 1. A chronological framework for Paleolithic and Jomon with sea-level changes in Japan (modified from Figure 2.8 in Habu 2004: 44).

Fig. 2. The frequency of sites among the three contiguous chronozones (i.e., Bølling-Allerød, Younger Dryas, Preboreal) at the Pleistocene/Holocene transition.

Fig. 3. Number of archaeological sites by latitudes, compared among the Bølling/Allerød, Younger Dryas, and Prebreal.

Fig. 4. Map of the Japanese Archipelago, showing locations of the Late Glacial sites by different periods

Fig. 5. Lithic artifacts and ceramic vessels compared among regions through chronozones. Regions are sorted by Kyushu, Kanto/Chubu/Tokai/Western Honoshu, and Hokkaido/Tohoku, from south to north.

Table 1. List of late Late Glacial sites in the Japanese Archipelago, with regions, sampled locations, laboratory numbers, methods, materials to be dated, $\delta\ ^{13}C$ values, radiocarbon dates (B.P.), upper and lower limits of confidence around the mean calibrated age, and references.

Table 2. Summary of Late Glacial sites with determined chronozones. Sites are ordered by region from north. Number of ^{14}C dates from a site, and number of groups that show continuous range of dates. “Chronozone for dominant dates” signifies the chronozone in which majority of dates from the site are encompassed. Chronozone represents the determined chronozone of the site.

Table 3. Median and maximum NISP for pottery assemblages compared among the Bølling/Allerød, Younger Dryas, and Prebreal.

Figure1

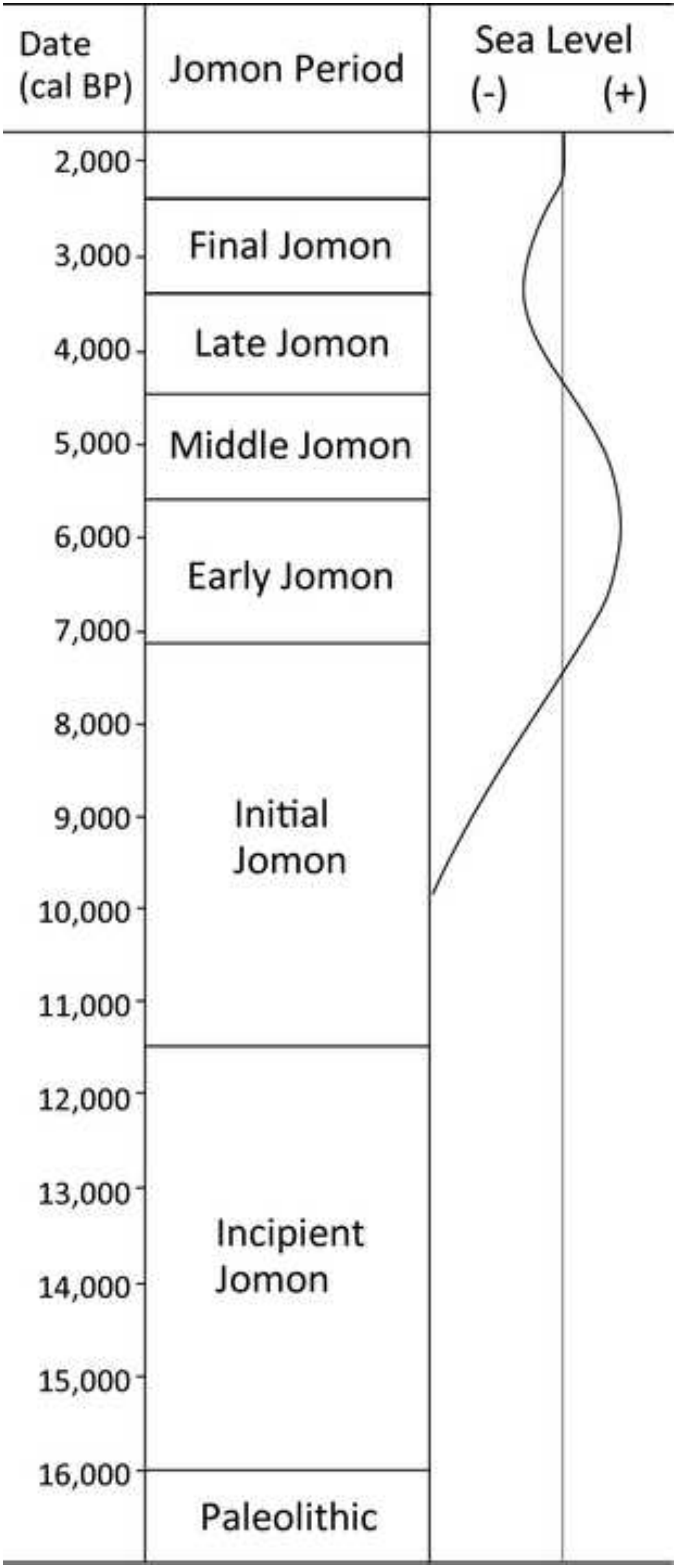

Date (cal BP)
Jomon Period
Sea Level
(-)
(+)
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
12,000
13,000
14,000
15,000
16,000
Final Jomon
Late Jomon
Middle Jomon
Early Jomon
Initial Jomon
Incipient Jomon
Paleolithic

Figure2

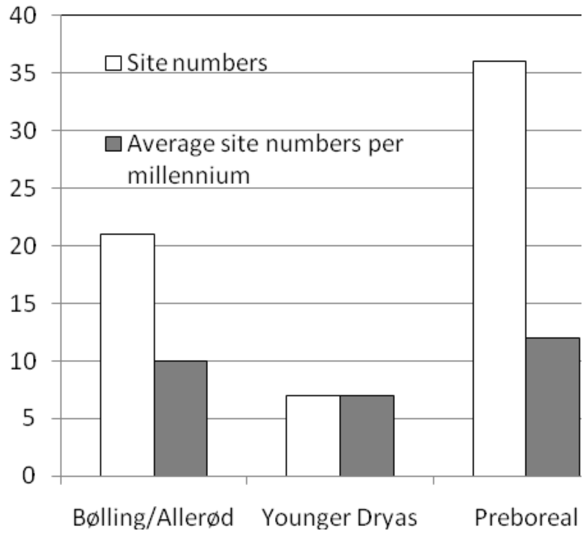


Fig. 2.

Figure3

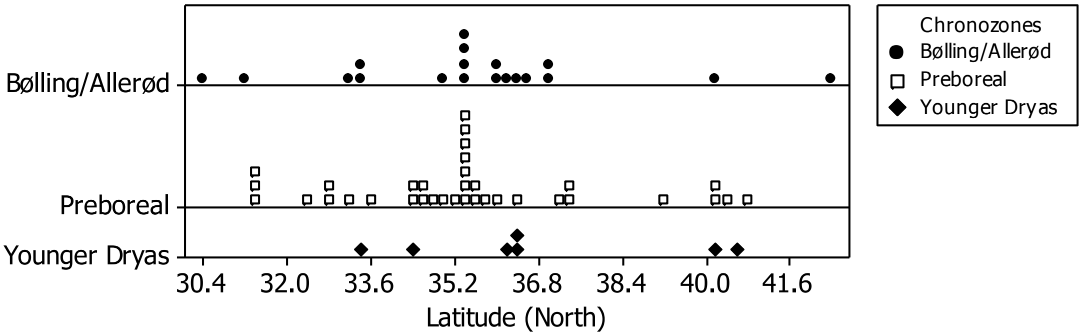
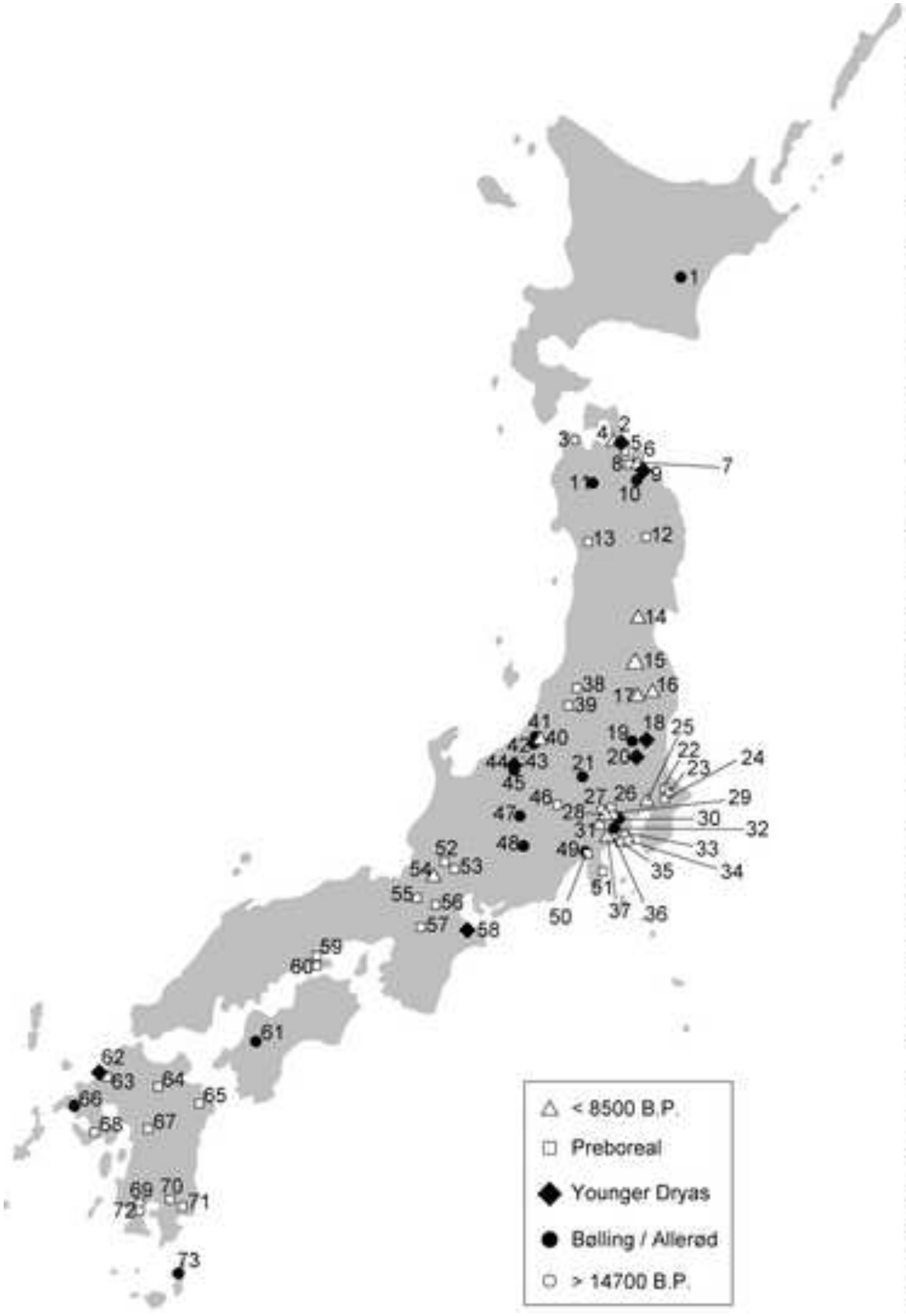


Fig. 3.

Figure4



1, Taisho 3; 2, Hachazawa B;
3, Odaiyamamoto; 4, Nohejikanita;
5, Neinuma 3; 6, Tamukai;
7, Katano; 8, Kushibiki;
9, Takihata; 10, Kiwada;
11, Shirasawa; 12, Uwadai 1;
13, Iwase; 14, Nogawa;
15, Sendai Uchimae; 16, Nishida H;
17, Akazawa B; 18, Toya;
19, Nozawa; 20, Tako minamihara;
21, Tokumarunakata; 22, Nishinojo;
23, Tokisaki; 24, Kinone No.6;
25, Mamiana; 26, Musashidai;
27, Maedakochi; 28, Shinmeiue;
29, Tenmondaikonai; 30, Manpukuji;
31, Kitappara; 32, Tsukimino Kamino;
33, Natsuhima; 34, Hirasaka Higashi;
35, Enoshima shokubutsu Ennai;
36, Keio SFC; 37, Minamikajiyama;
38, Muroya; 39, Kurohime;
40, Unoki; 41, Unoki minami;
42, Kubodera minami; 43, Seikosanso B;
44, Kannoki; 45, Nakamachi;
46, Tochihara; 47, Nakajima B;
48, Bijo; 49, Kuzuharasawa IV;
50, Ikeda B; 51, Sannohara;
52, Moroka; 53, Uegahira; 54, Irienaiko;
55, Awazukotei; 56, Kawakaminakanawate B;
57, Beshotsujido; 58, Kounoki;
59, Kuroshima; 60, Reitazaki;
61, Kamikuroiwa; 62, Obaru D;
63, Matsukida; 64, Futsukaichi;
65, Gonoharu; 66, Fukui; 67, Kushijima;
68, Takano; 69, Kakuriyama;
70, Kirikimimitori; 71, Higashikurotsuchida;
72, Maebaru; 73, Sankakuyama 1

Figure5


Bølling/Allerød
Younger Dryas
Preboreal
Hokkaido, Tohoku
Kanto, Chubu, Tokaii, W Honshu
Kyusyu
Taisho 3
Takihata
Kushibiki
Uegahira
Kubodera Minami
Kounoki
Sankakuyama I
Obaru D
Futsukaichi Cave
0
5cm
lithic(arrow head)=1/2
0
5cm
lithic(others)=1/3
0
5cm
pottery=1/6

Table1

Site	Region	Sampled location	Lab. No.	Method	Material	δ13C	14C Age (BP)	±1σ	Calibrated Date cal. BP (68.2%) upper	Calibrated Date cal. BP (68.2%) lower
Taisho 3	Hokkaido	District 3-17, Layer Vb-VIII	Beta-194626	AMS	CAP	-23.5	12380	40	14490	14160
Taisho 3	Hokkaido	District 3-17, Layer Vb-VIII	Beta-194627	AMS	CAP	-24	12200	40	14120	14000
Taisho 3	Hokkaido	District 3-17, Layer Vb-VIII	Beta-194628	AMS	CAP	-23.7	12330	40	14350	14100
Taisho 3	Hokkaido	District 3-16, Layer Vb-VIII	Beta-194629	AMS	CAP	-22.6	12420	40	14590	14240
Taisho 3	Hokkaido	District 3-16, Layer Vb-VIII	Beta-194630	AMS	CAP	-23.4	12180	40	14100	13980
Taisho 3	Hokkaido	District 3-16, Layer Vb-VIII	Beta-194631	AMS	CAP	-23.3	12100	40	14020	13880
Taisho 3	Hokkaido	Loam on the top of river gravels	IAAA-41603	AMS	CAP	-21.56	12290	60	14270	13880
Taisho 3	Hokkaido	Loam on the top of river gravels	IAAA-41604	AMS	CAP	-23.24	12330	60	14420	14090
Taisho 3	Hokkaido	Loam on the top of river gravels	IAAA-41605	AMS	CAP	-22.08	12120	50	14050	13890
Taisho 3	Hokkaido	Loam on the top of river gravels	IAAA-41606	AMS	CAP	-21.74	12470	50	14720	14300
Taisho 3	Hokkaido	Loam on the top of river gravels	IAAA-41607	AMS	CAP	-22.47	12160	60	14100	13940
Kiwada	Tohoku	Pit house No.2, Layer 2	Beta-148515	AMS	Ch	-23.8	12360	50	14460	14130
Odaiyamamoto I	Tohoku	Layer III	Beta-125550	AMS	CW	-26.1	12360	70	14570	14540
Odaiyamamoto I	Tohoku	Layer IV upper most	NUTA-6506	AMS	CAP	-29.6	12680	140	15200	14650
Odaiyamamoto I	Tohoku	Layer III lower	NUTA-6507	AMS	CAP	-30.5	13030	170	15700	15100
Odaiyamamoto I	Tohoku	Layer III bottom	NUTA-6509	AMS	CAP	N/A	12720	160	15300	14650
Odaiyamamoto I	Tohoku	Layer IV	NUTA-6510	AMS	CAP	N/A	13780	170	16700	16100
Odaiyamamoto I	Tohoku	Layer III	NUTA-6515	AMS	CAP	N/A	13210	160	15950	15350
Kushibiki	Tohoku	Pit No.4	Beta-113349	AMS	Ch	-30.5	10030	50	11630	11390
Takihata	Tohoku	Cobble concentration	Beta-138898	AMS	Ch	-25.3	10260	40	12100	11970
Hachazawa B	Tohoku	Bottom of the pit	Gak-9936	Beta	N/A	N/A	10140	300	12350	11250
Iwase	Tohoku	SN08 Burnt sediment	Gak-15803	Beta	Ch	N/A	8430	130	9550	9280
Iwase	Tohoku	SN16 Burnt sediment	Gak-15804	Beta	Ch	N/A	7460	170	8220	8050
Iwase	Tohoku	SQ77 cobble-filled hearth	Gak-17801	Beta	Ch	N/A	10050	50	11580	11400
Iwase	Tohoku	SXQ60 Hearth1	Gak-17802	Beta	Ch	N/A	10910	170	13070	12790
Uwadai 1	Tohoku	Pit house RA 02	Beta-161171	AMS	Ch	-26.1	9540	40	11070	10950
Uwadai 1	Tohoku	Pit house RA 03	Beta-161172	AMS	Ch	-27.6	9540	40	11070	10950
Uwadai 1	Tohoku	Pit house RA 02	Beta-183451	AMS	CAP	-25.1	4450	40	5070	4970
Uwadai 1	Tohoku	Pit house RA01	IAAA-31108	AMS	CAP	-26.0±0.9	9850	50	11275	11205
Nogawa	Tohoku	Pit 1	NUTA-3540	AMS	CW	N/A	5940	90	6890	6660
Nogawa	Tohoku	Pit 1 Fill1	NUTA-3550	AMS	CW	N/A	3320	70	3640	3470
Nogawa	Tohoku	Pit 1 Fill 1 & 2	NUTA-3551	AMS	CW	N/A	3710	80	4160	3920
Nogawa	Tohoku	Pit 2		AMS	CW	N/A	unable to date		N/A	N/A
Nogawa	Tohoku	Trench No.6 Layer 4, Ro	NUTA-3552	AMS	CW	N/A	3730	80	4180	3970
Nogawa	Tohoku	Trench No.6 Layer 4, Mu	NUTA-3553	AMS	CW	N/A	3160	80	3480	3320
Sendai Uchimae Loc. A	Tohoku	Grid Q-7	NUTA-603	AMS	Ch	N/A	6930	100	7860	7670
Sendai Uchimae Loc. F	Tohoku	Pit house 2	NUTA-604	AMS	Ch	N/A	9750	100	11270	11070
Sendai Uchimae Loc. F	Tohoku	Pit house 2	NUTA-605	AMS	Ch	N/A	9590	70	11040	10780
Nohejikanita	Tohoku	Cultural layer	Beta-173155	AMS	CAP	-23.7	6600	40	7240	7120
Tamukai	Tohoku		Beta-188189	AMS	CAP	-25.4	8530	50	9250	9080
Shirasawa	Tohoku	N/A	Beta-163737	Beta	CAP	-26	9410	50	10700	10580
Shirasawa	Tohoku	N/A	Beta-163735	Beta	CAP	-24.8	9080	60	10285	10185
Shirasawa	Tohoku	N/A	Beta-163736	Beta	CAP	-25.5	9030	60	10250	10160
Shirasawa	Tohoku	N/A	Beta-163738	Beta	CAP	-25.1	9020	40	10230	10185
Nishida H	Tohoku	Pit house SI08, floor	Beta-190355	AMS	CAP	-25.8	6950	40	7495	7415
Nishida H	Tohoku	District V19, Layer IV	MTC-04343	AMS	CAP	-24.3	6405	45	6950	6810
Akazawa B	Tohoku	Pit 81	Beta-158778	AMS	Ch	-25.9	7190	40	7695	7600
Akazawa B	Tohoku	Pit 81, Layer 3	Beta-158779	AMS	Ch	-26.1	7150	50	7665	7570
Akazawa B	Tohoku	Pit 25, Layer 2	Beta-158780	AMS	Ch	-26.6	7070	40	7590	7505
Akazawa B	Tohoku	Pit 11, Layer 2	Beta-158781	AMS	Ch	-24.4	4230	50	4410	4250
Katano	Tohoku	Layer IVa	MTC-08492	AMS	CAP		5730	45	6100	5950
Neinuma(3)	Tohoku	Q10 grid, Layer VI	MTC-08494	AMS	CAP		8520	60	9250	9060
Unoki Minami	Chubu	N/A	Beta-136739	AMS	CAP	-24.8	11000	50	12965	12875
Unoki Minami	Chubu	N/A	Beta-136740	AMS	CAP	-24.5	11040	50	13030	12900
Unoki Minami	Chubu	N/A	Beta-136741	AMS	CAP	-25.2	11130	50	13090	12970
Unoki Minami	Chubu	N/A	Beta-136742	AMS	CAP	-21.2	11630	50	13560	13390
Unoki	Chubu	N/A	Beta-156886	AMS	Ch	-24.7	2960	40	3210	3110
Kubodera Minami	Chubu	Layer 2 Lower	Beta-136743	AMS	CAP	-24.9	12280	50	14220	14050
Kubodera Minami	Chubu	Layer 2 Lower	Beta-136744	AMS	CAP	-24.8	12420	50	14600	14230
Kubodera Minami	Chubu	Layer 2	Beta-136745	AMS	CAP	-23.8	12490	60	14830	14380
Kubodera Minami	Chubu	Layer 2	Beta-136746	AMS	CAP	-23.6	12620	50	15020	14730
Kubodera Minami	Chubu	Layer 35	Beta-136747	AMS	CAP	-23.9	12510	40	14870	14480
Kubodera Minami	Chubu	Layer 33	Beta-140494	AMS	CAP	-25.2	12520	50	14890	14480
Kubodera Minami	Chubu	?	Beta-140495	AMS	CAP	-26.5	12630	50	15030	14750
Muroya	Chubu	Layer VII (Lower incipient)	Beta-156887	AMS	Ch	-26.9	7850	50	8720	8610
Shimomouchi Cultural Layer II	Chubu	Charcoal Con 1	NUTA-1515	AMS	Ch		16250	180	19560	19160
Kannoki	Chubu	SK37 fill	-		?		10260	140	12400	11750
Kannoki	Chubu	SK38 fill	-		?		10150	140	12100	11400
Kannoki	Chubu	SK63	-		?		10000		N/A	N/A
Kannoki	Chubu	SK35	-		?		9600		N/A	N/A
Kannoki loc.H5	Chubu	N/A	Nuta2-6883	AMS	CAP	-22.8	12360	50	14460	14130
Kannoki loc.H5	Chubu	N/A	Nuta2-6884	AMS	CAP	-24.6	12490	50	14820	14390
Kannoki loc.H5	Chubu	N/A	Nuta2-6885	AMS	CAP	-25.8	12350	50	14440	14120
Kannoki loc.H5	Chubu	N/A	Nuta2-6886	AMS	CAP	-42.4	11460	70	13380	13240
Kannoki loc.H5	Chubu	Layer III	PLD-1844	AMS	CAP	-25	13010	110	15560	15160
Kannoki loc.H5	Chubu	Layer III	PLD-1845	AMS	CAP	-24.8	12870	110	15370	15010
Nakajima B	Chubu	Pottery Con No.3	I-13767	Beta	Ch		12460	310	15000	14050
Nakamachi BP5a	Chubu	BP5a, Pottery Con No.SQ03. Layer 1	IAAA-40496	AMS	Ch	-30.6	11990	60	13920	13770

Table2

Region	Site	Number of dates	Number of groups	Chronozone for dominant dates
Hokkaido	Taisho 3	11	1	Bølling/Allerød
Tohoku	Kiwada	1	1	Bølling/Allerød
Tohoku	Odaiyamamoto I	3	2	> 14700 B.P.
Tohoku	Kushibiki	1	1	Preboreal
Tohoku	Takihata	1	1	Younger Dryas
Tohoku	Hachazawa B	1	1	Younger Dryas
Tohoku	Iwase	4	4	Preboreal
Tohoku	Uwadai 1	4	3	Preboreal
Tohoku	Nogawa	5	4	< 8500 B.P.
Tohoku	Sendai Uchimae loc. A	1	1	< 8500 B.P.
Tohoku	Sendai Uchimae loc. F	2	1	Preboreal
Tohoku	Nohejikanita	1	1	< 8500 B.P.
Tohoku	Tamukai	1	1	Preboreal
Tohoku	Shirasawa	4	2	Bølling/Allerød
Tohoku	Akazawa B	4	4	< 8500 B.P.
Tohoku	Katano	1	1	< 8500 B.P.
Tohoku	Neinuma(3)	1	1	Preboreal
Tohoku	Nishida H	2	1	< 8500 B.P.
Chubu	Bijo	3	1	Bølling/Allerød
Chubu	Kannoki	2	1	Younger Dryas
Chubu	Kannoki loc.H5	4	2	Bølling/Allerød
Chubu	Kubodera Minami	5	2	Bølling/Allerød
Chubu	Kurohime Cave	7	5	Preboreal
Chubu	Muroya	2	1	Preboreal
Chubu	Nakajima B	1	1	Bølling/Allerød
Chubu	Nakamachi BP4, 5a	10	2	Bølling/Allerød
Chubu	Nakamachi BP5a	1	1	Bølling/Allerød
Chubu	Seikosanso B	3	2	Preboreal
Chubu	Tochihara	1	1	Preboreal
Chubu	Unoki	1	1	< 8500 B.P.
Chubu	Unoki Minami	4	2	Bølling/Allerød
N Kanto	Nozawa	9	2	Bølling/Allerød
N Kanto	Saishikada Nakajima (B)	3	3	Bølling/Allerød, Younger Dryas, & Preboreal
N Kanto	Tako Minamihara	2	1	Younger Dryas
N Kanto	Tokumaru Nakata	5	2	Bølling/Allerød
N Kanto	Toya	2	1	Younger Dryas
S Kanto	Enoshima Shokubutu Ennai	2	1	Preboreal
S Kanto	Hirasaka Higashi	1	1	Preboreal
S Kanto	Shinmeiue	3	1	< 8500 B.P.
S Kanto	Juno	4	2	Bølling/Allerød & Younger Dryas
S Kanto	Keio SFC	8	6	Preboreal
S Kanto	Kinone No.6	1	1	Preboreal
S Kanto	Kitappara	1	1	Preboreal
S Kanto	Maeda Kochi	1	1	> 14700 B.P.
S Kanto	Mamiana	5	3	< 8500 B.P.
S Kanto	Manpukuji No.1	1	1	Bølling/Allerød
S Kanto	Minami Kajiyama	1	1	< 8500 B.P.
S Kanto	Musashidai	2	2	Preboreal
S Kanto	Natsushima	2	1	Preboreal
S Kanto	Nishinojo	2	1	Preboreal
S Kanto	Tenmondai Konai	1	1	Preboreal
S Kanto	Tokisaki (Trench 9)	3	1	Preboreal
S Kanto	Tsukimino Kamino Loc.1	2	1	Bølling/Allerød
S Kanto	Tsukimino Kamino Loc.2	1	1	Bølling/Allerød
Tokai	Ikeda B	5	2	Preboreal
Tokai	KamikawanakanawateA	1	1	Preboreal
Tokai	Kounoki	11	3	Younger Dryas
Tokai	Kuzuharazawa IV	4	2	Bølling/Allerød
Tokai	Moroka	17	2	Preboreal
Tokai	Ogakubo	4	4	Bølling/Allerød, Younger Dryas, & Preboreal
Tokai	Sannohara	2	2	Preboreal
Tokai	Uegahira	4	2	Preboreal
W Honshu	Awazu Kotei	5	1	Preboreal
W Honshu	Besyotsujido	1	1	Preboreal
W Honshu	Irienaiko	17	5	< 8500 B.P.
W Honshu	Kuroshima shell mound	4	3	Preboreal

Table3

	NISP of Pottery		
Chronozones	Number of pottery assemblages	Median	Maximum
Bølling/Allerød	10	341	3000
Younger Dryas	2	270	498
Preboreal	12	1134	33000

Table 3