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A Study of the Utilization of Wood to Build Pit Dwellings from the Epi-Jomon Culture to the Satsumon Culture in Hokkaido Region, Japan.

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Abstract: The purpose of this report is to reveal the utilization of woods, which were used for materials of pit dwellings from the Epi-Jomon culture (1st century) to Satsumon culture (13th century). I analyzed and concentrated on three points concerning the charred woods excavated at sites in Hokkaido. First, I analyzed the situations of wood materials that were construed as roof structure by investigating the distribution patterns of excavated woods in pit dwellings at several sites. In Hokkaido, some houses were discovered to be burned down, which is a sign of abandonment, and in those situations charred woods were found in the soil. Second, I made wood identifications by scanning an electron microscope over the charred woods excavated at pit dwellings and examining the results. Finally, I compared the results of the wood identifications with vegetation around each site, which has been suggested in previous analyses of geomorphological processes and pollen analyses. I concluded that the utilization of woods to build pit dwellings changed from diverse to uniformed between the Epi-Jomon culture and Satsumon culture, and that this was mainly due to the selections from surrounding environments.

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1. Introduction

The purpose of this paper is to reveal the utilization of wood for building pit dwellings in the Hokkaido region from the 1st century to the 13th century (from the Epi-Jomon culture to the Satsumon culture, including the Okhotsk culture). The island of Hokkaido is located in the northern most area of the Japanese archipelago (at almost 41 degrees 46 minutes to 45 degrees 25 minutes north latitude and 139 degrees 31 minutes to 145 degrees 49 minutes east longitude), and Sakhalin is to the north across the Soya Strait. Furthermore, Hokkaido and its islands are surrounded by the Pacific Ocean, the Sea of Japan, and the Sea of Okhotsk.

Hokkaido and Honshu have different features and names stemming from differing histories. While phases and names varied in the history of Japan on the main island starting from the Paleolithic and going to the Edo period, Hokkaido also went through differing phases and names

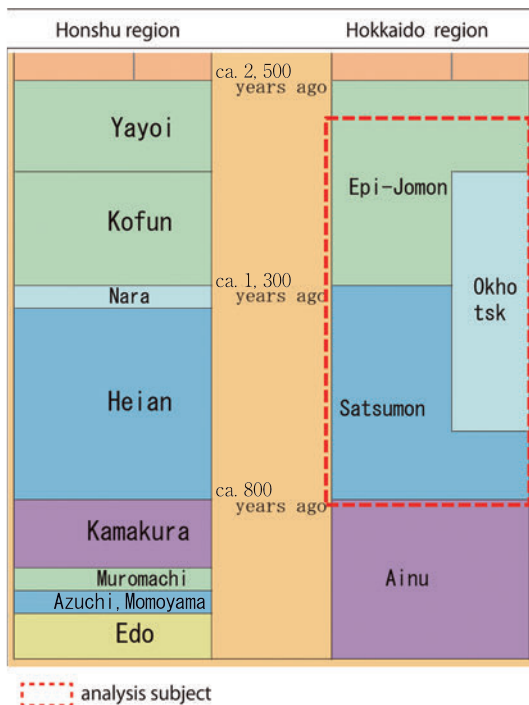


Figure 1 Historical period

starting from the 5th century B.C. The Epi-Jomon culture (between approximately 2500 and 1300 years ago) existed at the same time as the Yayoi and Kofun periods of the Japanese mainland (Fig. 1). The Satsumon culture (from approximately 1300 to 800 years ago) existed at the same time as the Nara and Heian periods in Honshu.

There are some notably significant features of the Epi-Jomon and Satsumon cultures. People of the Epi-Jomon culture engaged in hunting and fishing, which had lasted beyond the Jomon period, and used stone tools such as axes. Satsumon people adopted agriculture and cultivated various kinds of millets as well as continuing to hunt and fish. They lived in pit dwellings and cooked with ovens named “Kamado” which they built into one wall of their dwellings, and they used iron tools.

Clearly, life styles changed between the Epi-Jomon culture and the Satsumon culture

(fig. 2). During the first half of Epi-Jomon, the plane figures of pit dwellings were circular or had a top that was shaped like a hand glass handle, and had a hearth for cooking in the middle. From the latter half of the Epi-Jomon culture, we find very little evidence of pit dwellings. Many researchers have reported finding campsites at excavations and have discovered that ancient people used to live in caves. While pit dwellings decreased at that time, people again began to use them during the early Satsumon culture (8th century) and continued their usage until late Satsumon (13th century). During the Satsumon culture, the plane figure of pit dwellings was square or rectangular when seen from above, with the oven, the Kamado, on one side of the pit dwelling. Most of the time, four pit holes were discovered inside one pit dwelling. Researchers believe the entrance of the pit dwelling was located beside the Kamado.

As I will describe in Chapter 2, I have analyzed charred woods by comparing the results of the wood identifications. The charred woods found in “burned pit dwellings” are ancient remains of pit dwellings which show fire-related phenomena.

There are already some organized reports of identical wood studies in the Hokkaido area (Hirokawa 1986, Mino 1988, 1994, 1996, 1997, 2000, 2001). These researchers have studied the wood’s materials of a particular period and area and wood products created out of just one kind of tree species. Although their research results are important, they have not aimed to show the utilization of woods for building pit dwellings over thousands of years, or compared the positions of the charred woods in the context of sediment for the result of wood identification.

Therefore, I offer three points explaining the utilization of wood to build pit dwellings in the Hokkaido region. First, I will explain how to recognize and divide woods found in the “burned

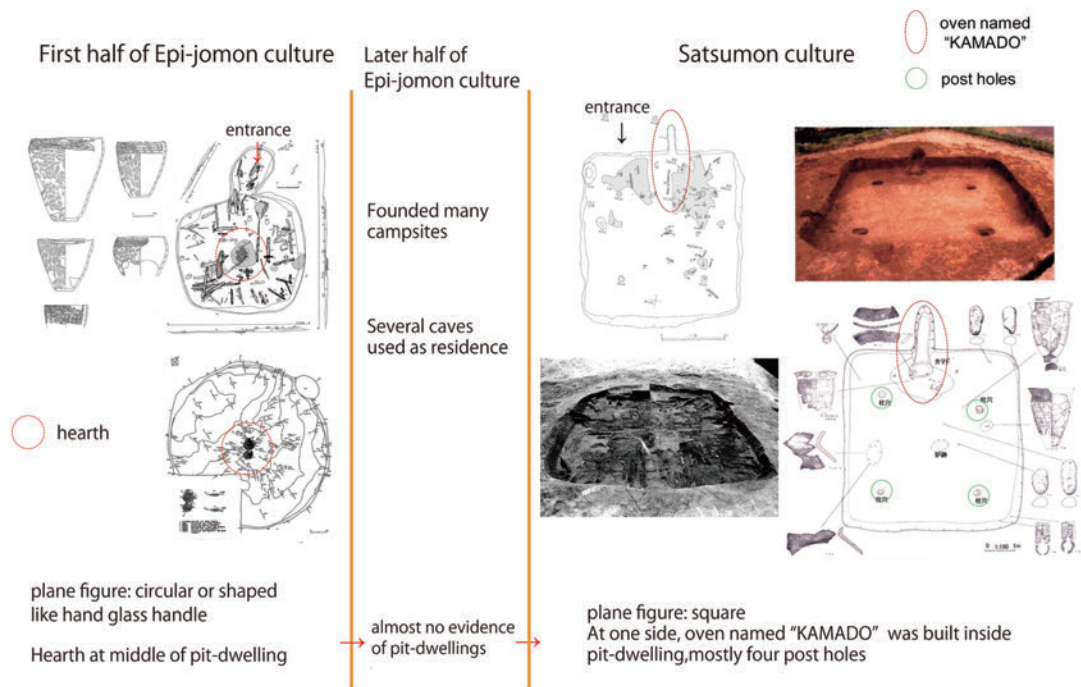


Figure 2 Lifestyle changes from Epi-Jomon culture to Satsumon culture

pit dwellings", classified individually at excavations. Secondly, I will present several results of the utilization by the wood identification method. Finally, I will compare the utilization of wood with the paleo environment of the Hokkaido region.

2. Material and Method

The materials that are examined in this study are the charred woods that are collected inside the "burned pit dwellings" (fig. 3). The name "burned pit dwelling" is derived from the idea that the ancient remains are pit dwellings which show fire-related phenomena. When we excavate burned pit dwelling at sites, we can see the existence of charred woods, a lot of burned soil, and burial processes. Though the burned pit dwellings have more remaining features than in normal dwellings, such as roof construction materials, it is not yet clear why these materials appeared on the burned pit dwellings at the time the homes were abandoned.

For this study, my coworkers and I analyzed charred woods found in pit dwellings using wood identification and three procedural phases. First, we take the charred wood from inside the sediments of pit dwellings and observe where the charred wood is found, determining what part of the roof construction it was, whether the rafter, pole, or ridge. After removing the piece, we manufacture several specimens for observation using the Scanning Electron Microscope (SEM). Finally, we compare the results of the charred wood with the features of various woody tissues from current botanical specimens because we have the individual woody tissues of living trees at present. However, although we can use the features to do wood identification, we cannot



Figure 3 Photos of burned pit-dwellings

(Kitami city Brood of Education 2007, Sapporo city Brood of Education 1993;
left side: epi-jomonculture, right side: Satsumon culture)

Methods Electron Microscope Pictures

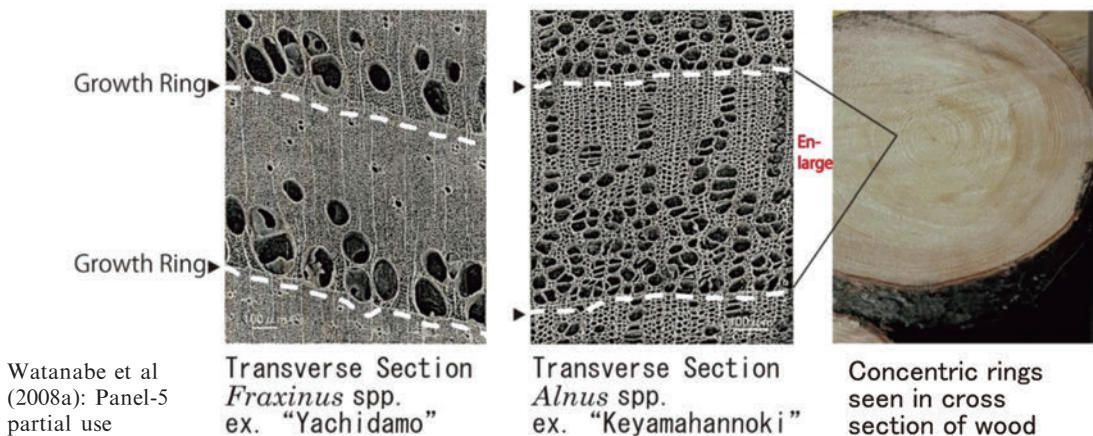


Figure 4 Two examples of wood identification using SEM

retrieve the genetics from our results. Here are two pictures (Watanabe et al 2008a) that explain the features of the species (fig. 4).

3. Result of the wood identification at several sites

(1) First half of the Epi-Jomon culture

We analyzed charred woods found at five burned pit dwellings at four sites of periods between the 1st and 2nd centuries, and which were located in three different areas of Hokkaido. Three pit dwellings were discovered in central Hokkaido, one in southwest Hokkaido, and one in eastern Hokkaido (fig. 5).

We identified a total of 281 wood pieces found in pit dwellings at sites H-37 and K-39 in central Hokkaido (Moriya et al 2007). Many of them were determined to be broadleaf trees, and we recognized eleven kinds of genetics, mainly *Fraxinus* (26%), *Carnus controversa* (10.6%), and *Alnus* (6.7%).

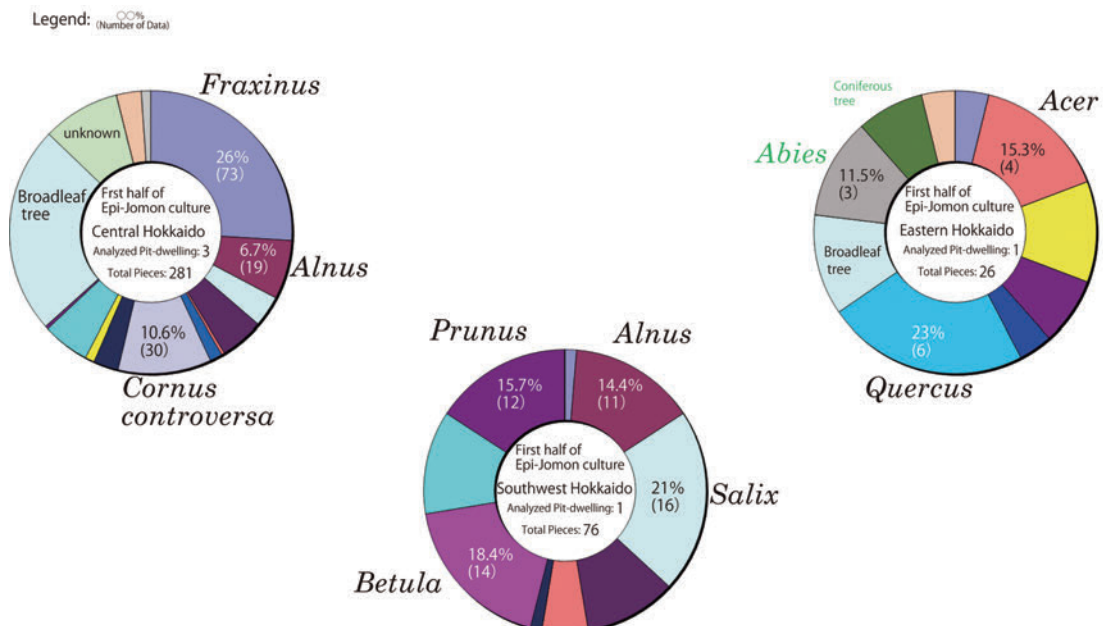


Figure 5 Results of wood identification in Epi-Jomon culture

I examined a total of 76 pieces at the Mobetsu site in southwest Hokkaido (Mino 1998). Many of them were determined to be broadleaf trees and we recognized nine kinds of genetics, mainly *Salix* (21%), *Betula* (18.4%), *Prunus* (15.7%), and *Alunus* (14.4%).

We identified a total of 26 pieces at Tokorogawakakou site in eastern Hokkaido (Watanabe et al 2008). They were divided into two groups, one the broadleaf tree (approximately 80%) and the other the coniferous tree (approximately 20%). We recognized six kinds of broadleaf genetics divided into such categories as *Quercus* (23%) and *Acer* (15.3%). We were able to determine one kind of coniferous tree, the *Abies* (11.5%).

With these results of wood identification, we were able to see that ancient people in the first half of the Epi-Jomon culture utilized many genetics of trees to build pit dwellings. From the distributed conditions of the sediments, we were able to conclude that most of the charred woods were mainly rafters layered above after the fireplace was destroyed.

(2) Satsumon culture

The Satsumon culture has been divided into three phases by researchers (Nakata et al 1999). The first is named the Early Satsumon culture (8th century through early 9th century), the second the Middle Satsumon culture (late 9th century through early 11th century), and the third the Late Satsumon culture (late 11th century through 13th century).

The latter half of the Okhotsk culture occurred around the same time as the Early Satsumon. The sites where the Okhotsk culture people lived spread between Sakhalin and the northern area of Hokkaido, and the residents mainly hunted sea animals and fished seawater fish from the 5th century to the early 9th century. In especially the early 9th century, they set up settlements around the Sea of Okhotsk in the Hokkaido area. The plane figures of the pit dwellings that they built

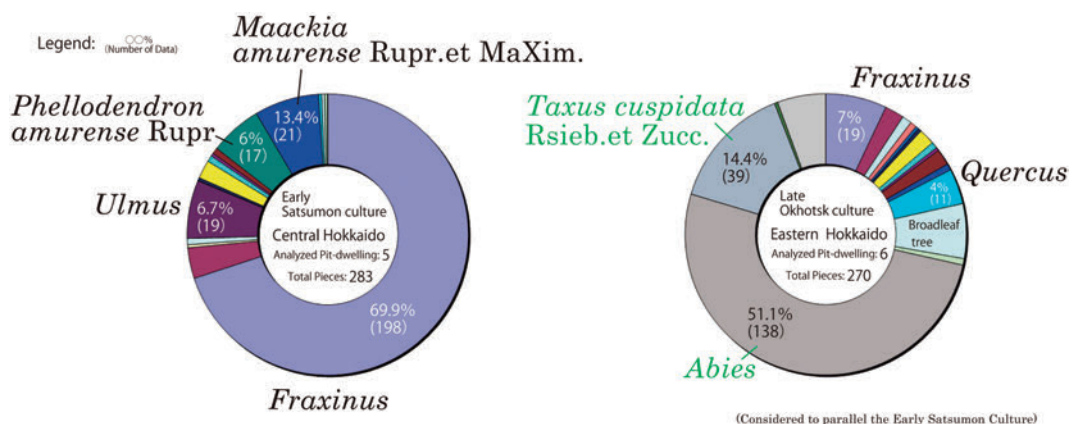


Figure 6 Results of wood identification from 8th century to early 9th century

were pentagonal or hexagonal when viewed directly from above, and fireplaces were placed in the middle of the floor of the pit dwelling.

a. Early Satsumon culture (along with the latter half of the Okhotsk culture)

From the 8th century to the early 9th century, there were two cultures in the Hokkaido region. One was the Early Satsumon culture in central Hokkaido, and the other was the latter half of the Okhotsk culture in northeastern Hokkaido (fig. 6).

We analyzed charred woods found at five burned pit dwellings at four sites in central Hokkaido and identified a total of 283 pieces taken from pit dwellings at site K-435, site K-39, etc (Sapporo city Board of Education 2005, Sano et al 2009a, Sano et al 2011). Many of them were determined as broadleaf trees, and we recognized 11 kinds of genetics, mainly *Fraxinus* (69.9%), *Maackia amurensis* Rupr. et Maxim (13.4%), and *Alnus* (6.7%). After conducting distribution of the sediments, the charred woods were recognized mainly as being rafters of the roof structure on the Kamado that were destroyed at abandonment.

We also analyzed charred woods unearthed at six burned pit dwellings at three sites in eastern Hokkaido in latter half of the Okhotsk culture, and identified 270 pieces of charred wood by using SEM or by organizing the results (Watanabe et al 2008, Matsunami et al 2012, Mino 2012). Many of these, however, were coniferous trees, with the results being 51.1% *Abies*, 14.4% *Taxus cuspidata* Sieb. et Zucc., and approximately 25% broadleaf trees. After conducting distribution of wood materials in the sediments, the charred woods were recognized mainly as laggings of the walls of pit dwellings after fireplaces were destroyed and not used.

b. Middle Satsumon culture

The Middle Satsumon culture was the period in the Hokkaido region from the late 9th century to the early 11th century. Although the material analyzed was only a little, their phases can be divided into two features (fig. 7).

We analyzed 52 pieces of charred wood found at seven burned pit dwellings on three sites (K-39, K-440, and K-518) in central Hokkaido (Hirakawa 1986, Sano 2008, Sapporo city Board of Education 2002, 2011). We identified mainly broadleaf trees, such as *Fraxinus* (65.3%) and

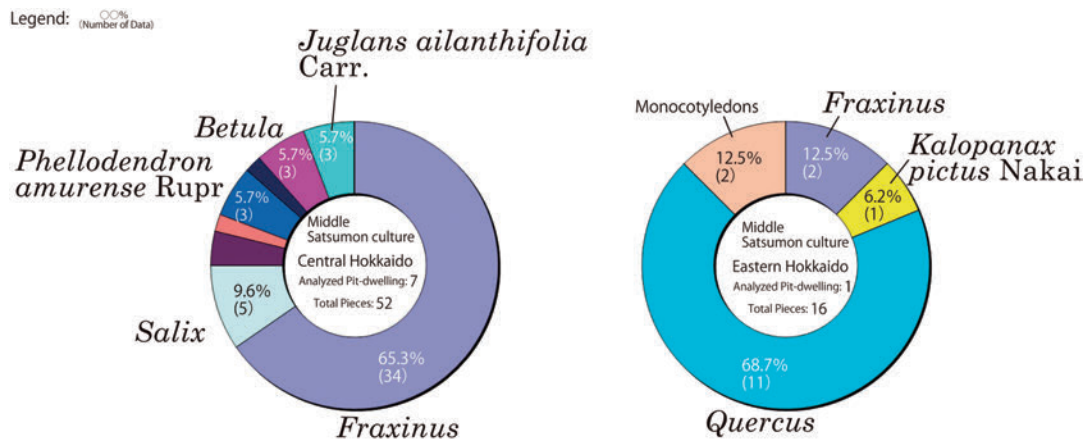


Figure 7 Results of wood identification in Middle Satsumon culture
 (between late 9th century and early 11th century)

Salix (9.6%).

We analyzed 16 pieces of charred wood recovered from one burned pit dwelling at Tokorog-awakakou site in eastern Hokkaido (Watanabe et al 2008b). It was clear that there were *Quercus* (68.7%), *Fraxinus* (12.5%) and *Kalopanax pictus* Nakai (6.2%). All of them are broadleaf trees, but the total number of pieces is a few.

After conducting the distribution in the sediments, the charred woods in both places were recognized as mainly rafters of the roof structure after the Kamado was destroyed at the time of abandonment.

c. Late Satsumon culture

The Late Satsumon culture refers to the late 11th century to the early 13th century in Hokkaido. At that time, three distinct characteristics existed in three areas: central Hokkaido, northern Hokkaido, and eastern Hokkaido. Furthermore, eastern Hokkaido was divided into two areas in which one occupied the coastal area of the Pacific, and the other the coastal area of the Okhotsk Sea (fig. 8).

We analyzed the charred woods found at two burned pit dwellings at sites K-39 and H-519 in central Hokkaido (Sano et al 2009b, Sapporo city Brood of Education 2006). A total of 85 pieces were collected as samples from burned pit dwellings. We identified and found out that most were broadleaf trees that can be subdivided into six kinds of genetics such as *Fraxinus* (57.6%), *Alnus* (10.5%), and *Phellodendron amurense* Rupr (20%).

In addition, I also analyzed the results of wood identification carried out by other researchers at the Kusunoki site in the northern area of Hokkaido. They collected 152 samples of charred woods at burned pit dwellings and identified them (Mino 1988). All the samples were broadleaf trees that were subdivided into five kinds of genetics, mainly *Fraxinus* (88.8%).

We analyzed charred woods found at three burned pit dwellings at three different sites: the Nusamai no.2 site, the Zaimokuchou no.5 site, and the Hokuto site (Mino 1994b) around the coastal area of the Pacific in Hokkaido. We organized results analyzed a total of 498 pieces. The results were that the majority were broadleaf trees such as *Quercus* (45.1%), *Salix* (39.9%), and

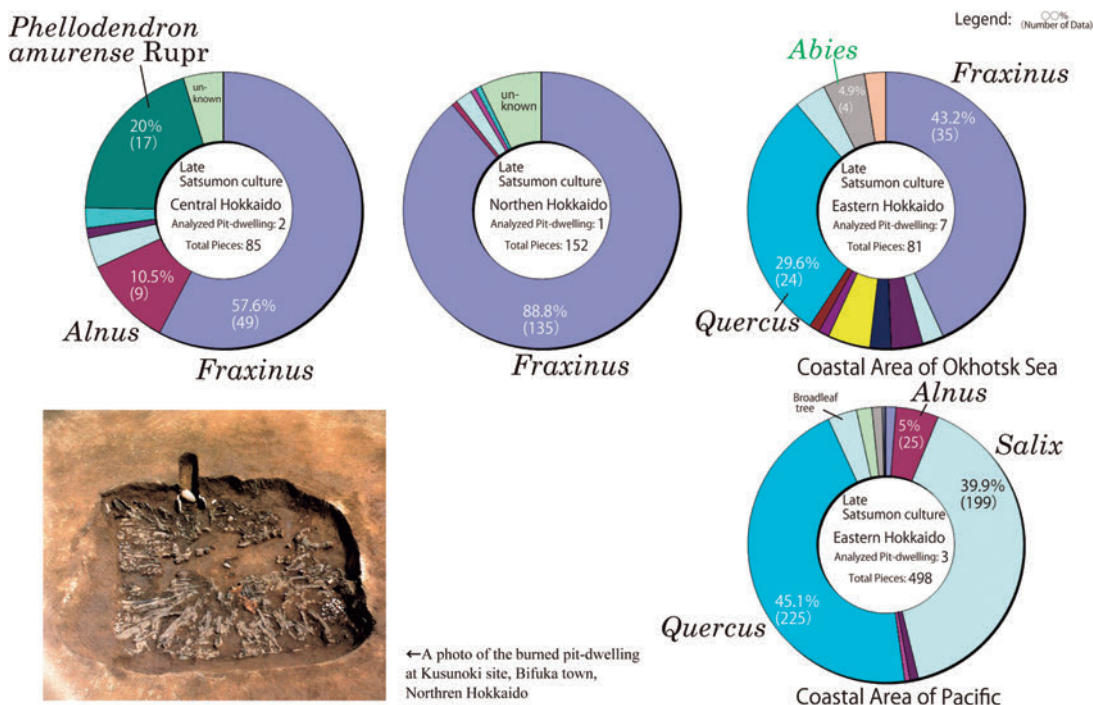


Figure 8 Results of wood identification in Late Satsumon culture

(Photo: Hokkaido archaeological operations center 1984)

Alnus (5%) and the rest consisted of three other kinds of broadleaf trees and two kinds of coniferous trees (almost 2%).

We identified a total of 81 pieces of charred wood unearthed at seven burned pit dwellings in the Tokorogawakakou site around the coastal area of the Okhotsk Sea. There were both broadleaf trees (approximately 90%) and coniferous trees (approximately 5%), the broadleaf trees being subdivided into eight kinds such as *Fraxinus* (43.2%) and *Quercus* (29.6%), and the coniferous tree being *Abies* (Watanabe et al 2008).

After conducting the distribution of the sediments, the charred woods of several areas were recognized mainly as rafters of the roof structure after the Kamado was destroyed at the time of abandonment. The locations of the charred woods were difficult to determine at the Tokorogawakakou site in eastern Hokkaido, but we were able to conclude that all of the woody materials came from a common shed structure.

4. Discussion

This chapter will compare paleo environment with the utilization of woods to build sections of pit dwellings such as roof constructions, after which I will explain how to recognize the Hokkaido region's paleo vegetation of the periods between the Epi-Jomon culture and the Satsumon culture. Then, I will compare the paleo vegetation with the locations of the sites where the pit dwellings were built. Finally, I will show how ancient people selected wood material from paleo vegetation around the sites to shape and use them for building.

(1) Flora of Hokkaido

Pollen analysis reveals that the flora of Hokkaido has not changed since approximately 2,000 years ago (Igarashi 2010). Igarashi has analyzed a lot of pollen fossils in sediments taken from the northern side of Sakhalin to the southern side of Hokkaido.

At first, she describes features of flora in Sakhalin, the southwest side of Hokkaido, and other areas of Hokkaido in the present age (fig. 9). The flora of Sakhalin can be divided into two features. *Picea jezoensis* dominates Northern Sakhalin, which is named the “evergreen coniferous forest that has the *Larix gmelinii*”. *Abies sachalinensis* and *Picea jezoensis* dominate Southern Sakhalin, which is called the “evergreen coniferous forest”.

Similarly, Igarashi states that the flora of Hokkaido is divided into two areas. The majority of the flora in the southwestern area of Hokkaido is *Fagus crenata*, and that area which is named the “cold-temperate deciduous broadleaf forest” has the same flora as the northern Honshu region. The flora of central Hokkaido, northern Hokkaido, and eastern Hokkaido are a mixture of either an “evergreen coniferous forest” or “mix needleleaf and broadleaf forest”, including *Quercus mongolica*, *Acer mono* and *Abies sachalinensis*. This may mean that the flora of Hokkaido is a cross between the flora of southern Sakhalin and northern Honshu of Japan.

Igarashi shows a pollen diagram that was created from targeting sediments at the Kenbuchi Basin in central Hokkaido (fig. 10). The results indicate that there is an increase of *Quercus*, *Ulmus*, and *Betula* from 7,647 cal yrs BP to the present. This is the point of variation.

There is another place in Hokkaido where pollen analysis has been conducted. Sawada *et al* have investigated sediments under the Uiruntou Lowland at eastern Hokkaido and created a pollen diagram (fig. 11) to reveal the change of paleo environments (Sawada et al 1999). As seen

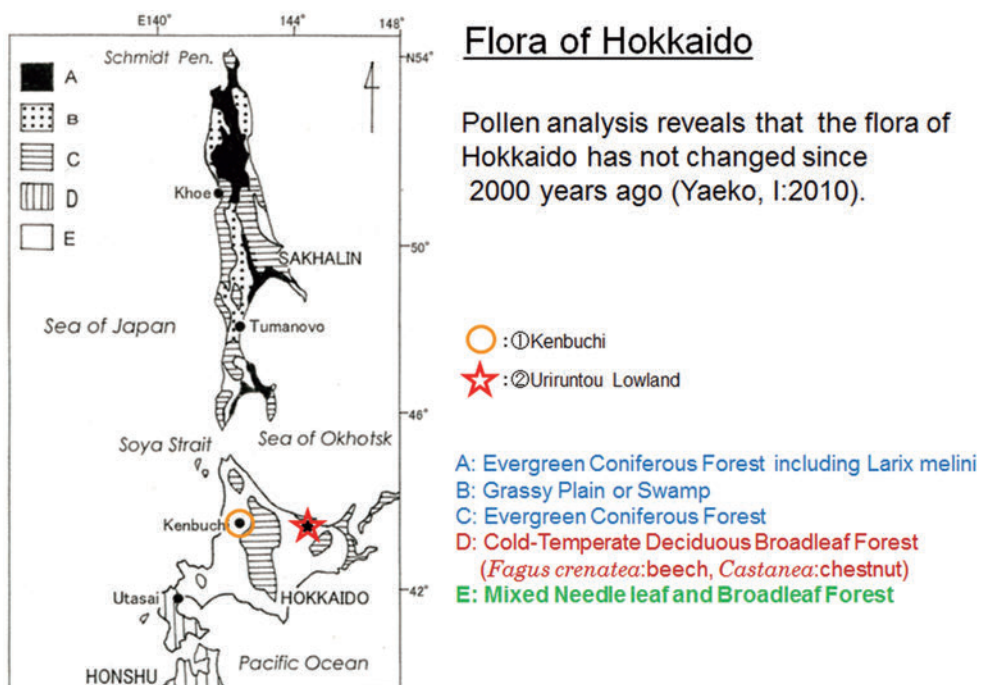


Figure 9 Flora of Hokkaido

here, there is a change in that pollen fossils of several genetics such as *Abies*, *Picea*, *Betula*, and *Lepidobalanus* have increased since $1,700 \pm 60$ yrs BP. They conclude that forests which are a mixture of needleleaf and broadleaf have widely spread throughout eastern Hokkaido since $1,700 \pm 60$ yrs BP.

(2) Results of the location of tree species through investigation of natural forests in Hokkaido

Although pollen analysis is useful in revealing the existence of several genetics in wide geographical areas, it is necessary to understand compositions of trees at narrower geographical ranges. Ishibashi has reported distributions of tree species in Hokkaido regions by investigating locations (Ishibashi 2000).

Ishibashi has performed analysis using permanent forest survey plot data which have been collected in cool-temperate and boreal forests in central Hokkaido since 1959. He has selected 216 places and calculated the appearance probability of the tree species in connection to the difference of height above sea level (fig. 12). As a result, there is a point of variation in the diagram that shows an increase in *Picea jezoensis* and *Betula ermanii* above the elevation of 200 m or more, while *Quercus crispula* and *Acer mono* decrease at the elevation of 200 m or more. This report also shows that the ratio of species for coniferous trees is between 20% and 40% and the ratio of species for broadleaf trees is between 80% and 100% in forests in central Hokkaido at the elevation of 200 m or less. This estimation map (fig. 13) is designed using the results and scientific investigations of Riparian forest (Sakio et al 2002).

(3) Geographical conditions of the locations and elevation of sites

Fig. 14 confirms the locations of the sites explained in chapter 3. On this map of Hokkaido, the locations of the sites in the Epi-Jomon culture are shown in triangle, the Okhotsk culture in square, and the Satsumon culture in circle. As this figure shows, all of the sites are located near several rivers, especially river banks, and at 200 m below.

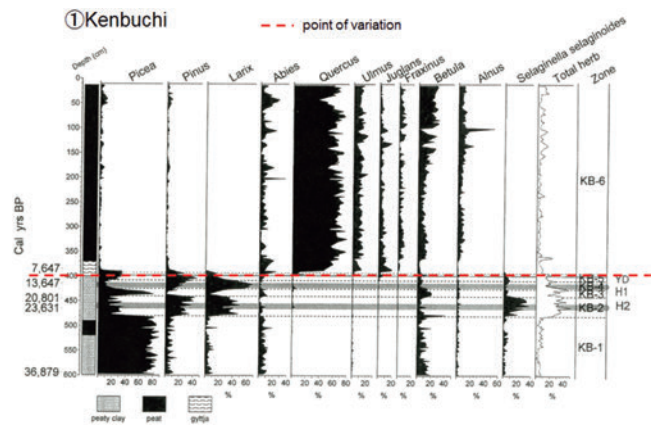
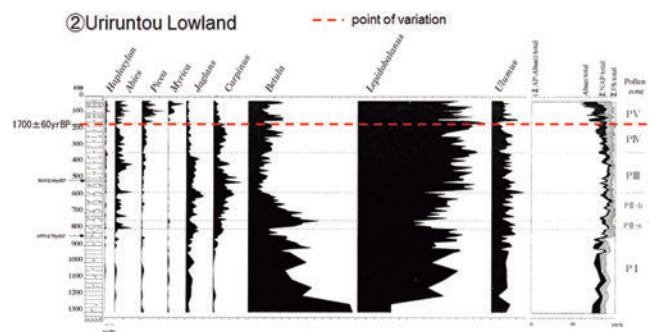


Figure 10 Pollen diagram at Kenbuchi



Sawada et al (1999): Figure 4 resized character

Figure 11 Pollen diagram at Uriruntou Lowland

(4) Comparing the utilization of wood with the paleo environment

I conclude that ancient people prepared materials of wood to build pit dwellings from forests near the sites. Those forests are occupied by broadleaf trees (80%~100%) but also include coniferous trees (approximately 20%~40%) and grow in elevations of 200 m or less (fig. 15).

5. Conclusion

With this research, first, I have shown that it is important to understand the “burned pit dwelling”. Secondly, I have explained and presented the conclusions at which we have organized results of wood identification on the charred woods in burned pit dwellings. Finally, I have compared the results of the wood identifications with the paleo environment. The conclusion of this study, therefore, is summarized as follows:

- 1) From the Epi-Jomon culture period to the Satsumon culture period, in order to build pit dwellings, ancient people mainly prepared rafters by cutting broadleaf trees that existed near the sites. During the Okhotsk culture, they prepared materials of wood from coniferous trees

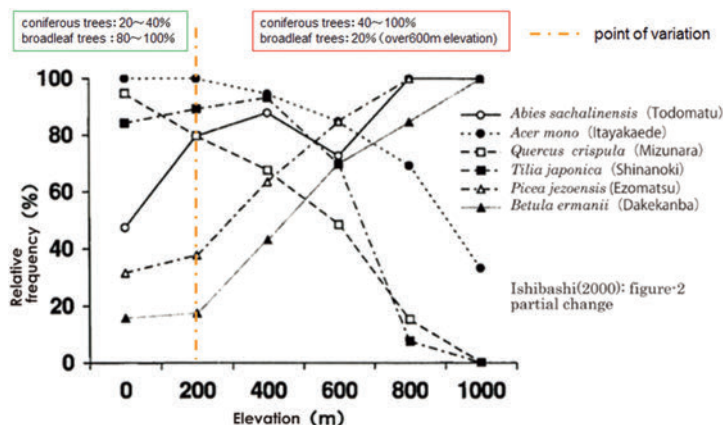


Figure 12 Relative frequency of kind of species according to estimated altitude

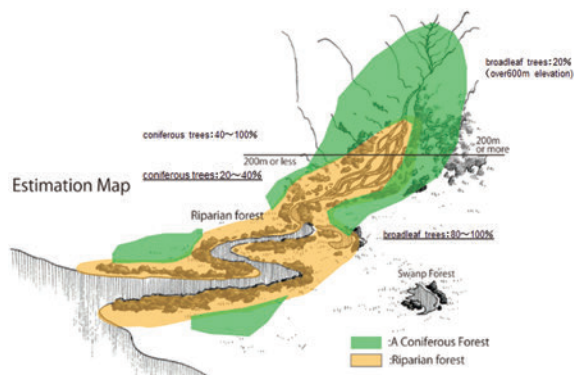
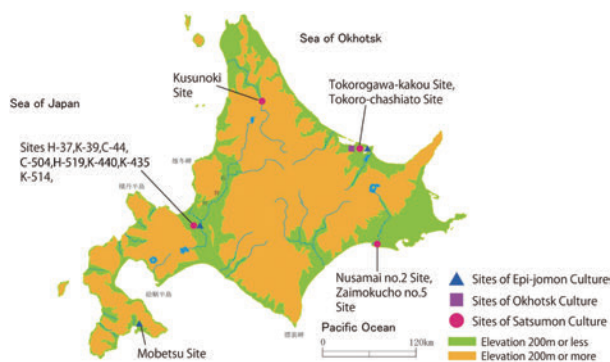


Figure 13 Estimation map of paleo botany in Hokkaido



Sites located near several river and below 200m
Figure 14 Location of sites between Epi-Jomon and Satsumon cultures

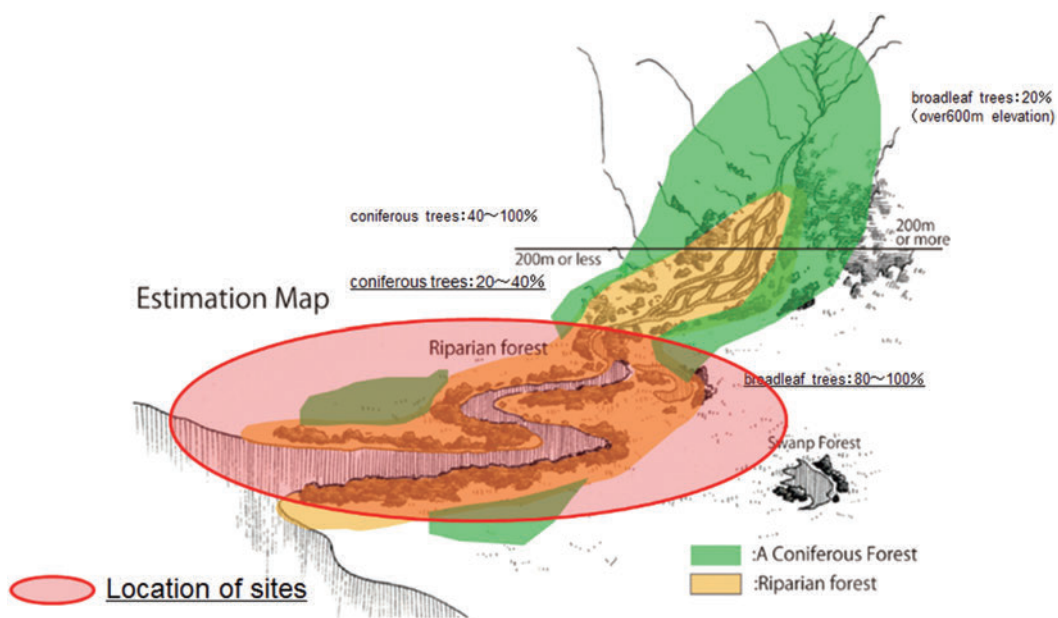


Figure 15 Comparison of paleo vegetation to location of sites

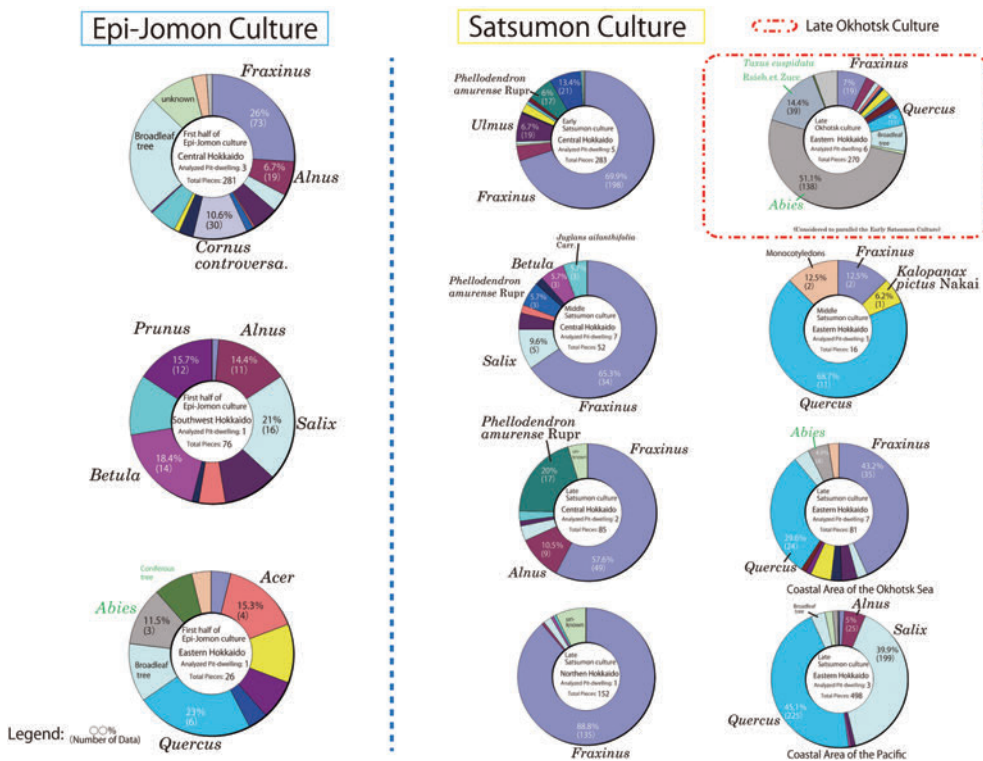


Figure 16 Changes from Epi-Jomon culture to Satsumon culture

from nearby sites for mainly setting laggings of pit dwellings.

- 2) The utilization of wood to build pit dwellings changed from diversity to uniformity between the Epi-Jomon culture and the Satsumon culture in the Hokkaido region (fig. 16). In the Epi-Jomon culture, several kinds of broadleaf trees were found to be predominant in genetics and existing at about the same percentage each. In the meantime, in the Satsumon culture, one or two broadleaf trees were found to be predominant genetically, such as the *Fraxinus*, *Quercus*, and *Salix*, in the burned pit dwellings. In the late Okhotsk culture (8th century to early 9th century), ancient people used one coniferous tree, the *Abies*, to construct the pit dwellings.
- 3) However, there are still not enough analyzed samples to understand the history of building pit dwellings, and therefore, I must do further analysis.

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Table1 Results of wood identifications

number: points of results of wood identification	The first half of the epi-jomon culture the southern Hokkaido	The first half of the epi-jomon culture the central Hokkaido	The first half of the epi-jomon culture the eastern Hokkaido
<i>Fraxinus</i>	1	73	1
<i>Alnus</i>	11	19	0
<i>Alnus</i> , Subgen. <i>Alnus</i>	0	0	0
<i>Salix</i>	16	10	0
<i>Ulmus</i>	8	14	0
<i>Acer</i>	4	1	4
<i>Phellodendron</i> (<i>Phellodron amurense</i> Rupr)	0	4	0
<i>Cornus</i> (<i>Cornus controversa</i>)	0	30	0
<i>Morus</i>	1	8	0
<i>Betula</i>	14	0	0
<i>kalopanax pictus</i>	0	3	3
<i>Juglance</i> (<i>Juglans ailanthifolia</i>)	9	15	0
<i>Prunus</i>	12	1	2
<i>Cercidiphyllum japonicum</i>	0	0	0
<i>Maackia amurensis</i> Rupr. et Maxim.	0	0	1
<i>Quercus</i> (<i>Quercus</i> , Sect, <i>Prinus</i>)	0	0	6
Broadleaf tree (<i>Angiosperm</i>)	0	67	3
Unknown	0	25	0
<i>Abies</i>	0	0	3
<i>Tuxus cuspidata</i> Rsieb. et Zucc.	0	0	0
Coniferous tree (<i>Softwood</i>)	0	0	2
Monocotyledons	0	8	1
Bark	0	3	0
Total	76	281	26

number: points of results of wood identification	The early Satsumon culture the central Hokkaido	The late Okhotsk culture the eastern Hokkaido	The middle Satsumon culture the central Hokkaido	The middle Satsumon culture the eastern Hokkaido	The late Satsumon culture the central Hokkaido	The late Satsumon culture the northern Hokkaido	The late Satsumon culture the eastern Hokkaido	The late Satsumon culture the eastern Hokkaido
							Coastal area of the Okhotsk sea	Coastal area of the Pacific
<i>Fraxinus</i>	198	19	34	2	49	135	35	6
<i>Alnus</i>	10	6	0	0	9	1	0	25
<i>Alnus</i> , Subgen. <i>Alnus</i>	1	0	0	0	0	0	0	0
<i>Salix</i>	2	3	5	0	3	3	2	199
<i>Ulmus</i>	19	0	2	0	1	0	3	5
<i>Acer</i>	0	2	1	0	0	0	0	0
<i>Phellodendron</i> (<i>Phellodron amurense</i> Rupr)	17	1	3	0	17	0	0	0
<i>Cornus</i> (<i>Cornus controversa</i>)	0	0	0	0	0	0	0	0
<i>Morus</i>	1	1	1	0	0	0	2	0
<i>Betula</i>	0	0	3	0	0	1	0	3
<i>kalopanax pictus</i>	6	5	0	1	0	0	4	0
<i>Juglance</i> (<i>Juglans ailanthifolia</i>)	2	2	3	0	2	1	0	0
<i>Prunus</i>	1	1	0	0	0	0	1	0
<i>Cercidiphyllum japonicum</i>	2	5	0	0	0	0	1	0
<i>Maackia amurensis</i> Rupr. et Maxim.	21	2	0	0	0	0	0	0
<i>Quercus</i> (<i>Quercus</i> , Sect, <i>Prinus</i>)	1	11	0	11	0	0	24	226
Broadleaf tree (<i>Angiosperm</i>)	1	17	0	0	0	0	3	17
Unknown	1	2	0	0	4	11	0	9
<i>Abies</i>	0	138	0	0	0	0	4	6
<i>Tuxus cuspidata</i> Rsieb. et Zucc.	0	39	0	0	0	0	0	1
Coniferous tree (<i>Softwood</i>)	0	1	0	0	0	0	0	0
Monocotyledons	0	0	0	2	0	0	2	1
Bark	0	15	0	0	0	0	0	0
Total	283	270	52	16	85	152	81	498