

Article

# Early Grain Cultivation and Starting Processes in the Japanese Archipelago

Shin'ichiro Fujio <sup>1,2,3,4</sup>

<sup>1</sup> Department of Archaeology, National Museum of Japanese History, Chiba 285-8502, Japan; shin-f@rekihaku.ac.jp

<sup>2</sup> Department of Anthropology, Boise State University, Boise, ID 83525, USA

<sup>3</sup> National Museum of Japanese History, 117 Jonaicho, Sakura, Chiba 285-0017, Japan

<sup>4</sup> Institute of Archaeological Science, Fudan University, Shanghai 200433, China

**Abstract:** This paper presents a specific examination of the introduction of grain cultivation and the processes of development in the Japanese Archipelago. In fact, no definitive archaeological evidence has been found that Jomon hunter-gatherers cultivated grain in the Japanese Archipelago; the earliest potential evidence of grain is a stamp mark of rice on the surface of a final late-Jomon, in about 11th century BC, pottery found at the Itaya 3 site in Shimane Prefecture. Current evidence indicates that the first grain cultivation was started by Jomon people who adopted irrigated wet rice cultivation that had arrived from the Korean Peninsula to northern parts of Kyushu, and gradually spread eastward thereafter. This study specifically examines four regions, including northern Kyushu, Kinki, southern Kanto, and northern Tohoku, in order to investigate the processes of grain cultivation initiation and spread. First, the years during which wet rice cultivation started in each region are estimated based on carbon-14 dating of earthenware types used during that period. Secondly, the timing of the spread of wet rice cultivation has been estimated based on carbon-14 dating of earthenware. Subsequently, differences in the periods between the initiation and dissemination of wet rice cultivation were estimated. Results suggest that dissemination took place over approximately 250 years in northern Kyushu, where wet rice cultivation first started. The time required for adoption decreased gradually as the trend moved eastward. It was estimated to have taken approximately 150 years in Kinki and 20–30 years in southern Kanto, taking place at about the same time. A factor, significantly contributing to such differences in timing and development processes among regions, was likely the relationship between the first farmers who introduced wet rice farming and the indigenous hunter-gatherers who lived there.

**Keywords:** bronze age; hunter gatherers; interaction; irrigation system; Jomon people; Korean Peninsula; wet rice cultivation



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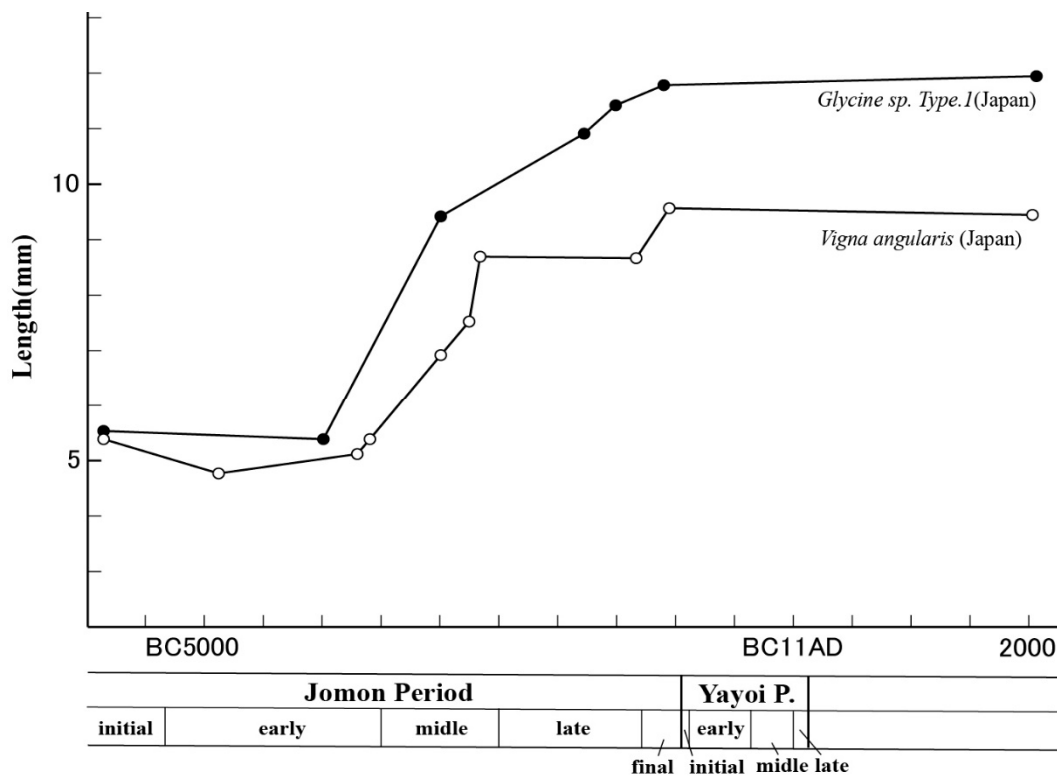
## 1. Introduction

Since the last glacial maximum, about 22,000 years ago, rising temperatures in the Japanese archipelago saw the emergence of pottery about 16,000 years ago. Earthenware appeared during the late glacial period [1]. In terms of Japanese archaeology, the Old Stone Age to the Jomon era is indicated by the appearance of earthenware [2].

The temperature rose only slightly during the Younger Dryas period of about 14,000 years ago, then warmed drastically from about 11,000 years ago [3]. This change marked the beginning of the post-glacial period in the Japanese archipelago. In this region, no edible wild grains grew during the post-glacial period. Major foods sought by Jomon people included nuts and other forest plants, forest animals, and seafood [4]. At the Sannai Maruyama site in Aomori Prefecture, a chestnut forest (*Castanea crenata*) existed that was as dense as today's chestnut gardens [5]. Stable sustenance using chestnuts as a staple food for subsistence is known to have continued for more than 500 years. Archaeological evidence suggests that Jomon people were able to grill and boil chestnuts.

Keiji Imamura defined the Neolithic culture of the Japanese archipelago as a “forest Neolithic culture” that used forest plants as a major food, in contrast to the “grassland Neolithic culture”, which used grains and livestock as major foods in western Asia [6]. About 4200 years ago, the climate cooled suddenly and the Sannai Maruyama site was abandoned. Jomon people switched their subsistence emphasis from chestnuts to more cold-resistant horse chestnuts (*Aesculus turbinata*). Jomon people were compelled to go through complicated processes, such as heating and immersion, to make horse chestnuts edible [5]. Therefore, such water-exposed remains are being investigated continually at various locations.

In addition to gathering, the Jomon people might have conducted domestication of some plants. Soybeans and azuki beans (*Glycine soja* and *Vigna angularis*, respectively) are grown on Honshu Island and were collected by Jomon people as early as 10,000 years ago. Seiji Nakayama and Hiroki Obata confirmed from replica analysis that the wild bean size increased gradually over time, approaching the size of modern soybeans and adzuki beans (Figure 1). Nakayama and Obata designated these as Jomon beans, which are smaller than modern soybeans and adzuki beans, but suggest that they might constitute evidence of plant domestication by Jomon people [7].



**Figure 1.** Changes in legume size during Japanese archipelago prehistory (Modified from Figure 101; referred from Hiroki Obata [7]).

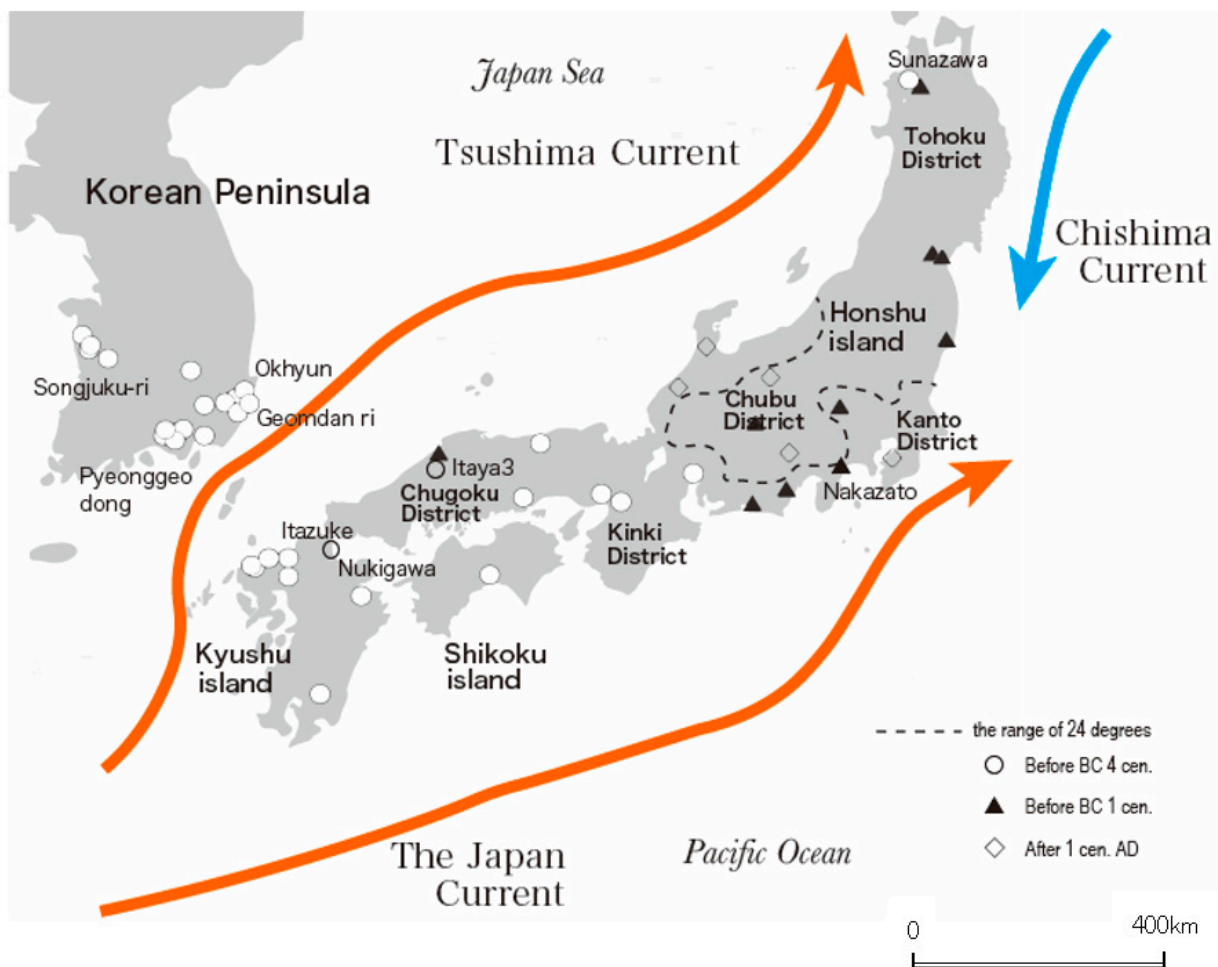
From that experience with beans, Jomon people might have learned that managing plants would produce delicious and larger nuts or beans. Therefore, grain cultivation arrived at a time when the Jomon people had already accumulated selective cultivation knowledge and experience over thousands of years.

## 2. Who Brought Grain Cultivation to the Japanese Archipelago?

### 2.1. Diffusion from the Korean Peninsula to the Japanese Archipelago

Grain cultivation was introduced to the Japanese Archipelago from outside cultures in the late 10th century BC. Ancient Korean people of Bronze-age culture brought wet rice cultivation to northern parts of Kyushu [8]. The wet rice cultivation technique, which

incorporated irrigation systems, was accepted by hunter–gatherers from Honshu, Shikoku, and Kyushu over an approximately 700-year span (Figure 2).

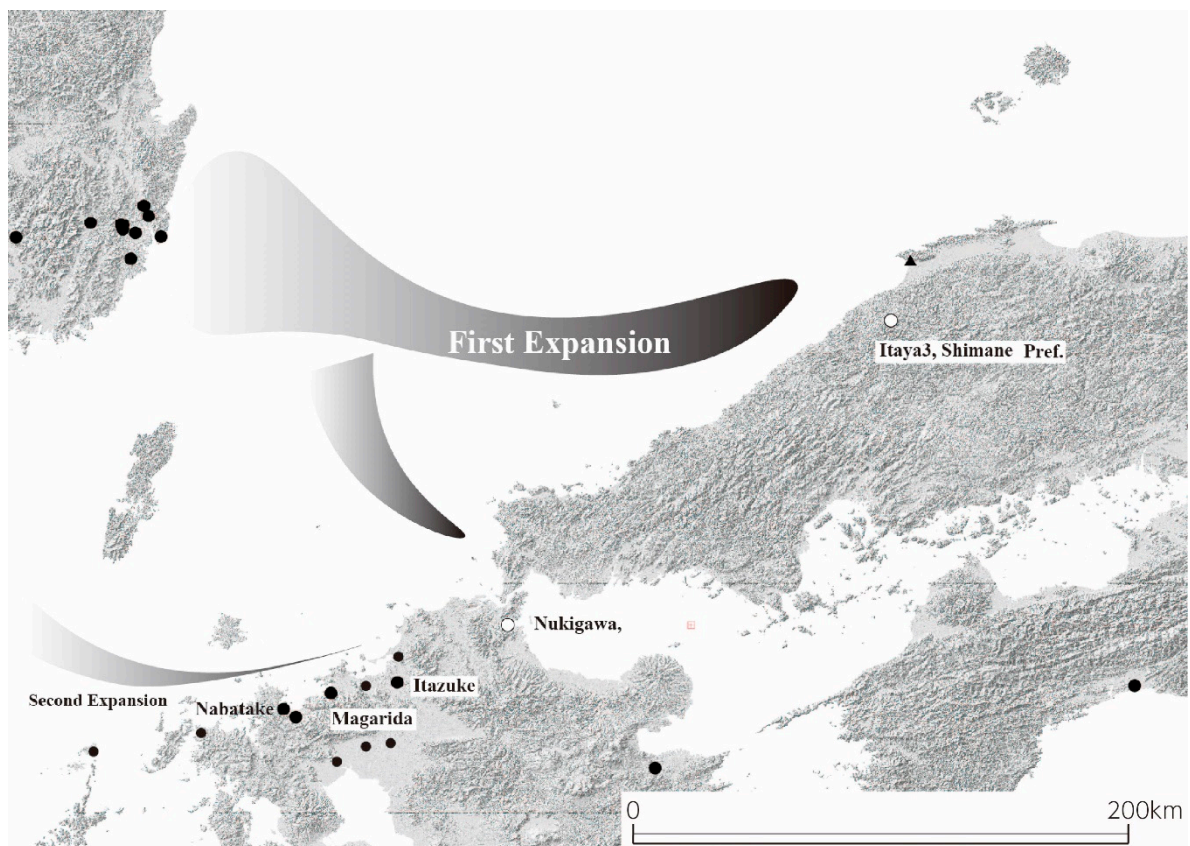


**Figure 2.** Geography, ocean currents, and prehistoric sites of the Korean Peninsula and the Japanese archipelago. (by Author).

The Tsushima warm current flows along the western Japanese archipelago; the Chishima cold current and the Japanese warm current flow along the eastern side. Therefore, during summer on the western Sea of Japan side, the Tohoku region is warm, but the eastern or Pacific side remains cold because of oceanic currents. The distribution of early rice farming sites is in areas with about 24 °C average temperature in August.

## 2.2. Introduction of Rice Cultivation

It seems that two occurrences supported the spread of grain cultivation to western Japan during the Jomon period (Figure 3). The first was the spread of rice and millet in the 11th century BC from the southeastern Korean Peninsula to eastern Kyushu and the Chugoku region [9]. The second was the spread of rice cultivation incorporating irrigation systems from the southern Korean Peninsula to northwestern Kyushu in the second half of the 10th century BC [10].



**Figure 3.** Two opportunities are apparent for grain cultivation to have spread from the Korean Peninsula to northern Kyushu and the Chugoku region. (by Author).

### 2.3. First Expansion

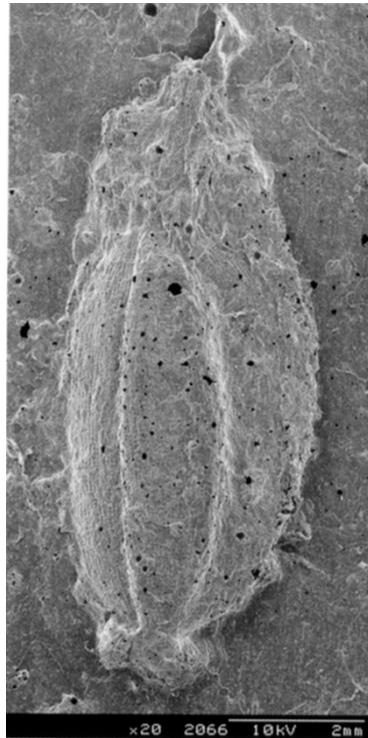
Evidence for Japan's oldest rice is the impression of rice plants on pottery excavated from the Itaya III site in Shimane Prefecture (Figure 4) [11]. This evidence has been dated to the 11th century BC, at the end of the Jomon period. Contemporaneous harvesting tools (stone reaping knives) for gathering rice ears have also been found at the Nukigawa site in Kitakyushu-shi, Fukuoka Prefecture (Figure 5) [12]. This evidence indicates that rice was present, but it is not clear that rice was being cultivated. However, even if Jomon people grew rice, they did not subsist mainly on rice production. Since then, no evidence of the spread of rice cultivation has been found in this area. Rice cultivation in this area was not generalized until the early Yayoi period, about 400 years later.

The following archaeological evidence confirms that Kyushu's interaction with the Korean Peninsula took place approximately 7000 years ago. The first is that obsidian from Koshidake Mountain, Saga Prefecture was found in the southern part of the Korean Peninsula, and the joint fishing hooks and stone harpoons for catching large fishes are widely distributed in the area from the east coast of the Korean peninsula to the west coast of Kyushu. In particular, the presence of common fishing gear in both areas indicates the possibility that there were people engaged in fishing activities in both areas, and there is no doubt that exchanges of both areas were common. Takakura Hiroaki calls this type of exchange the "fishermen's exchange" [13]. The first expansions of the 11th century BC may have been brought about through such exchanges.

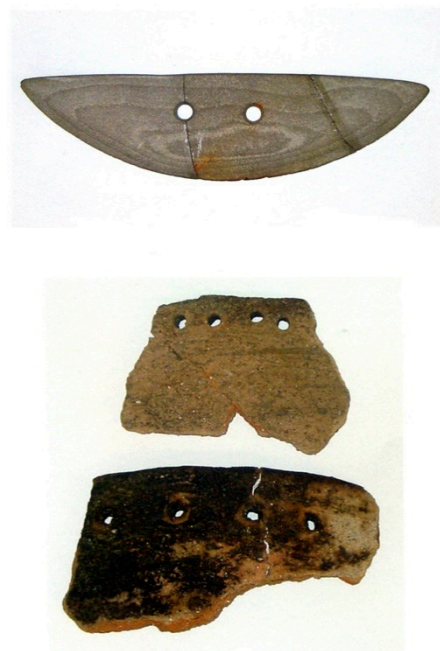
### 2.4. Second Expansion

Paddy field cultivation began during the second half of the 10th century BC, in the initial Yayoi period, along the shores of the Genkai Nada in northwestern Kyushu. The paddy field excavated at the Itazuke site in Fukuoka Prefecture was full-scale, including

irrigation facilities (Figure 6) [14]. Tools for rice cultivation were also present, such as stylized wooden farming tools, continental polished stoneware to make them, and stone reaping knives used for gathering rice ears.



**Figure 4.** Evidence of oldest rice in Japanese Archipelago revealed by the replica method provided by Tsuyoshi Ushino. The replica method investigates stamp marks by embedding a resin in a fine hole indented on the pottery surface, removal after hardening, and observation of the surface using an electron microscope.



**Figure 5.** Stone reaping knives and a series of pottery items excavated from the Nukigawa site, Fukuoka Prefecture. Provided by Kitakyushu City Buried Cultural Property Research Office.



**Figure 6.** Reconstructed picture of paddy fields and wells and drainage channels during the latter 10th century BC excavated at Itazuke Site, Fukuoka Prefecture, provided by Fukuoka City Buried Cultural Property Center.

The paddy field found in the Itazuke site is a large-scale paddy field plot with a section of more than 300 square meters. Weirs installed at 50-m intervals in the main waterways supplied paddy fields with water.

### 2.5. Each Homeland

In the southern part of the Korean Peninsula, paddy field cultivation began during the 11th century BC. Small-plot paddy fields have been found at the Ulsan Okhyun site (Figure 7) [15]. The common pattern of pottery excavated at Itaya III Site indicates that the Yeungnam area might be its home region [9]. At that time, material culture of the southern Korean Peninsula in 11th century BC included bronze swords, which had not been used before the formation of agricultural society. The social situation was unstable. Moreover, the cultural elements of the southern Korean peninsula found in western Japan are fragmentary. Therefore, it is unlikely that rice was transmitted by large-scale movements of people from the southern Korean Peninsula.



**Figure 7.** Oldest paddy field on the Korean Peninsula, Okhyun site, Ulsan, Korea. Provided by Busan University Museum.

During the 10th century BC, ditch-enclosed settlements began to appear in the Yeungnam area; an agricultural society had become established. Consequently, social contradictions became apparent. Some people who escaped from the society have been identified, who would have crossed the Korean strait to Kyushu [16].

One theory holds that, given the characteristics of small pots excavated from both areas, the origin of persons arriving from across the Korean strait was the homeland of the Nakdong River Basin. This second spread of paddy field cultivation occurred along with the spread of bronze age culture based on paddy rice cultivation, such as tools and techniques for paddy field cultivation, as well as a festival to pray for fertility. Such practices might have been imported along with the movement of large groups of people.

### 3. Interaction between Native Hunter–Gatherers and Newcomer Farmers

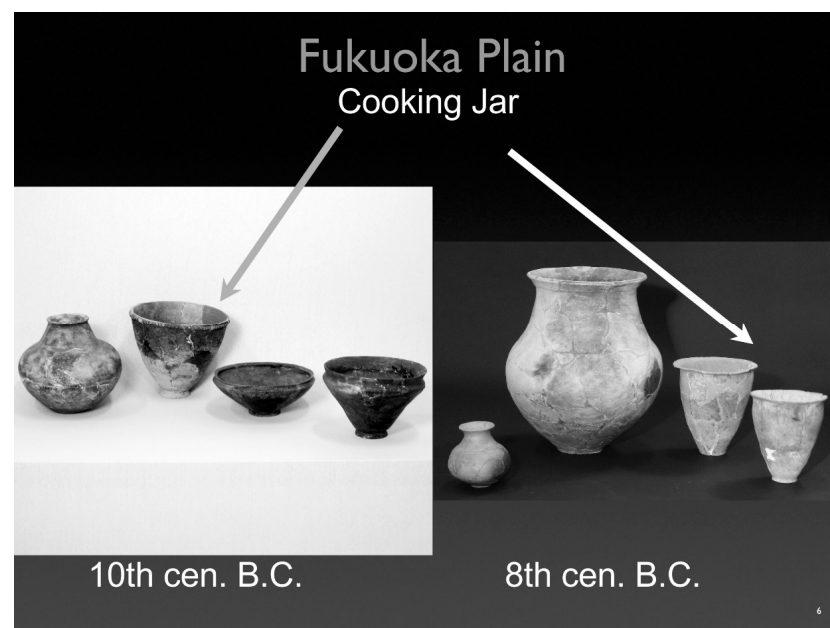
#### 3.1. Introduction

Jomon people from about 16,000 to 3000 years ago depended on gathering, fishing, hunting, and some farming for subsistence. They cultivated gourds, soybeans, and adzuki beans but not grains such as foxtail millet (*awa*, *Setaria italica*), or rice. Consequently, farming was only a component of Jomon subsistence. Farmers who came from the southern Korean Peninsula began wet rice cultivation with irrigation systems 3000 years ago in cooperation with original inhabitants of the Fukuoka Plain in northern Kyushu. Their interaction had just begun to resemble similar situations found in prehistoric Europe [17].

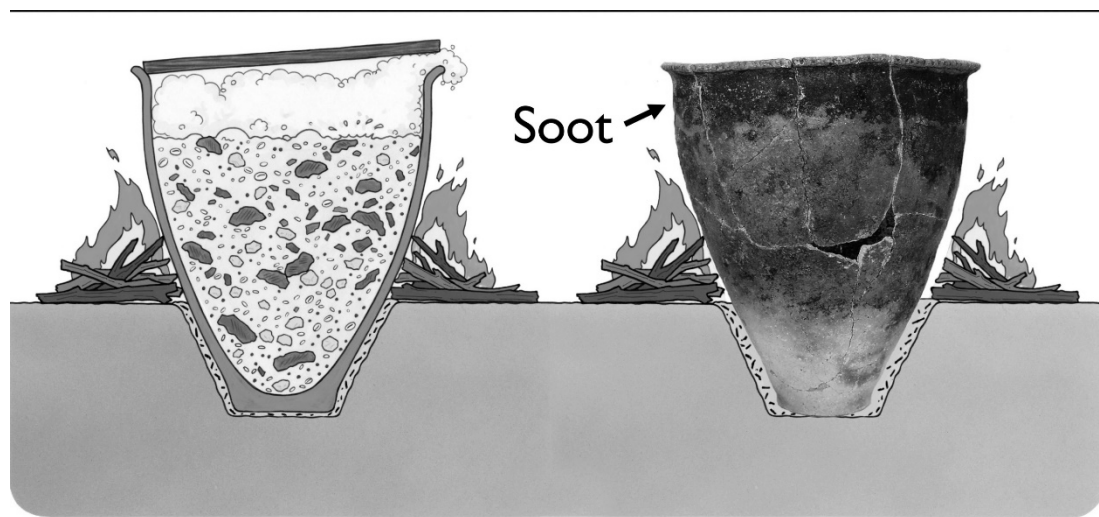
Research of the time period of interactions among these peoples has included AMS-<sup>14</sup>C analyses of the Fukuoka Plain, Osaka Plain, Ashigara Plain, and Hirosaki Plain. Based on those results, the times of interaction are known to be shorter for east and north areas. The reason for this phenomenon must be discussed.

#### 3.2. Analysis

In Figure 8, the left panel portrays a set of pottery used by a farmer who began working on the Fukuoka Plain in the 10th century BC (Figure 8 left). The right panel depicts a set of pottery used by a farmer 200 years later in the 8th century BC (Figure 8 right). Cooking pots came to show a new form and style through cultural interaction. Moreover, one can ascertain the time of interaction and when such jars were used through <sup>14</sup>C analysis of soot adhering to the cooking pot surface, as shown in the left and right panels of Figure 9.



**Figure 8.** (Left), Set of pottery used by a farmer during earliest farming on the Fukuoka Plain in the 10th century BC; (Right), Set of pottery used by a farmer 200 years later during the 8th century BC. (photograph by Fujio).



**Figure 9.** Schematic diagram of cooking in the early Yayoi period and the attachment of soot. (referred from Fujio) By carbon-14 dating of the soot which collected on the surface of the pottery during cooking, one can ascertain the age during which the pottery was used [18].

### 3.3. Northern Kyushu

Figure 10 portrays the distribution of sites on the Sawara Plain and Fukuoka Plain at the end of the final Jomon period in the 11th century BC [19]. Sites are rarely found in downstream basins on the plain. They are distributed in the middle and upper reaches of rivers. Native hunters and gatherers lived at sites in middle and upstream areas suitable for collecting nuts, fishing, and hunting, preferring these areas to the downstream basins.

Figure 11 presents the distribution of sites in the same region in the second half of the latter of 10th BC, when paddy field cultivation began [19]. The archaeological remains of paddy field farmers appeared in the downstream basin on the plain, where few archaeological sites had been identified to that time. For farmers, the downstream basin on the plains was a convenient place for paddy rice cultivation. *Sumiwake*, so-called habitat segregation, had begun.

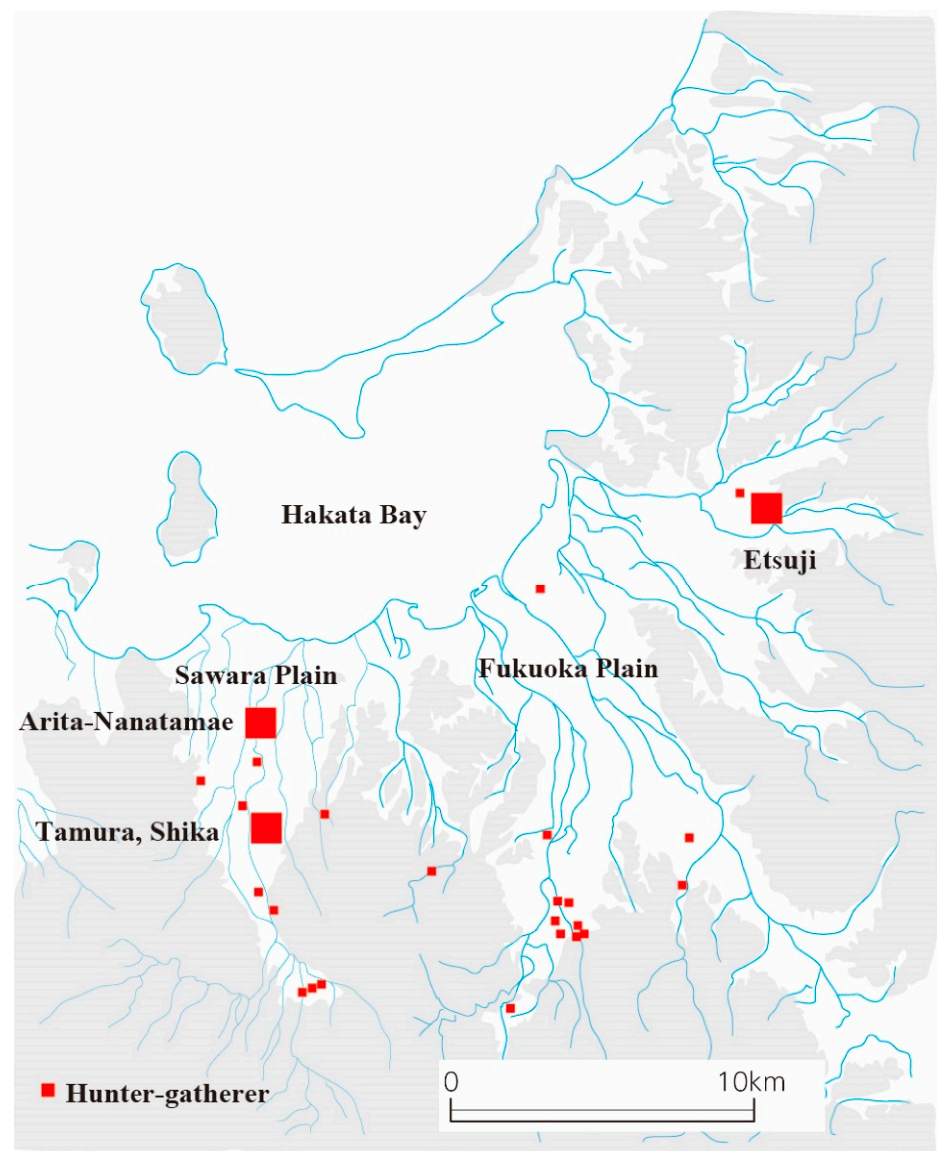
In the Sawara Plain, numerous rice paddy farmers' settlements appear in the downstream region. Even in the Fukuoka Plain, numerous rice paddy farmers' settlements have appeared.

Circumstances leading to this situation are explained below [20].

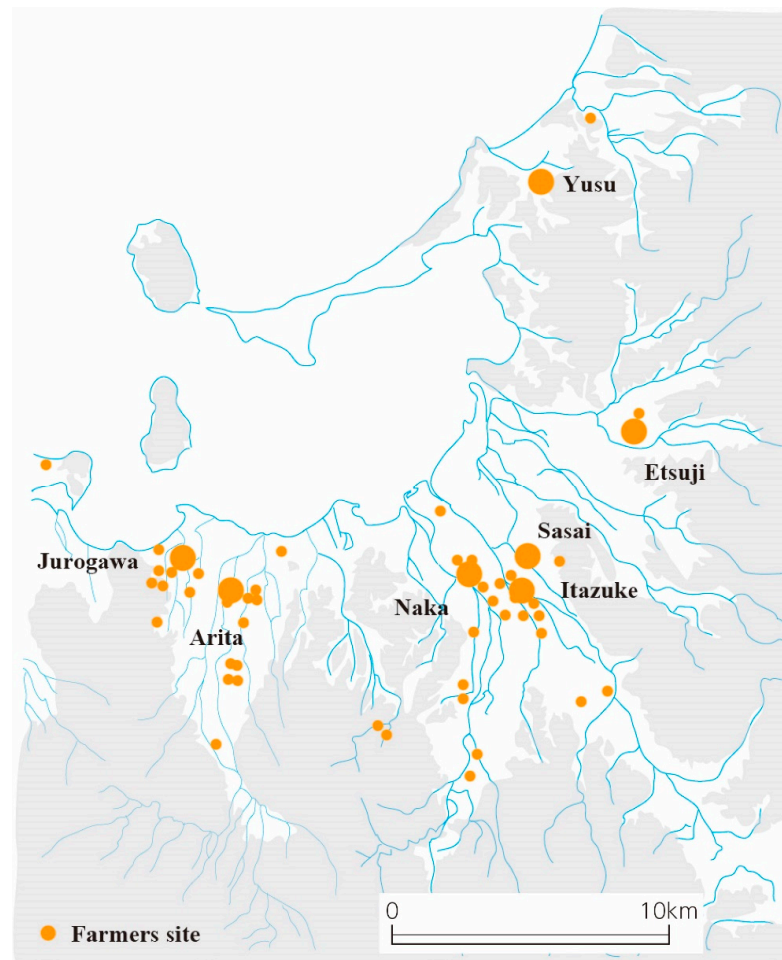
The first farmers, as newcomers, developed paddy fields in downstream basins on the plains that had been used only slightly by the indigenous hunter-gatherers. Because the latter cultivated beans and other crops, collected nuts, and hunted in middle and upstream areas, the former settled there peacefully with few conflicts of interest. However, they did have mutual relations. Apparently, farmers were unable to cultivate wet rice independently. For example, without help from indigenous hunter-gatherers familiar with the land, they would have been unable to gain knowledge about rare raw materials: hard stone that might be processed for use as axes to cut down trees and hard oak trees with wood suitable for crafting wooden farming tools. The indigenous hunter-gatherers might have also been valuable for marriage and as laborers necessary to grow wet rice.

The farmers were also valuable for indigenous hunter-gatherers. Farmers offered food such as rice in exchange for information about local rare materials, as well as cultivation knowledge and social opportunities. These groups might therefore be regarded as interdependent. About 250 years passed from the start of farming to their interaction, which ended when hunter-gatherers themselves became farmers.





**Figure 10.** Distribution of sites at the end of final Jomon period in the Sawara Plain and Fukuoka Plain [19] (by Author). The Tamura and Shika sites are indigenous hunter–gatherer villages that have persisted since the late Jomon period. They are located in the middle reaches of the Sawara Plain. The Arita Nanatamae Site, which appears at the end of the final Jomon period, is located in the downstream area. It persisted in the initial Yayoi period. No site was found in the lower reaches of the Fukuoka Plain. The sites are located only in the upper and middle reaches.



**Figure 11.** Distribution of initial Yayoi period sites in the Sawara Plain and Fukuoka Plain [19] (by Author).

### 3.4. Osaka Plain

On the Osaka Plain, farmer settlement occurred on the banks of Old Kawachi lagoon, whereas hunter–gatherer settlements were located on the upper and middle plains and hill-sides in the 6th century BC to 5th century BC [21]. Their mutual interaction for 150 years has been ascertained from the character of pottery used by farmers and hunter–gatherers [22].

Reportedly, the Sanuki region in the northeastern part of Shikoku brought paddy field cultivation to coastal areas of Osaka Bay. Large amounts of Sanukite from the Sanuki region have been excavated from sites on the coast of Osaka Bay at the beginning of the Yayoi period [23].

### 3.5. Ashigara Plain in Kanagawa Prefecture, West of Kanto District

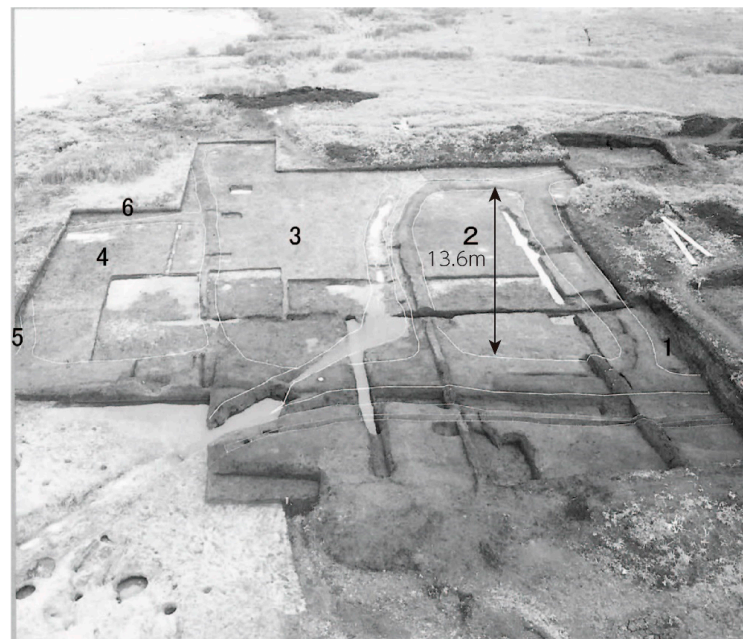
At Ashigara Plain in Kanagawa Prefecture, west of Kanto District, Jomon people had been cultivating foxtail millet, etc., in the upper and lower reaches of the river for about 500 years. Around 250 BC, paddy field cultivation suddenly began along the lower reaches of the river. Paddy field farmers set up paddy fields in the lower reaches of the plains, where no hunter–gatherers lived [19]. The farmers created ditch-enclosed settlements and built burial mounds surrounded by square moats (Figure 12). Because their pottery has been found in western Japan, it is believed that paddy field farmers immigrated from the west. Their interaction continued for 30–50 years [24]. The *Sumiwake* is shown between the lower plain and hillside.



**Figure 12.** Ditch-enclosed settlement with a pit dwelling and a burial mound surrounded by a square moat excavated at the Nakazato site, which appeared during the third century BC. Provided by Tamagawa Cultural Property Research Institute.

### 3.6. Northern Tohoku District

On the Tsugaru Plain in Aomori prefecture, in the northern part of Tohoku district, the northernmost paddy field, at 40° N latitude, was discovered at the Sunazawa site, Hirosaki-shi, Aomori Prefecture (Figure 13).



**Figure 13.** Oldest paddy field in the Tohoku region: Sunazawa site. Provided by the Hirosaki City Board of Education. There were seven large-scale paddy fields discovered at the Sunazawa site, which has no irrigation facility. The water flows naturally downward. The long axis of No. 2 paddy field is about 13.6 m.

Jomon people began wet rice cultivation with independently operated irrigation systems in the 4th century BC. Sunazawa people fundamentally used paddy field cultivation with traditional stone tools from the final Jomon period. They also continued traditional

festivals using clay figurines, stone rods, and other materials. Paddy field farmers using these Jomon-origin festival tools resided only in Aomori prefecture.

Phytolith analysis results suggest that wet rice cultivation was conducted at the Sunazawa site for 12–13 years. Wet rice farming was practiced in this region for approximately 300 years thereafter. However, the paddy fields were eventually inundated and ruined because of the falling temperatures and flooding which occurred approximately in the 1st century BC [25]. Farmers subsequently returned to hunting and gathering without resuming wet rice cultivation. Not until ancient, but more recent, times did grain cultivation recommence in this region [19]. The Epi-Jomon culture would therefore continue without establishing agricultural society, let alone a transition to the Kofun period.

### 3.7. Discussion

As described above for these four regions, the processes extending from the beginning of paddy field cultivation to the establishment of a fully agricultural society are readily apparent [23]. The duration of the transition was shorter in eastern regions. The analytical results also revealed that, likely as a result of climatic changes, some people resumed their original hunting and gathering life after ceasing the wet rice farming practices that they had used continuously for approximately 300 years. The models presented below illustrate the durations of interaction (Table 1) [24].

- (A) 250 years, e.g., Fukuoka Plain.
- (B) 150 years, e.g., Osaka Plain, probably western Japan.
- (C) 20–50 years, e.g., Kanto Plain, probably eastern Japan.
- (D) Native hunter-gatherers started wet rice cultivation independently without any new arrival of plant farmers. They passed down Jomon festivals. No mutual exchange occurred. They resumed hunting and gathering after approximately 300 years.

**Table 1.** Durations of interaction.

Model	Duration of Interaction	Newcomers	Example
A	250 years	Korean Peninsula	Northern Kyushu
B	150	e.g., Sanuki	Osaka Bay area
C	30–50	e.g., Harima, Mikawa	Eastern Japan
D	0	0	Northern Tohoku

Carbon-14 dating of soot on the surface of cooking utensils found at the oldest paddy field site in the four regions supports the following hypothesis: Although immigrants spread from Kyushu to Honshu, excluding northern Tohoku, the period of interactions between natives and immigrants became shorter as they advanced to the east. Native hunter-gatherers came to dominate smaller areas as the introduction of wet rice farming moved eastward. People from the Korean Peninsula brought wet rice farming into northern Kyushu, not only as an occupation and method of sustenance, but as a cultural complex including social and ritual systems with wet rice cultivation as the productive base.

Establishment took 250 years presumably because of the considerable time necessary for adaptation of wet rice cultivation, which was the production base for the Bronze Age culture of the Korean Peninsula, to environmental conditions prevailing in northern Kyushu. In other words, most hunter-gatherers in northern Kyushu might have taken time to convert wet rice cultivation from the Korean Peninsula into the Yayoi rice farming appropriate for the ecosystems and daytime lengths of northern Kyushu. This adaptation represents the creation of the Yayoi wet rice farming.

Why, then, did the period of interaction decrease as the trend moved to the eastern regions? First, acceptance of the system based on wet rice cultivation, of which the conversion to the Yayoi system had been completed in northern Kyushu, was likely to have been easier for people of Osaka Bay coastal areas, where the natural environment, ecosystems, and culture resembled those of northern Kyushu. The reason for the shorter

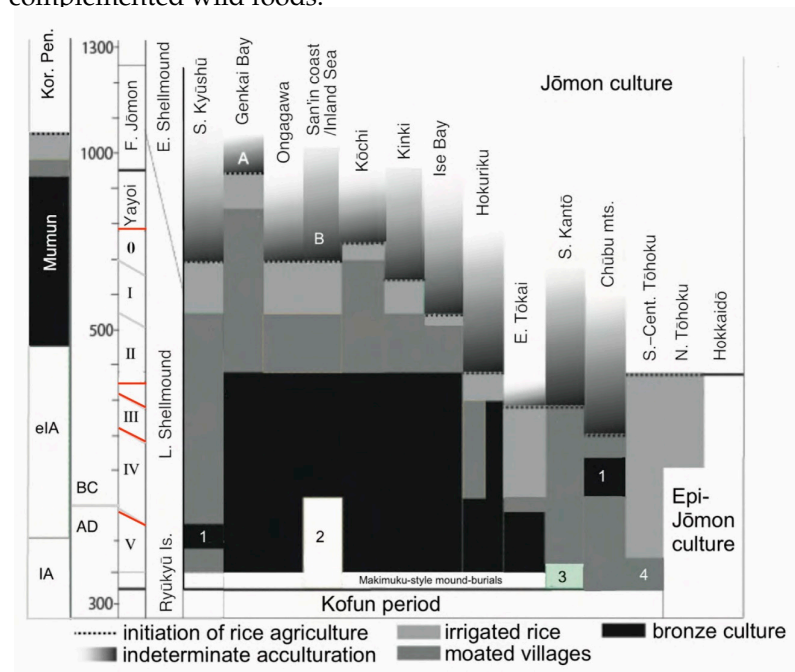
periods required by people in the regions other than northern Kyushu might have been that they had accepted the Japanese archipelago version of Yayoi farming that had been created in northern Kyushu [26].

The first people to bring wet rice cultivation into the Ashigara Plain in southern Kanto were purportedly wet rice farmers who had migrated from western Japan, as suggested by the introduction of cooking earthenware from the western region. In other words, wet rice cultivation was started by migrants from western Japan, rather than by indigenous hunter-gatherers. Moated settlements and square-moated burial precincts suggest rapid formation of agricultural society, which was achieved through the efforts of such migrants.

The last region is northern Tohoku. The local people resumed their original hunting and gathering life after relinquishing agriculture, which had served them for approximately 300 years from the start. That reversion occurred because they accepted wet-rice farming into their comprehensive work structure maintained since the Jomon period, but only as a part-time livelihood. If paddy fields were buried by severe flooding, such as that which occurred before the 1st century BC, then the people would not have had such severe difficulty in abandoning wet rice farming for alternative resources: it was merely one of several occupations on which they relied for subsistence. It was fortunate that they had adopted wet rice cultivation while maintaining labor organization and clay figure festivals and other rituals continuously since the Jomon period.

#### 4. Conclusions: Early Grain Cultivation and the Starting Process

Two groups of farmers resided on Honshu, Shikoku, and Kyushu islands: those who started wet rice cultivation and those who started millet cultivation [19]. Hunter-gatherers of northern Kyushu and northern Tohoku first began wet rice cultivation (Figure 14). However, hunter-gatherers in other areas first began millet cultivation and subsequently switched to wet rice cultivation several hundred years later. Hunter-gatherers of the latter areas started paddy rice cultivation after cultivating foxtail millet and broomcorn millet (*Panicum* spp.) for about 300–500 years (Figure 14) as a means of subsistence that complemented wild foods.



**Figure 14.** Regional distribution of the three elements of Yayoi culture: 1, bronze cache (Cache is designed to hold a bronze sword or a bronze bell-shaped vessel in soil until it is time to be spent next.); 2, withdrawal from bronze culture; 3, small bronze bell; and 4, burial mound surrounded by square moat. Japanese version provided by [19] (Fuji 2013: Figure 80) English version provided by Gina Barnes [27].

Komoto designated such a subsistence structure as comprehensive and regarded it as a generalized subsistence strategy of Jomon society [28]. However, paddy field farmers in northern Kyushu also collected, hunted, and fished, yet subsisted mainly on paddy field cultivation. Komoto designated this as a selective subsistence structure and regarded it as the representative subsistence structure of Yayoi society.

People who grew foxtail millet (awa) and broomcorn millet in the Jomon-like occupational structure crafted Jomon culture-specific festival tools such as clay figurines and stone rods. By contrast, paddy field farmers practicing selective subsistence had no clay figurines or stone rods. This important difference signifies that Jomon-like rituals are compatible with millet cultivation in the comprehensive occupation structure, but not with paddy field cultivation in the selective occupation structure. The rice prayer festival and the clay figurines and stone rod rituals might be completely different. Wet rice farmers in Aomori Prefecture used clay figurines probably because they used paddy field cultivation under a comprehensive subsistence structure.

The period from the start of millet cultivation to the start of irrigated paddy rice cultivation is designated as one of indeterminate acculturation. At this stage, neither Jomon nor Yayoi culture predominated. The transition period was short in areas where paddy field farmers might have migrated, as in northern Kyushu, and longer in areas where native hunter-gatherer and hunting people started with millet, as in western and eastern Japan. The length of the transition period increases with distance to the east, with that in Chubu and southern Kanto region lasting as long as 500 years. Figure 14 illustrates that the transitional period length varies among regions.

The next subject is the process that took place after adopting wet rice cultivation. There are four patterns that have been developed from the lengths of period between the introduction and dissemination of wet-rice farming in the regions. The analysis revealed that the period became shorter as the introduction of wet rice farming moved eastward, i.e., approximately 250 years in northern Kyushu, approximately 150 years in Kinki, and 20–30 years in southern Kanto. Only the hunter-gatherers in northern Tohoku resumed hunting and gathering after practicing wet rice farming for approximately 300 years. Thus, pre-existing conditions of subsistence structure are demonstrated to have a clear and predictable influence upon the adoption, retention, and intensification of wet paddy agriculture in the Japanese Archipelago.

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