

How did agriculture spread? — case studies from Japan —

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INTRODUCTION

Beginning of agriculture has become one of the puzzling themes in the disciplines of anthropology and archaeology. While more than thirty hypotheses have been proposed and hotly debated as to how and why agriculture began for more than half a century, no satisfactory conclusion has been established yet. At the same time, the theme on “the spread” of agriculture has been as puzzling as those of origins. If hunting and gathering way of life was much easier than that of the agriculturists (Lee and Devore 1968), why the former accepted the latter? Indeed, when Richard Lee asked one of the !Kung as to why they did not accept agriculture, he replied that why they should begin food production since there were plenty of mongongo nuts available (Lee 1968). This conversation implies that foragers do not become farmers easily. Why agriculture spread into the regions where hunter-gatherer inhabited? Two explanations have been proposed: cultural diffusion and demic diffusion, latter meaning actual migration of farmers in to the forager land who likely replaced hunter-gatherer population (Bellwood 2004) .

The Primorye region in Far Eastern Russia is of course not the primary center of the origin of agriculture. The archaeological research conducted by Japanese and Russian team between 2002 and 2006 successfully recovered millets from the Krounovka 1 site, dating 4600BP, revealing that transition from hunting and gathering to agriculture likely took place by that time (Sergusheva 2004). The next question to be asked is, naturally, how it spread into this region. Was it due to cultural or demic diffusion? Vostretsov would like to support the demic diffusion (2006 Pers. Comm.). While possibility of cultural diffusion should not be excluded, I would like to focus on two types of demic diffusion in this paper based on the data from Japan. One is actual movement of farmers into forager land; the other is introduction of agriculture by acculturated forager who accepted agriculture and then moved to a forager region. In both cases, original inhabitants seemed to be replaced by new comers, or at least the foragers became minority. While the second case is extremely important, this phenomenon does not appear to be realized widely. These data are significant in order to understand the beginning of food production in the Primorye region.

DEMIC DIFFUSION: Case study 1

The beginning of agriculture in the Okinawa archipelago seems to be an excellent example of demic diffusion. The archipelago is located approximately 600 km south of Kyushu island, where agriculture was introduced from Korean peninsula at the beginning of the Yayoi or earlier period. The beginning of agriculture in Okinawa has been also one of the anxiously debated themes among

the Okinawan archaeologists. Hiroe Takamiya (1986), for example, speculated that Yayoi agriculture might have diffused into the region since at that time the Yayoi culture was thought to have spread into the Amami archipelago, only about two hundred kilometers north of Okinawa. It should be mentioned that one of the bases of this speculation was the fact that the Okinawan population was heavily involved in the long distance exchange system with the Yayoi agriculture based chiefdom societies in the mainland Japan. Thus this speculation seemed to be plausible.

However, paleoethnobotanical studies since 1992 have clarified the following results. Firstly, the earliest evidence of agriculture comes from the Nazakibaru site dated AD 8 / 9th to 10th century. The site yielded small number of rice, wheat, burley, and weed seeds. The site also unearthed more than 250 hoe marks and two lines of ditches, which were interpreted as agriculture related features. If the dating of the Nazakibaru site is acceptable, agriculture began suddenly. All recovered dietary plant remains belong to cultigens with no nuts remains. Although it was once thought that the Nazakibaru agriculture was basis for the Gusuku agriculture, now it seems that this agriculture was not the foundation for the Gusuku agriculture (Takamiya 2005). In this case, the Gusuku agriculture began somewhere between the AD10th and 12th century, just before the beginning of this period. Second, the Gusuku agriculture seems to have begun abruptly. Thirdly, the prehistoric (pre Gusuku) sites contained only wild plant remains such as nuts, nut shells, and wild grapes, except the remains recovered from the Nazakibaru site.

Since the Nazakibaru data indicate ephemeral presence of agriculture, I would focus on the Gusuku agriculture in this paper. It was known, prior to the introduction of flotation method to the Gusuku sites, that the subsistence economy of this period was agriculture. Many Gusuku sites yielded remains of wheat, barley and rice (Asato 1985). With the introduction of flotation, small sized cultigens such as broomcorn and foxtail millets have been collected in addition to the large ones mentioned above. An intensive agriculture system was well established here during the Gusuku period. How did agriculture spread into the islands?

One of the reasons I decided to conduct research in this region was that I believed I could test two popular hypotheses on the spread of agriculture during the 1990s, population pressure and competitive feasting, using data from Okinawa. Shortly after I began to work there, I realized that archaeological data did not support neither hypotheses. Thus, a new hypothesis was necessary in order to explain the transition from forager economy to farmer economy.

In case of Okinawa, the key word to understand the development of agriculture is that it began "suddenly". Why did agriculture begin suddenly? Two lines of evidence provide possible explanation for the suddenness. One is linguistic data. Linguists have early on noticed similarity between Old Japanese and Okinawan dialect, although the latter is incomprehensible to the mainland Japanese today (Hokama 1977). According to Hattori (1998), Japanese dialects and Okinawan dialects are closely related to each other. Hattori (1998) believes that Okinawan dialects diverged from Old Japanese around 1400 years ago. Hokama (1977) also believes that this process (divergence) took place somewhere between AD 3rd and 7th century (also Hudson 1994). While many linguists believe that this process must have taken place prior to the Nara period, there is a possibility that the Okinawan dialects diverged from Japanese after that period. We must examine

this possibility in the near future.

In addition to the linguistic data, osteological data provide some clues to understand why agriculture began abruptly. Firstly, Doi Naomi of the Ryukyu University has been intensively working on the Gusuku and Recent human skeletal remains since early 1990s. Gusuku population were ancestors of the Recent population who were in turn direct ancestors of the Modern Okinawan population. Probably she is the first researcher who realized the importance of these materials. Her intensive studies on Gusuku and Recent populations have resulted in the finding of extremely valuable data. Morphologically, there is sharp differences between the prehistoric (ie. Jomon and Early Yayoi-Heian population) and the Gusuku and Recent populations. According to Doi, the former population is characterized by short, fragile, and round headed. On the other hand, the latter populations are characterized by tall, robust, and long headed (Asato and Doi 1999) . How did this change took place?

Furthermore, Dodo(1993) analyzed non-metric traits of Jomon, Ainu, Recent Okinawan, several Yayoi and historical populations, other East Asian populations, and some native American groups. The result is shown in Fig. 1. Two points are of extreme importance. First, the Jomon and Ainu populations cluster together. This point is expected since the dual population model, an influential model proposed by Hanihara predicted so (Hanihara 1993) . Hanihara (1993) believed that Japanese population today consists of two large groupes: immigrant Yayoi and their descendants on one hand, and Jomon, Ainu, and Okinawan populations on the other. However, as seen Fig. 1, Okinawan population is not grouped together with the Jomon and Ainu populations. The result demonstrates that Okinawan population is closely related to migrant Yayoi and their descendants. This was an unexpected result. Dodo (1993) result has given a new dimension on the origins of Modern Okinawans.

Several years later, Pietrusewsky (1997) published a stimulating paper on the origins of Japanese. He is a well known osteologist and has intensively worked on the human skeletal remains from Southeast Asia and Oceania. During the 1990' s, he added Japanese data into his enormous data collection. His Japanese data include six Okinawan populations, eight immigrant Yayoi and their descendants populations in addition to Jomon and Ainu populations. Contrary to Dodo's approach, his analysis was based on metric data. The result is shown in Fig. 2. Here again Jomon and Ainu are clustered together, but Okinawan population is not. The Okinawan groups including Amami) are tightly related. Then they are closely related to the mainland Japanese and their ancestors, the immigrant Yayoi. The result again indicate close relationships Okinawan population to the immigrant Yayoi and their descendants; not Jomon and Ainu populations.

To summarize, 1) the Okinawan dialects are closely related to the Old Japanese; the former probably derived from the latter sometime during the Yayoi-Heian period. 2) The prehistoric Okinawan and Gusuku populations as well as their descendants are morphologically very distinctive. 3) The Recent Okinawan population is closely related to the immigrant Yayoi and their descendants, not Jomon and Ainu. 4) Agriculture began in Okinawa suddenly. How to explain these pieces of information? The simplest explanation seems to be migration of farmers who were physically tall, robust, and long headed and spoke Old Japanese into the region. Thus, the Okinawan

case appear to be a good example of demic diffusion.

DEMIC DIFFUSION: Case study 2

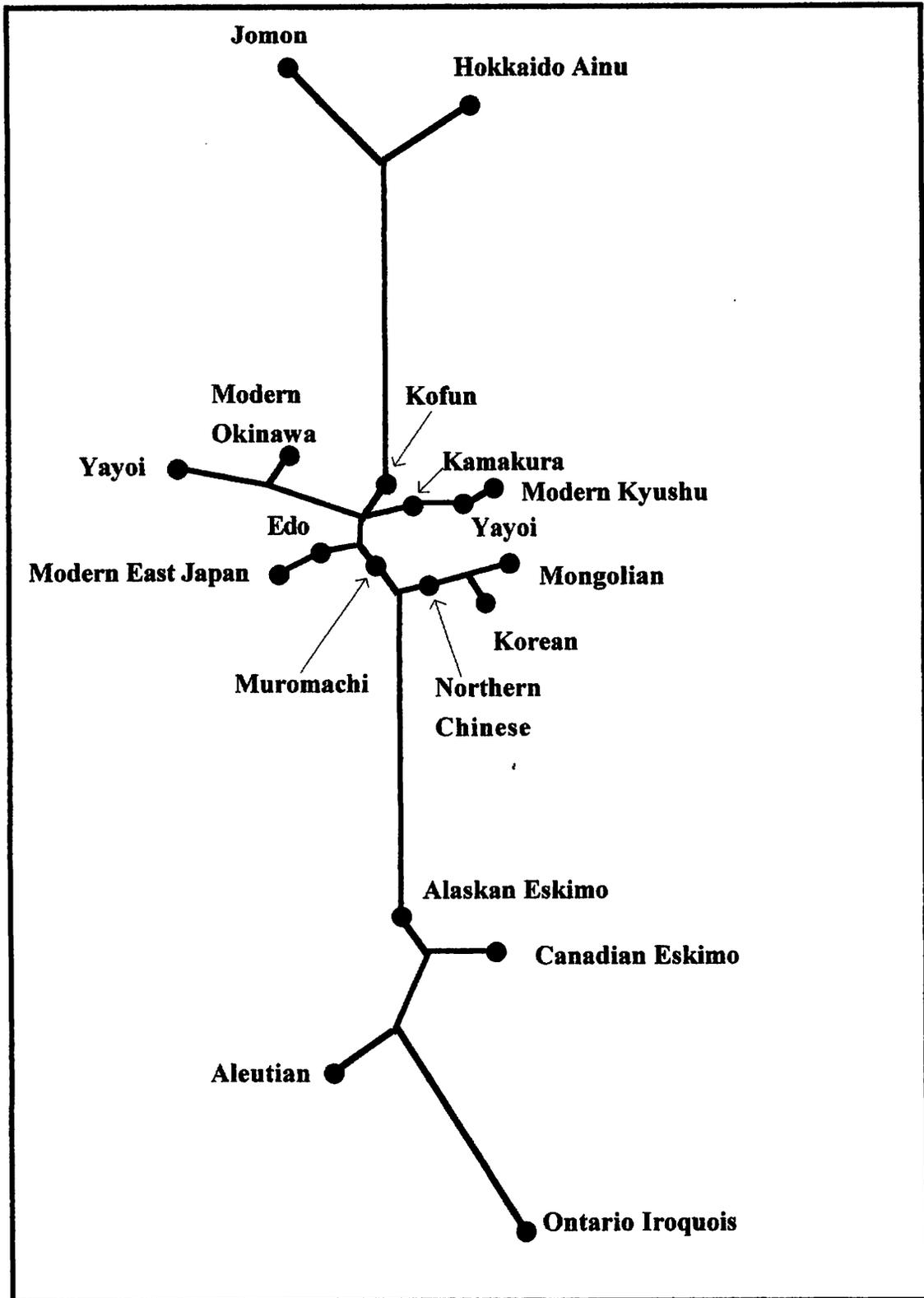
Until recently, Hokkaido was thought as a home land of hunter-gatherers. However, it was known that some Satsumon sites, such as the Nishitsukigaoka and Toyotomi sites fortuitously had yielded cultigens (Kohno 1959; Iwasaki 1966). During the 1980's flotation method was applied to the Sakushu Kotoni River site. The site is located on Hokkaido University campus in Sapporo city and belonged to the Satsumon period (Crawford 1986). The consequence of application of flotation was astonishing. Not only at least 11 types of cultigens were recovered but also these cultigens comprised about 186,000 out of 200,000 total seeds identified. That is, more than 90 % of recovered seeds were cultigens. This finding implied that the Satsumon people were not foragers but farmers and heavily relied on cultigens.

Since the findings of the Sakushu Kotoni River site, Hokkaido archaeologists have attempted to recover plant remains. As a result of application of flotation method, it is now understood that the subsistence economy of the Satsumon period was based on non-rice cultigens, namely, barley, wheat, foxtail millet, broomcorn millet, and barnyard millet. Nearly 93% of recovered cultigens from the Sakushu Kotoni River site consisted of these cultigens. Rice was extremely rare (Crawford 1986). This agriculture system spread quickly almost all over Hokkaido briefly after the introduction of this new economic system. For example, the Satsumon sites are found the Okhotsk sea coast region, far northeastern part of Hokkaido within several hundred years after food production was introduced (Crawford and Takamiya 1990). This rapid expansion of the Satsumon sites in Hokkaido implies rapid population growth during this period. This in turn suggests that the Satsumon agriculture system based on non-rice cultigens was extremely successful.

What about a subsistence economy of the Zoku Jomon, just preceding the Satsumon? The subsistence system of the Zoku Jomon, appears to be hunting and gathering. For example, the K135-4 chome and K135-5 chome sites in Sapporo city yielded mainly nuts remains. Only one barley and wall barley were recovered. Crawford and Takamiya (1990) write while the Zoku Jomon people knew of the presence of cultigens, their subsistence economy was mainly based on hunting and gathering. Cultigens were probably obtained by exchange with farming population in Honshu. Thus transition from foraging to farming took place somewhere between the Zoku Jomon and Satsumon periods.

However, the series of palaeoethnobotanical studies have revealed that the economic change took place not gradually but abruptly. Furthermore, agriculture began not during the Zoku Jomon period but between the Zoku Jomon and Satsumon periods. In case of Hokkaido, in addition to archaeobotanical data, other archaeological data also appear to demonstrate sudden change. For example, the house structure of this period, characterized by semi-subterranean and rectangular shapes with one or sometimes two ovens, is very distinctive from that of the Zoku Jomon period. Furthermore, pottery manufactured from the Jomon to Zoku Jomon seems to be continuous, even to a lay person, but suddenly changes between the Zoku Jomon and Satsumon, suggesting discontinuity in pottery manufacture technology between these periods. In short, the Satsumon

**Relationship of Modern Okinawans with 14 other groups:
non-metric data (simplified from Dodo 1993)**



period brought to Hokkaido “an entirely new technology and subsistence system. The change appear to be sudden … (Crawford and Takamiya 1990: 908)”. Here again, the transition from foraging to farming was sudden. Was it due to demic diffusion or cultural diffusion? Kudo (2000) considers cultural diffusion was the cause. Both Dodo (1993) and Pietresewsky’s (1997) results (Fig. 1, 2) demonstrate that the Ainu population is closely related to Jomon people. Furthermore, unlike Okinawan case, Ainu language is not related to Japanese but probably Emishi language (Kudo 2000; Hudson 1994). These pieces of information seem to support cultural diffusion. However, the beginning of agriculture in Hokkaido appear to be more complex than the merely cultural diffusion. In order to understand agriculture origin in Hokkaido, it is necessary to review beginning of food production in northern Tohoku.

In northern Tohoku, rice was cultivated during the Yayoi and even earlier period as seen from the findings of actual rice paddy fields at the Tareyanagi and Sunazawa sites (Kudo 2000) as well as rice grains from the Kazahari site (D’ Andrea 1992). However, rice agriculture was not successful in this region. Indeed, prior to AD 7 th and 8 th centuries, the Zoku Jomon culture distributed in this region. Meanwhile, after AD 6 th to 7 th centuries, the chiefdom like Yamato state was expanding to Tohoku region. By the late AD 7 th century, Haji pottery and final stage of Kofun appeared in the northern Tohoku region (Crawford and Takamiya 1990; Kudo 2000). Several decades later, Haji villages were established in this region. These villages were associated with the rectangular, semi-subterranean houses with ovens (Kudo 2000). The house structure is identical to the Satsumon house structure mentioned above. Furthermore, according to Kudo (2000:205), it is difficult to distinguish not only pottery types between northern Tohoku and Hokkaido, but also between cultures of these regions. In other words, the cultures distributed in these two regions were almost identical. Then what about subsistence economy of northern Tohoku? Miura (in Kudo 2000) states that crops grown at some northern Tohoku villages were not rice but millets. In addition, D’ Andrea (1992), who applied flotation method for the first time in Aomori, recovered millets and rice. Archaeobotanical studies conducted by Yoshizaki and Tsubakisaka (1990;1998) successfully recovered not only rice but also millets. Crawford (2006) feels that northern Tohoku population selected dry field agriculture by this time.

Crawford and Takamiya (1990) once suggested that this dry field agriculture system in northern Tohoku probably developed through intensive cultural contact between wet rice Japanese and local population in southern Tohoku, known as the Emishi. During the Kofun period, it is known that Kofun burial practice spread into southern Tohoku soon after it appeared in western Japan (Kudo 2000). Soon after the spread, the contact between the Japanese and the local population took place. At the beginning, this contact appears to be peaceful one. For example, during AD 655, the Court invited about 200 Emishi to Naniwa to entertain them. This kind of invitations were recorded several times (Kudo 2000). According to Kudo (2000), prior to the Taika Reform, the state aggressively attempted to make contact with the Emishi; at the same time, some Emishi apparently wanted to make contact with the Japanese. This contact probably provided an opportunity for the Emishi to know presence of wet rice agriculture systems and some might have been acculturated during this peaceful period.

Shortly after this peaceful relationship, the Nara period Japanese continued to expand into Tohoku region. This expansion caused great resistance by the local people, and the Tohoku region witnessed the period of upheaval (Crawford and Takamiya 1990; Kudo 2000). The Emishi were either assimilated or killed if they opposed the Japanese. In addition to military expansion, non-military Japanese immigrated into regions where the state successfully expanded. In such regions, both assimilated Emishi and non-military Japanese lived side by side. Kudo (2000) speculates that there must have been conflicts between the Emishi and Japanese. Thus, the Tohoku region was, in other words, the regions where the native people were acculturated. Those local population who were oppressed must have fled from the Japanese government to further north. Kudo (2000) states that some farmers must have migrated further north. Having studied Tohoku situation, Crawford and Takamiya (1990: 898) conclude “by AD 800, the indigenous Ezo (Emishi) appear to have been extirpated in Tohoku (Takakura 1960) – assimilated into Japanese society in Tohoku and/or killed but there is evidence of emigration of this population to Hokkaido at the end of the Zoku Jomon.” These pieces of information implies that the Satsumon agriculture was most likely introduced by these acculturated Emishi. Therefore, the archaeological data indicate similarities between northern Tohoku and Satsumon. This hypothesis seems to best explain suddenness of the beginning of food production in Hokkaido, the osteological similarities between the Jomon and Ainu, and presence of Ainu language. In case of agriculture origin in Hokkaido, it seems that cultural diffusion took place in southern Tohoku first, then demic diffusion followed into this northern island.

CONCLUSIONS

The spread of agriculture is as important theme as the origins of agriculture in anthropological archaeology. In Japan, rice centered agriculture was introduced during the Yayoi (or more precisely shortly prior to this period). This new economic system spread into the north and south. Hokkaido and Okinawa were the last regions in the archipelago where this subsistence change from foraging to farming took place. This paper examined how agriculture spread into these regions. In Okinawa, it had been believed that cultural diffusion was the main cause of agriculture origin. However, paleoethnobotanical studies have demonstrated that agriculture began suddenly in this region. Furthermore, osteological and linguistic data imply that new population migrated to Okinawa. These pieces of evidence strongly indicate that agriculture began in this region by demic diffusion. Paleoethnobotanical studies also have revealed that food production was practiced in Hokkaido during the Satsumon period. Agriculture origin in this northernmost island is more complex than the Okinawan case. Unlike Okinawan case, Osteological data indicate closeness between Ainu and Jomon. Furthermore, linguistic date suggest Ainu language is unique in East Asia. These pieces of information strongly imply cultural diffusion. However, brief review of agriculture origin in Tohoku area provides a possibility of demic diffusion. In this case, the Emishi in Tohoku region were acculturated by the Japanese influence, and agriculture was introduced into Hokkaido by the migration of these acculturated Emishi.

Recent archaeological research by the Japanese and Russian team have revealed that food production was practiced in the Primorye region by 4600 BP. The question as to how and why

agriculture began in this region is the next theme to be examined. Was it due to cultural diffusion? Or did actual migration of farmers introduced agriculture? If the latter is the case, two possibilities should be considered. First is direct migration of farmers like Okinawan case. Second is the migration of acculturated foragers who accepted agriculture into new land like Hokkaido case. When scholars discuss about demic diffusion, they tend to focus on the first possibility (eg. Bellwood 2004; Ammerman and Biagi 2003). However, the regions like Primorye, the second possibility should be also considered.

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