

# The spread of rice agriculture during the Yayoi Period: From the Shandong Peninsula to the Japanese Archipelago via the Korean Peninsula

MIYAMOTO Kazuo<sup>1</sup>

## ABSTRACT

*According to the four phases theory of early agriculture based on the demic expansion theory, rice agriculture is said to have spread to northern Kyushu via mainland Asia. In particular, during the fourth wave of early agricultural diffusion, irrigated rice agriculture spread from southern Korea to northern Kyushu. During this fourth spread of early agriculture, two different diffusion routes from southern Korea to northern Kyushu existed between the Yusu 1 and Yusu 2 periods due to cooler climatic conditions. Evidence for these two separate routes can be seen in differences in the distribution of two kinds of burial systems and two kinds of polished stone daggers. The first spread from the Namgang River area of southern Korea to the Karatsu and Itoshima Plains in northern Kyushu during the 9<sup>th</sup> and 8<sup>th</sup> centuries BC. At the same time, tropical Japonica rice spread mainly to the Karatsu Plain from southern Korea along with rice paddies, agricultural tools and dolmens. The second spread from the lower Nakdonggang area to the Fukuoka Plain during the 7<sup>th</sup> and 6<sup>th</sup> centuries BC. At this time, a wooden coffin burial system and moated settlements appeared on the Fukuoka Plain. It is probable that temperate Japonica rice spread at this time. This is because rice seeds dating to between the 6<sup>th</sup> and 5<sup>th</sup> centuries BC discovered at Arita Site, Fukuoka City, were proven to be temperate Japonica through the DNA analysis and size variation analysis of charred rice grains. It is believed that the second wave also triggered the production of the Itazuke pottery style on the Fukuoka Plain. The Itazuke Pottery style spread to western Japan between the 6<sup>th</sup> and 5<sup>th</sup> centuries BC. This is the beginning of the Yayoi period in Japan.*

**KEYWORDS:** rice agriculture, demic expansion theory, temperate Japonica, the beginning of the Yayoi period

## 1. Introduction

I have hypothesized the existence of four stages in the development of agriculture in northeast Asia during prehistoric times based on the demic expansion theory (Figure 1) (Miyamoto 2014). Cooler climatic conditions were one of the main factors which triggered the spread of agriculture in northeast Asia. The first stage involved the spread of millet

<sup>1</sup> Faculty of Humanities, Kyushu University, 744 Moto'oka, Nishi Ward, Fukuoka 819–0395, Japan (miyamoto@lit.kyushu-u.ac.jp)

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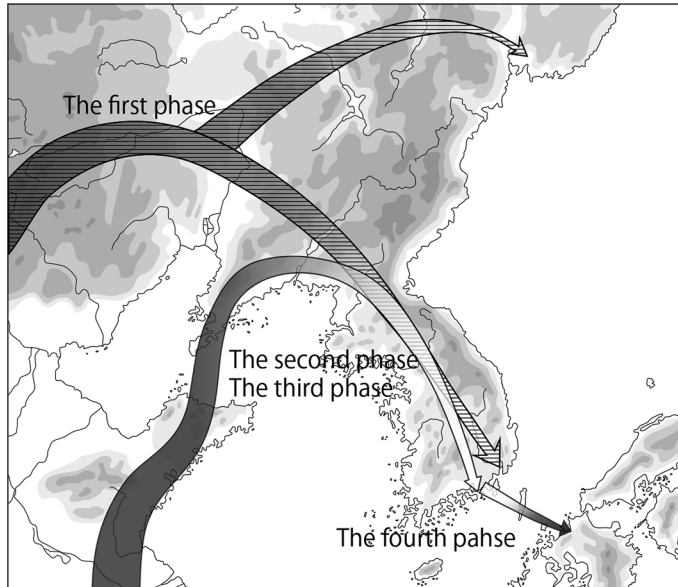


Figure 1. Four phases theory of agriculture in northeast Asia

agriculture from Northeast China to the southern Korean Peninsula and to the southern Russian Far East in around 3400 BC (Miyamoto 2015). The second stage was the spread of wet-rice agriculture from the Shandong Peninsula to the Liaodong Peninsula in around 2400 BC. At the same time, the Pianpu culture spread from the eastern Liaoxi district through the Liaodong district to the northwestern Korean Peninsula (Miyamoto 2016). The third stage was the spread of irrigated agriculture associated with new polished stone tools, including reaping knives and flat plano-convex stone adzes. The third phase saw the introduction of a third agricultural system consisting of wet (rice) and dry (millet, wheat, etc.) fields. This irrigated agriculture also spread from the Shandong Peninsula to the Korean Peninsula via the Liaodong Peninsula in c.1500 BC. Finally, the fourth stage involved the spread of irrigated agriculture to northern Kyushu, Japan, beginning around the 9<sup>th</sup> to 8<sup>th</sup> centuries BC.

Rice agriculture spread from eastern Shandong Peninsula to the northern Japanese archipelago from the second stage to the fourth stage. Archaeological evidence shows that rice agriculture originated in the middle or lower Yangtze River basin. Domesticated rice is classified botanically into Japonica and Indica. Charred rice grains found at archaeological sites in these areas show that, at least in prehistoric times, only Japonica existed in China and northeast Asia, including the Korean Peninsula and Japanese archipelago. In prehistoric times, only Japonica was cultivated in continental China and northeast Asia, although Indica was also cultivated in historical times.

However, Japonica can be classified genetically into tropical Japonica and temperate Japonica. DNA analysis of charred grains (Sato 1996) and phytolith analysis (Fujiwara 1998) conducted in the middle and lower Yangtze River basin confirmed the presence of tropical Japonica only, although on these occasions few samples were taken and detailed reports were not made, even concerning the analysis of data. On the other hand, charred rice grains from the Yayoi period found in Japan, which arrived here with the spread of rice agriculture from the southern Korean Peninsula during the Yayoi period, has been identified genetically as belonging to both types: tropical Japonica and temperate Japonica (Tanaka *et al.* 2010). When considering this archaeological evidence, we are presented with the following three questions. 1) When was temperate Japonica established in East Asia? 2) Where was temperate Japonica established in East Asia? 3) How did tropical Japonica and temperate Japonica spread to the Japanese archipelago? I would like to answer these questions based on new archeological data. Furthermore, I will examine how and why rice agriculture spread into northern Kyushu to establish the Yayoi culture.

## **2. Hypothesis concerning the spread of temperate Japonica**

Rice agriculture spread from the lower Yangtze River basin to the eastern Shandong Peninsula, which includes Yangjiaquan Site, Qixia District, Shandong Province along the Yellow Sea. Rice agriculture then spread to the Liaodong Peninsula in the Upper Xiaozhushan culture. This is the second stage in the spread of early agriculture, in around 2400 BC. In recent years, charred rice grains from the Upper Xiaozhushan culture dating to between 2400 and 2000 BC were found at Wangjiacun Site, Dalian City on the Liaodong Peninsula (Ma *et al.* 2015). Using a replica SEM method for seed impressions on pottery at this same site, Prof. Hiroki Obata identified these seed impressions to be those of rice grains (Obata *et al.* 2018). He also used this method to identify rice grains on pottery from the Upper Xiaozhushan culture at Wenjiadun Site, Dalian City on the Liaodong Peninsula (Obata 2019). Therefore, this proves the hypothesis that rice agriculture spread from the Shandong Peninsula to the Liaodong Peninsula around c. 2400 BC.

In this case, we face the question of whether the rice found on the Liaodong Peninsula at the second stage of the spread of agriculture in northeast Asia is tropical Japonica or temperate Japonica, or both. There is the possibility that temperate Japonica became established on the Shandong Peninsula, Liaodong Peninsula or Korean Peninsula, as temperate Japonica is not found in the middle and lower Yangtze River basin area, the original birthplace of domesticated rice.

Based on historical records, we can say that wild rice did not grow to the north of Huaihe River but to the south of Huaihe River. However, charred rice grains dating to 6060–5750 cal. BC were found using floatation analysis at Yuezhuang Site, Jinan City, Shandong



Figure 2. Charred rice grains found at Yuezhuang Site

Province to the north of the Huaihe River (Figure 2) (Crawford *et al.* 2006). Charred grains from the same Houli culture have been found not only at Yuezhuang Site but also at Xihe Site, Zhangqiu City, Shandong Province. This means that rice grew during the Houli culture period, which is the earliest Neolithic culture in Shandong district, although the morphological analysis of charred rice grains does not show whether or not this rice is domesticated. But it is interesting to note that rice disappeared in the next phase of Beixin culture and Dawenkou culture to the north of the Huaihe River. Domesticated rice spread beyond the north of the Huaihe River later on in the Dawenkou culture period, and spread to the Shandong Peninsula during the Longshan culture period along the Yellow Sea area. In this case, rice from the Houli culture existed separately near to the lower Yellow River basin.

Controversy surrounds the discovery of charred rice grains at a Paleolithic site at Sorori Site, Chunchong Pukudo, Korea (Figure 3). Charred rice grains believed to be wild rice dating to  $12500 \pm 150$  BP were found at this site (Kim *et al.* 2012). If wild rice grew on the Korean Peninsula during the Paleolithic period, we can suppose that wild rice disappeared from the Korean Peninsula and that domesticated rice spread from the Shandong Peninsula to the Korean Peninsula via the Liaodong Peninsula during the third stage of early agriculture in Northeast Asia, c. 1500 BC.

On the other hand, wild water buffalo bones, which disappeared from northern China during the Holocene, were discovered at Neolithic sites. These bones were found only during the early Neolithic period in northern China, at sites such as Shihushan Site and Baijia Site (Figure 4). Even in the northern Korean Peninsula, bones have been found at Gumusanni Site (Figure 4). However, the fact remains that wild water buffalo disappeared because no bones have been found after the middle Neolithic period, c. 4000 BC. This indicates that some species from the Paleolithic period still grew in the early Neolithic period and then disappeared. The same is believed to apply to wild rice north of the Huaihe River, like at

## THE SPREAD OF RICE AGRICULTURE DURING THE YAYOI PERIOD

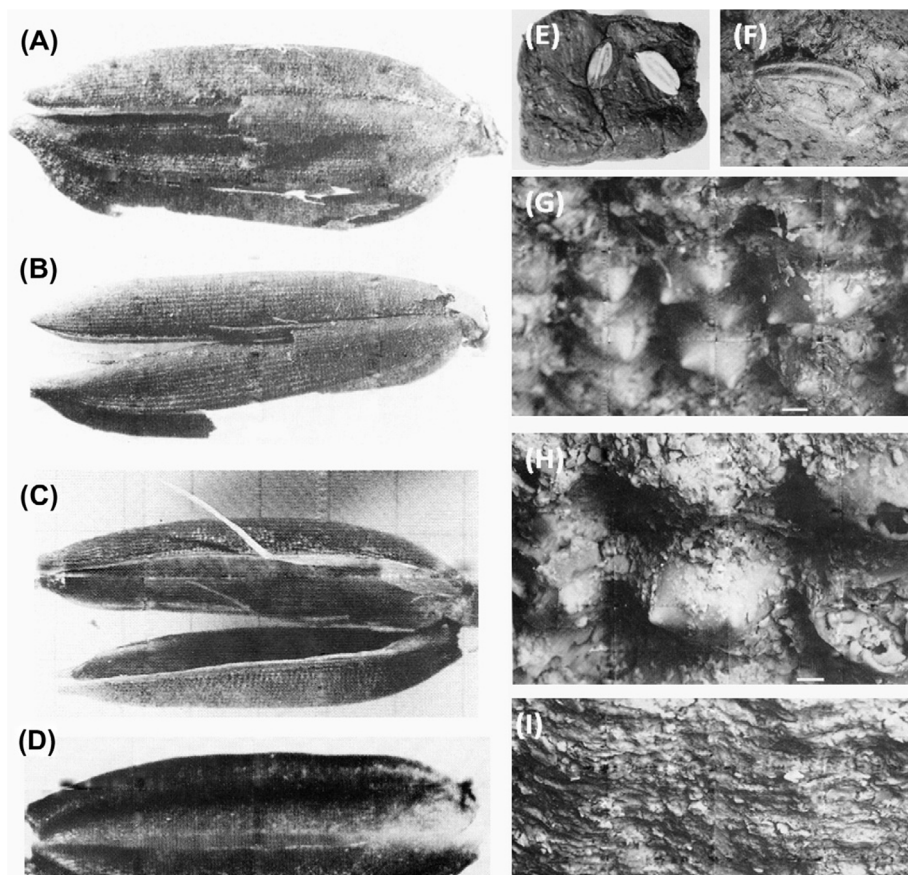


Figure 3. Charred rice chaffs found at Sorori Site

Yuezhuang Site and Sorori Site.

Another hypothesis suggests that rice from the Houli culture in Shandong spread from the lower Yangtze River basin due to warmer climatic conditions (D'Alpoim Guedes *et al.* 2015). However, charred rice grains dating to around 6000 BC were not from a period of warmer climatic conditions. Cooler climatic conditions were present around 6000 BC, corresponding to 8.2 kiloyear Bond event (Bond *et al.* 1997). Therefore, it is thought that the existence of rice during the Houli culture was an isolated occurrence, and that it is not connected in any way with domesticated rice in the middle and lower Yangtze River basin.

It is extremely significant that rice from the Houli culture and rice in the Paleolithic on the Korean Peninsula disappeared, and that domesticated rice spread from the lower Yangtze River basin to the Shandong Peninsula, Liaodong Peninsula and Korean Peninsula. Genetic and phytolith analysis suggests that the domesticated rice which spread to these

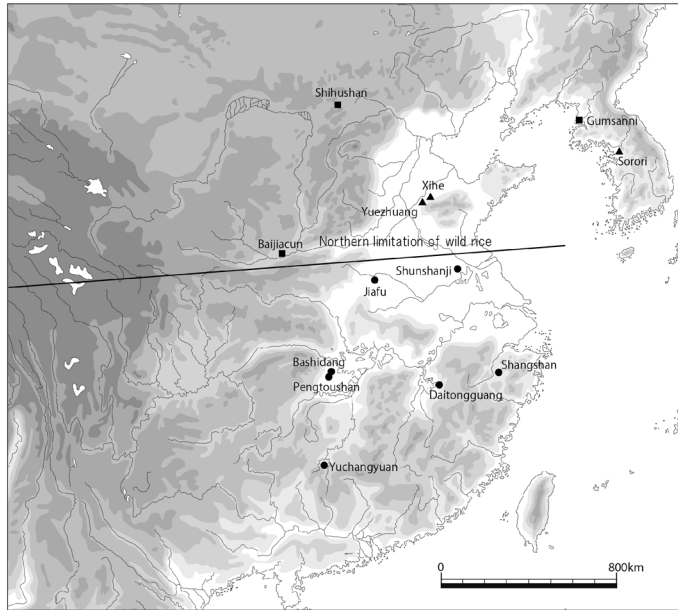


Figure 4. Archaeological sites discovering wild water buffalo bones (■) and archeological sites related with early rice agriculture (●, ▲)

areas from the lower Yangtze River is tropical Japonica (Sato 1996, Fujiwara 1998). Based on the archaeological evidence, I have posited a hypothesis that tropical Japonica spread to Shandong or the Korean Peninsula and mixed with the offspring of wild rice from the Houli culture or at Sorori Site, where it developed into temperate Japonica as an adaptation to the climate conditions of those areas with a much cooler climate and drier conditions than in the middle and lower Yangtze River basin. If this hypothesis is true, it is probable that rice in the Houli culture and rice during the Paleolithic on the Korean Peninsula is a species of wild temperate rice. Thus, it is possible that wild rice was already divided into tropical and temperate Japonica in East Asia at that time. As such, we can infer that temperate Japonica was established on the Shandong Peninsula, Liaodong Peninsula or Korean Peninsula, following which both tropical Japonica and temperate Japonica spread to the Japanese archipelago during the Yayoi period.

### 3. Two routes by which rice agriculture spread from southern Korea to northern Kyushu

It was during the third stage of early agriculture in northeast Asia that irrigated rice agriculture such as paddy fields first appeared, when the Mumun pottery culture was

## *THE SPREAD OF RICE AGRICULTURE DURING THE YAYOI PERIOD*

established on the Korean Peninsula. New polished stone tools such as reaping knives and plano-convex adzes prevailed during the Mumun pottery culture and also spread to the Korean Peninsula by way of the Liaodong Peninsula from the Shandong Peninsula. The agrarian society of the Mumun culture became increasingly more complex than societies on the Korean Peninsula during the Neolithic due to a rising population. In addition, we begin to see the existence of large settlements and chieftain graves in response to the expansion of agricultural production. During this phase, cooler climatic conditions brought about a migration of peoples from the southern Korean Peninsula between the 9<sup>th</sup> and 8<sup>th</sup> centuries BC. Based on the demic expansion theory, a handful of people migrated to northern Kyushu in search of new land for agriculture due to these cooler climatic conditions. The first wave of migrants may have settled on the Karatsu Plain in northern Kyushu, the area nearest to the Korean Peninsula. One site located here is Ukikunden Site, Karatsu City, Saga Prefecture. AMS dating of charred rice grains from the Yusu 1 period dates them to the latter half of the 9<sup>th</sup> century BC, coinciding with the emergence of the Yayoi culture in Japan (Miyamoto 2018). This is the fourth stage of early Agriculture in northeast Asia.

Migrants from the Mumun pottery culture on the Korean Peninsula migrated along with Jomon people at this time. The physical differences between Jomon and Yayoi are very clear, with Yayoi people being physically similar to people from the continent. These people from the continent migrated with native Jomon people in northern Kyushu, and Yayoi people gradually became dominant. The beginning of the Yayoi period saw the emergence of rice paddy fields, a form of irrigated agriculture, new polished agricultural tools like reaping stone knives, a change in pottery style including changes in techniques for making pottery, moated circular settlements, and new burial customs like dolmens and wooden coffin burials (Miyamoto 2016).

Although migration and the influence of Mumun culture are very important factors in the transitional stage between the Jomon and Yayoi, migrants did not move from the Korean Peninsula to northern Kyushu on only one occasion during this transitional time. Cooler climatic conditions indicated by the efficiency of C14 production have been identified as follows: 900 BC, 850–700 BC and 670 BC (Imamura & Fujio 2009). Cooler climatic conditions between 850 and 700 BC resulted in greater efficiency of C14 production, and the duration of coolness at this time was the longest among the three periods of cooler climatic conditions. These cooler climatic conditions triggered the movement of migrants from the southern Korean Peninsula and established the Yusu 1 style of the initial Yayoi period. This movement has been proved through the dating of charred rice grains from the Yusu 1 period (Miyamoto 2018).

According to the pottery chronology, banded pottery originated in the Seto Inland Sea area or Kinki area and gradually spread to northern Kyushu to replace the Kurokawa pottery of the Final Jomon. At the time of Yusu pottery in northern Kyushu, Yayoi culture

was established with the migration of Mumon culture. However, a complex mixture of pottery styles existed consisting of two types: deep bowls deriving from Jomon culture and tubular pots deriving from Mumun culture. Deep bowls replaced necked jars based on Mumun culture, and these pottery combinations developed into an innovative style of pottery known as the Itazuke pottery.

The distribution of archaeological sites is different between the Kurokawa and Yusu periods, and there are very few sites of an intermediate time bridging these two periods like Etsuji 4 period. Archaeological sites at Kurokawa are located in the upper river basin or on hillsides. On the other hand, archaeological sites belonging Yusu 1 and Yusu 2 moved to the lower river basin or near coastlines (Figure 5). This change in the distribution of archaeological sites also indicates sea regression due to cooler climatic conditions. Analysis of C14 production efficiency indicates that in the case of Yusu 1, sea regression corresponds with the period of coolest climatic conditions, dating to c. 850–700cal BC. This dating of Yusu 1 has also been proved through the AMS dating of charred rice grains at Ukikunden Site (Miyamoto 2018). During these cooler climatic conditions, the sea was regressing and the alluvial fan along the coastline was stable in the lower river basin, where land for rice paddy fields was available.

During the Yusu 1 period, rice paddy fields, a new pottery style similar to tubular pots, and new polished stone tools are found on the Karatsu Plain and Fukuoka Plain. Following this, moated circular settlements were established during the Yusu 2 period on the Fukuoka Plain. New burial customs like wooden coffins emerged on the Fukuoka Plain during the Yusu 2 and Itazuke periods. Cultural elements were added gradually during the time between Yusu 1 and Yusu 2. Also, irrigated rice agriculture was perfected during the Itazuke period.

Although dolmens were established during the Yusu 1 period, their distributions were concentrated in the Karatsu and Itoshima Plains (Figure 6-1). However, wooden coffins were introduced to the Fukuoka Plain and eastward areas during the Yusu 2 period (Figure 6-2). Polished stone daggers accompany wooden coffins as grave goods. The polished stone daggers found in northern Kyushu are classified mainly into two types: Type A and Type B (Figure 7) based on the classification of polished stones on the southern Korean Peninsula (Miyamoto 2017). Type A is characterized as having a stepped section on the profile of the guard portion of stone daggers. Type B is characterized as having a projected line on the profile of stone daggers. Type A is distributed in the western area of northern Kyushu, although a relatively earlier variant of Type A is distributed in the Onga River basin (Figure 8-1). On the other hand, Type B was distributed eastward from the Fukuoka Plain in northern Kyushu (Figure 8-2). Type B spread to northern Kyushu during the Yusu 2 period, later than when Type A spread to northern Kyushu (Figure 8). The distribution of Type A is similar to that of dolmens (Figures 7-1 and 8-1), while the distribution of Type B



THE SPREAD OF RICE AGRICULTURE DURING THE YAYOI PERIOD

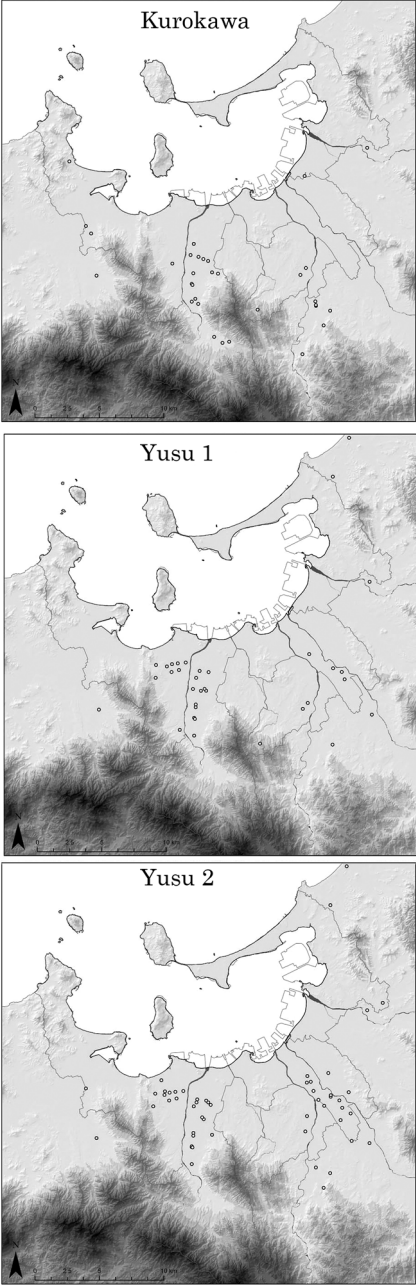


Figure 5. Changes in site distribution between Jomon and Yayoi



Figure 6. Changes in site distribution between dolmens and wooden coffins

is similar to that of wooden coffins (Figures 7-2 and 8-2). Also, dolmens are believed to have spread from the Namgang River basin to the Karatsu and Itoshima Plains during the Yusu 1 period (Hashino 2006). This route corresponds with the distribution of Type A polished stone daggers. On the other hand, it is believed that wooden coffins spread directly to the Fukuoka Plain during the Yusu 2 period. This route of diffusion also corresponds with the distribution of Type B polished stone daggers and that of wooden coffins. Differences in the time of introduction and area of distribution between the dolmens and wooden coffins, with the addition of differences in the distribution area by type of polished stone daggers between the Korean Peninsula and northern Kyushu, indicate the dual spread of culture from the Korean Peninsula (Figure 9) (Miyamoto 2016, 2017).

Concluding the spread of rice agriculture, during the Yusu 1 period, rice agriculture first of all spread from the Namgan River basin on the southern Korean Peninsula by way of the middle Tsushima Island to the Karatsu and Itoshima Plains (Figure 9-1). This was accompanied by the spread of rice paddy fields, polished stone axes, dolmens, and Type A polished stone daggers. Then, during the Yusu 2 period, it subsequently spread from the lower Naktonggang River Basin by way of northern Tsushima to the Fukuoka Plain mainly under the influence of the Songgunni pottery culture (Figure 9-2). This was accompanied by the spread of moated settlements, wooden coffins, and Type B polished stone daggers. In

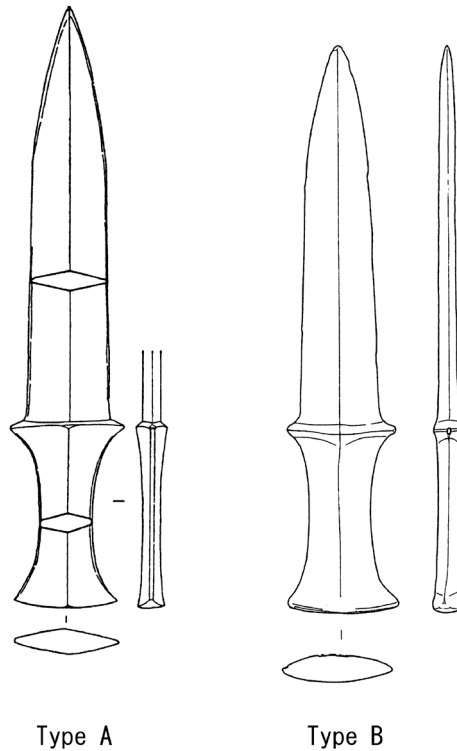


Figure 7. Type A and Type B of polished stone daggers

addition, the Itazuke pottery style, including tubular pots and necked jars, was established mainly on the Fukuoka Plain. Itazuke Type 1 is believed to represent the establishment of Yayoi culture, a form of agriculture distinctive to the Japanese archipelago, as seen in the creation of the Itazuke pottery style. At this time, new Yayoi farming people moved into the Seto Inland Sea and Kansai areas, where other farming people and indigenous Jomon people migrated. During this process, Yayoi culture was fundamentally established with the replacement of Jomon culture in western Japan.

#### 4. Charred rice grains in northern Kyushu

More than 600 pieces of charred rice grains were found in Layer No. 10 of the Yusu 1 period at Ukikunden Site through floatation analysis (Miyamoto 2018). Based on the DNA analysis of charred grains, rice grains from the Yusu 1 period dating to the latter half of the 9<sup>th</sup> century BC were found to be mainly tropical Japonica (Tanaka 2019). On the other hand, charred rice grains dating from the 6<sup>th</sup> to 5<sup>th</sup> centuries BC found in a cereal deposit pit at Arita Site, Fukuoka City, of Itazuke 1b to Itazuke 2a, were found to be temperate Japonica

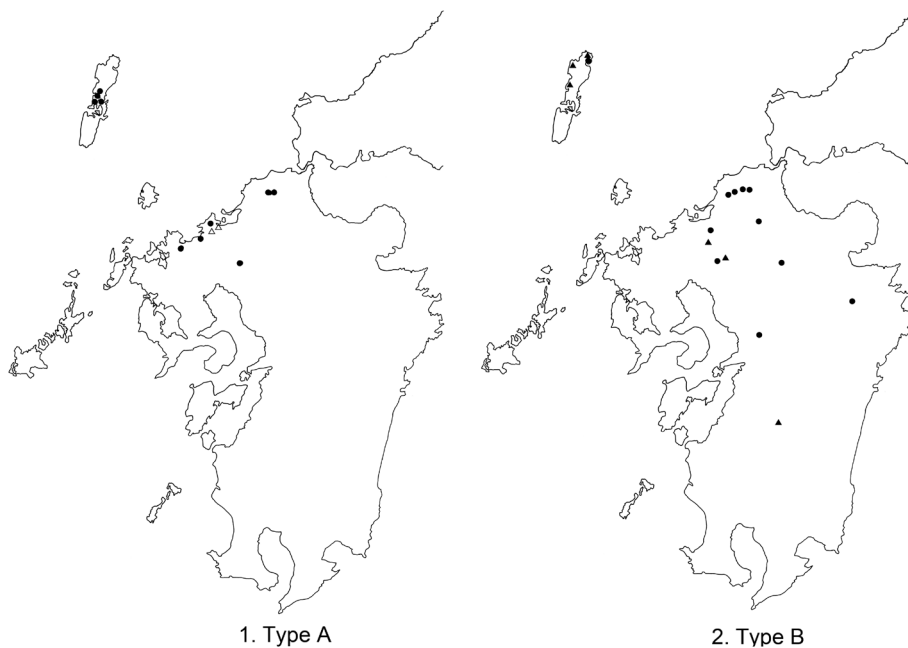


Figure 8. Changes in site distribution between Type A and Type B of polished stone daggers

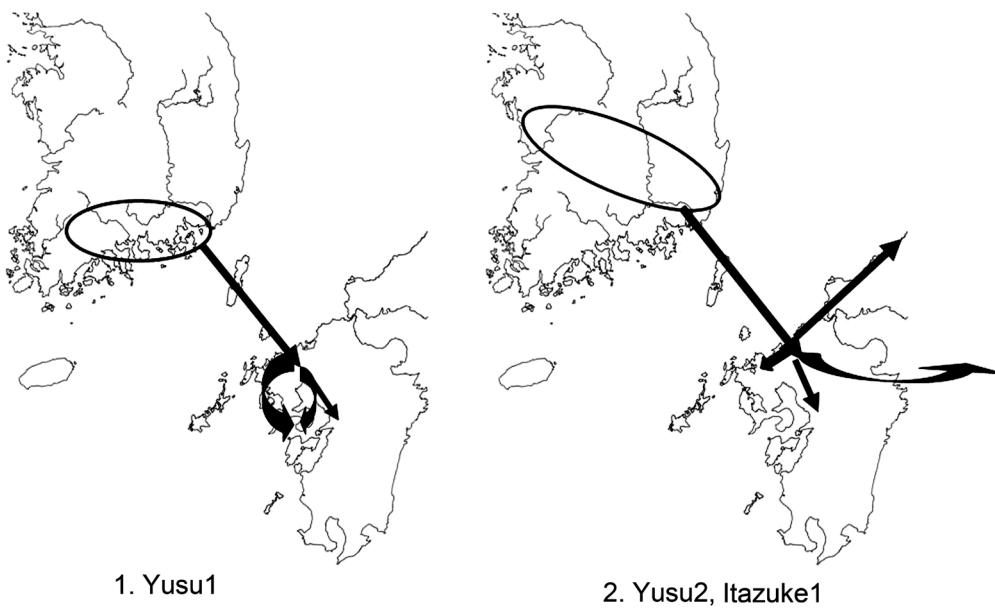


Figure 9. Processes of dual cultural spread from southern Korea

through DNA analysis (Tanaka 2019).

Size variation analysis on charred rice grains from the Yayoi period was also conducted by Prof. Nobuyuki Kamijo (Kamijo 2018). According to the results, rice grains from the Initial Yayoi period found at Ukikunden and Nabatake Sites on Karatsu Plain, dating to the 9<sup>th</sup> century BC, are of various sizes. In addition, these rice grains are smaller and thinner than those of other periods. On the other hand, rice grains from the Early Yayoi period, dating from the 6<sup>th</sup> to 4<sup>th</sup> centuries BC, are not of various sizes but are rounder and medium sized. Therefore, a morphological change in rice grains took place between the Initial and Early Yayoi.

Tropical Japonica rice grains are known to be more primitive and smaller than those of temperate Japonica, while temperate Japonica rice grains are larger and rounder than those of tropical Japonica. Based on DNA analysis and analysis of the size of charred rice grains in northern Kyushu, it is believed that rice during the Initial Yayoi was mainly tropical Japonica, while rice during the Early Yayoi was temperate Japonica.

Based on this archaeological evidence, we can infer that tropical Japonica, which was domesticated at an earlier stage in East Asia, spread from the Namgang River basin to the Karatsu and Itoshima Plains during the Yusu 1 period, dating from the 9<sup>th</sup> to 8<sup>th</sup> centuries BC. In addition, we can also infer that temperate Japonica, which may have been cultivated mainly during the Songgunni period on the southern Korean Peninsula, spread to the Fukuoka Plain during the Yusu 2 period, dating from the 7<sup>th</sup> to 6<sup>th</sup> centuries BC. Therefore, temperate Japonica was the main species of rice to be cultivated in western Japan during the Itazuke 1 and Itazuke 2 periods, dating from the 6<sup>th</sup> to 4<sup>th</sup> centuries BC.

## **5. Conclusion**

Where and when was temperate Japonica established? And how did tropical Japonica and temperate Japonica spread to the Japanese archipelago? These are the questions first posed by this paper. The first and second questions are most likely related to the second and third stages of the spread of early agriculture in northeast Asia. The third question is perhaps related to the fourth stage of the spread of early agriculture in northeast Asia.

The answers to these questions, based on the results of several archaeological analyses, are summarized as below.

- (1) It is more probable that temperate Japonica was produced in northeast Asia, including the Shandong Peninsula, Liaodong Peninsula and Korean Peninsula due to archaeological evidence pointing to the existence of tropical Japonica. However, we need more samples in order to conduct DNA analysis of charred rice grains from these areas.
- (2) Following the spread of domesticated Japonica—in this case, tropical Japonica—in the middle and lower Yangtze River basin to the Shandong Peninsula, along the Yellow Sea at

the end of the Dawenkou culture and the beginning of the Longshan culture, around 2400 BC, it is probable that temperate Japonica was domesticated and changed genetically from the wild temperate Japonica where wild rice originally grew, like at Yuezhuang and Sorori sites. However, this idea is still only a hypothesis and has yet to be proved.

- (3) During the fourth stage of the spread of early agriculture in northeast Asia, there were two different diffusion routes from the southern Korean Peninsula to northern Kyushu, due to cooler climatic conditions. Migrants from the southern Korean peninsula moved from the Namgang River basin to the Karatsu and Itoshima Plains in northern Kyushu, bringing with them rice paddy fields, dolmens, new polished stone tools, and Type A polished stone daggers during the Yusu 1 period, dating to between the 9<sup>th</sup> and 8<sup>th</sup> centuries BC. They brought mainly tropical Japonica for cultivation on the Karatsu Plain, migrating along with the Jomon people. And then different migrants belonging to the Songgunni culture from the Nakdonggang River basin moved to the Fukuoka Plain, bringing with them moated circular settlements, wooden coffins and Type B polished stone daggers during the Yusu 2 period, dating to between the 7<sup>th</sup> and 6<sup>th</sup> centuries BC. They brought temperate Japonica, migrating along with the Jomon people. As a result, interaction between a handful of migrants and a large number of Jomon people established the Itazuke pottery style, which is based on the pottery production techniques of Mumun pottery on the southern Korean Peninsula (Miyamoto 2016, 2017).

The establishment of the Itazuke pottery style, which includes tubular pots and necked jars, on the Fukuoka Plain signals the start of the Early Yayoi period. The Itazuke pottery style culture diffused into western Japan during the 6<sup>th</sup> and 5<sup>th</sup> centuries BC (Miyamoto 2018). The Itazuke pottery style culture led to the spread not only of the Itazuke pottery style, but also moated circular settlements, polished stone tools, rice paddy fields and temperate Japonica. Therefore, the spread of the Itazuke pottery style, which is also called the Ongagawa pottery style, in western Japan can be said to constitute the starting point for the Yayoi culture.

## References

- Bond, G., W. Showers, M. Cheseby, R. Lotti, P. Almasi, P. deMenocal, P. Priore, H. Cullen, I. Hajdas, & G. Bonani. 1997. A pervasive millennial-scale cycle in North Atlantic Holocene and glacial climates. *Science* 278(5341): 1257–1266.
- Crawford, G.W., X. Chen, & J. Wang. 2006. Houli Culture rice from the Yuezhuang site, Jinan. *East Asia Archaeology* 3: 247–251.
- D’Alpoim Guedes, J., G. Jin, & R. K. Bocinsky. 2015. The impact of climate on the spread of rice to North-Eastern China: A new look at the data from Shandong province. *PLOS ONE* DOI: 10.1371:1-19.

## THE SPREAD OF RICE AGRICULTURE DURING THE YAYOI PERIOD

- Fujiwara, H. 藤原宏志 1998. *Talking of the origin of rice agriculture* 稲作の起源を語る. Tokyo: Iwanami Shoten 岩波書店.
- Hashino, S. 端野晋平 2006. The dolmen diffusion process Southern Edge of Korean Peninsula and Northern Kyushu region. *Interaction and Transformations* 4: 1–52.
- Imamura, M. & S. Fujio 今村峯雄・藤尾慎一郎. 2009. The environmental change seen by the record of carbon 14. 炭素14の記録から見た自然環境変動—弥生文化成立期—. *The Emergence of Yayoi Culture, The Archaeology of Yayoi Period*. Vol. 2 弥生文化誕生 弥生時代の考古学(2): 47–58, 同成社.
- Kamijo, N. 上條信彦 2018. The morphological variation of rice grain in the Kyushu Island in the Yayoi and Kofun periods 水稻農耕定着段階における九州出土米の粒形質変異. *Kyushu Kokogaku* 九州考古学 94: 23–43.
- Kim, K., Y. Lee, J. Woob, & T.A.J. Jull. 2013. Radiocarbon ages of Sorori ancient rice of Korea. *Nuclear Instruments & Methods in Physics Research. Section B, Beam Interactions with Materials and Atoms* 294: 675–679.
- Ma, Y., W. Wu, Q. Wang, Z. Zhang, & G. Jin. 馬永超・呉文婉・王強・張翠敏・靳桂雲 2015. Dalian Wangjiacun Yzhi Danhua Zhiwu Yicun Yanjiu 大連王家村遺址炭化植物遺存研究, *Beifang Wenwu* 北方文物. 2: 39–43.
- Miyamoto, K. 宮本一夫 2014. Human Dispersal in the Prehistoric Era in East Asia. in T. Nakahashi & W. Fan (ed.) *Ancient People of the Central Plains in China*: 63–83. Fukuoka: Kyushu University Press.
- Miyamoto, K. 宮本一夫 2015. The initial spread of agriculture into Northeast Asia. *Asian Archaeology* 3: 11–26.
- Miyamoto, K. 宮本一夫 2016. Archeological explanation for the diffusion theory of the Japonic and Koreanic languages. *Japanese Journal of Archaeology*, 4(1): 53–75.
- Miyamoto, K. 宮本一夫 2017. *Early agriculture in northeast Asia and the origin of Yayoi* 東北アジアの初期農耕と弥生の起源. Tokyo: Doseisha 同成社.
- Miyamoto, K. 宮本一夫 2018. A new discussion of the actual date of the beginning of the Yayoi period 弥生時代開始期の実年代再論. *Kokogaku Zasshi (Journal of the Archeological Society of Nippon)* 考古学雑誌 100(2): 1–27.
- Obata, H., N. Saitou, & Q. Wang 小畑弘己・斉藤希・王強 2018. Wangjiacun Yizhi Chutu Taoqi Yahan Fenxi de Chnegguo he Wenti 王家村遺址出土陶器压痕分析的成果和问题. *Dongfang Kaogu* 东方考古 27: 1–20.
- Obata, H. 小畑弘己 2019. The result of pottery impression analysis in Wenjiadun Shell midden of Liaodong Peninsula 遼東半島文家屯貝塚出土土器の压痕分析成果. in K. Miyamoto (ed.) *A scientific research on the process of spread of agriculture in North-Eastern Asia by botanic archaeology* 東北アジア農耕伝播過程の植物考古学分析による実証的研究. Fukuoka: Kyushu University 九州大学: 38–60.
- Sato, Y. 佐藤洋一郎 1996. *Rice agricultural civilization shown by DNA analysis* DNA が語る稲作文明. Tokyo: NHK.
- Tanaka, K., T. Honda, & R. Ishikawa. 2010. Rice archaeological remains and the possibility of DNA archaeology: Examples from Yayoi and Heian periods of Northern Japan.

*Archeology and Anthropological Sciences* 2(2): 69–78.

Tanaka, K. 田中克典 2019. DNA analysis on charred grains found at Ukikundenand Arita sites 宇木汲田遺跡・有田遺跡出土炭化米のDNA分析. in K. Miyamoto (ed.) *A scientific research on the process of spread of agriculture in North-Eastern Asia by botanic archaeology* 東北アジア農耕伝播過程の植物考古学分析による実証的研究. Fukuoka: Kyushu University 九州大学: 145–159.