

## The Spread of Cultivated Rice into Southwest China

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### Abstract

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Archaeobotany data from the Baodun culture in Chengdu Plain have provided very important evidence to discuss the spread of cultivated rice into Southwest China. Based on the climatic condition, archaeological cultures elements such as bottom-pointed bottle and archaeobotany data, this paper argued that the origin of cultivated rice and millet in the Baodun culture is caused by southward expansion of the late Neolithic culture in the Wei and Min Rivers through a crescent-shaped fashion along the border region from Northeast to Southwest China. Rice and millet agriculture development in Chengdu Plain then spread quickly to northwestern Yunnan, Guizhou and Guangxi, eventually the Indo-China Peninsula.

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**Keywords:** Archaeology of cultivated rice-japonica, foxtail millet, Southwest China, expansion of archaeological culture, the Guiyuanqiao culture;

### Introduction

In recent years, the expansion and spread of rice agriculture has received considerable attention and has been viewed as crucial to understanding the spread of people, social complexity, and language across East Asia (Bellwood et al. 2007). New archaeobotany data from the Baodu culture in Chengdu Plain (Jiang et al. 2011; Guedes et al. 2013) provided very important evidence to discuss the spread of cultivated rice into Southwest China (Guedes et al. 2013).

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A combined system of rice and millet in this region had been well proposed (Guedes 2011). Millet was from Gansu and Qinghai northwest China with the expansion of the Majiayao culture, and two possible spread routine was seriously proposed on the origin of rice in the Baodun culture (Guedes 2011). "The first of these is a northern route, following the Yangzi River through the Three Gorges area, however the lack of evidence from Eastern Sichuan makes this claim hard to evaluate". "Another potential route for the spread of rice agriculture is a southern route through the foothills of Guizhou Province, from which it could have moved northward into the Sichuan Basin".

However, most of the material from southern area is almost dated to Bronze Age, which are all later than rice remains in the Baodun culture. Therefore the origin of rice in the Baodun culture is still not clear, and this issue has remained alive. Based on evidence from archaeobotany data, environmental and climatic research, and archaeological cultural connections, this article mainly discussed the spread routine of cultivated rice into Southwest China, and then proposed a likely way further into Indo-China Peninsula.

### **Climate of the Holocene and topography in the Chengdu plain**

The climate of the Holocene in the Chengdu plain area included four alternating dry and wet phases: the Qianjiangbei (9,500-7,500 B.P.), Ziyang (7,500-5,000 B.P.), Jiangbei (5,000-2,700 B.P.), and Santai (2,700-) phases (Liu 1981; Liu 1998). During the Ziyang period, when the Yangshao Culture (7,000-5,000 B.P.) was developing rapidly in the Central Plain of China, the climate and environment could be unfavorable for human occupation in the Chengdu Plain because of flood. Interestingly, when the climate became dryer (Jiangbei: 5,000-2,700 B.P.) than in previous times, the Guiyuanqiao and Baodun culture developed. The man-made wall was consciously built in a comparatively higher position which was obviously consciousness of flood control (Liu 1998).

According to topography, the southeast area of the Chengdu plain is lower than the northwest part. Most of rivers from the western plateau of Sichuan to the Sichuan basin such as the Jinsha, Yalong, Dadu, Min, Tuo, Pu, and Jialing Rivers flow from the north to the southeast. The normal gradient of the plain includes a gradient of about 3-5 percent.

However the area in front of the mountains has a much stronger gradient of about 7-11 percent. This affects the type and amount of land available for agriculture. The central places of these cultures were typically located on a promontory and surrounded by man-made walls along the upper rivers in order to prevent flooding (Li et al 2005).

### **Archaeological cultural connections with the Baodun culture**

In the northeast of the Sichuan basin predating the Baodun culture is the Guiyuanqiao culture that was dated to 5,100-4,600 B.P. (Sichuan 2013). Especially it is worth noting that double lip bottom-pointed bottle in the Guiyuanqiao culture was similar to that in phase 4 of the Dadiwan culture in southeast Gansu province and phase 2 of Lijiaping site close to Guiyuanqiao site in Bailong River southeast Gansu (Wan and Lei 2013). As well, bottom-pointed bottle like Guiyuanqiao culture was found in Yingpanshan (Chendu 2000), Jiangweichen (Sichuan 2006). Analysis of the chemical composition of paint pottery unearthed in the sites of Haxiu and Yingpanshan suggests that it was similar to painted and unpainted pottery in Gansu that was made with a mixture of high calcium and magnesium loam, as well painted pottery samples from western Sichuan (Hong et al. 2011). Some of this painted pottery was found as far away as the highlands of the Hengduan mountain range in southwestern China (Wang 2011). (Fig.1)

Therefore, scholars summarized that the people living in the Chengdu Plain were emigrated from southeast Gansu along Bailong River (Chen and Wang 2004), then along the Min River (Jiang 2015). Initially, the Baodun culture were regarded that it evolved from a kind of Yingpanshan remains which was very similar to Guiyuanqiao culture (Jiang 2004; Jiang 2015). Now the excavation of Guiyuanqiao site have revealed the origin of the Baodun culture (Wan and Lei 2013; Jiang 2015).

The earliest archaeological remains in the east of Chengdu plain and in the valley of the Yangtze River are from the phase 1 sites of Shaopengzui and the lower layer of the Laoguanmiao site culture. This corresponds approximately to the Miaodigou Phase 2 c.5000-4500 B.P. which predates the Baodun culture (Wang 1996). The entire style of ceramics at this time is simple and mostly unadorned, unlike those at Baodun. Pottery styles suggest that there is no obvious relationship between these cultural groups.

The archaeological remains from the site of Zhongbazi (Lei and Chen 1991), which developed shortly after Shaopengzui phase 1, have more similarities to Baodun but also exhibit obvious differences. It is possible that the limited similarities may be the result of contact with some archaeological cultures in the central region of the Chengdu plain when the Baodun culture was still developing.

### **Rice and millet remains in Chengdu Plain**

Evidence from the Middle Neolithic sites in Chengdu plain (ca 4,700-4,000 B.P) provides important data for understanding how and when cultivated rice agriculture spread into this region. (Fig. 2) The appearance of rice and foxtail millet agriculture is accompanied by a number of sociopolitical transformations which include a settlement pattern dominated by a large, central places at Sanxingdui, Baodun, Shuanghecun, Zizhucun, Guchengcun and Yufucun (Wang and Song 1999 a,b). These sites were located in the western Chengdu plain forming a crescent shape along a mountainous edge from northeast to southwest. All of them are surrounded by man-made walls that would have required considerable investment in terms of labor.

Most of the plant remains from phase 2 of the Baodun culture, including rice and foxtail millet, were recovered through water screening and flotation. After two seasons of excavation at the Baodun site, all the samples collected contained rice, but only a third of the samples contained foxtail millet (Jiang et al. 2011). Especially, millet remains from phase 1 of the Baodun culture seems to be dominant subsistence. These finds show that a combined system of rice and millet appeared in sites of the Baodun culture dating to c. 4,700 B.P. (Guedes 2011; Guedes et al. 2013). It has been suggested that rice spread to the Baodun culture probably from the Middle to Upper Yangtze River (Zhang and Hong 2009; Guedes et al. 2013).

Due to the lack of analysis a comparison of rice characteristics has not currently been made for the rice remains from the middle Yangzi River. As a result the agricultural and economic model of the Daxi (6,500-5,300 B.P), Qujialing (4,600-4,200 B.P.) cultures are not completely clear, and it is unclear whether rice agriculture developed alongside limited millet production or independently (Qin 2004). Domesticated foxtail millet was recovered from the site of Chengtoushan,

which dates to the Daxi cultural period(Nasu, Gu, Momohar& Yasuda, 2012). But it was reported foxtail grass, but not domesticated foxtail millet.<sup>4</sup>

During phase 1 (4,500-3,700B.P.) at the Zhongba site, in the Three Gorges area of the Yangzi River region, millet appears to have dominated subsistence (Zhao 2013). Only a few rice remains were found in phase 3 (3,100-2,100 B.P.) of the Zhongba site. The date of millet and rice remains appears very late when compared with the Shijiahe and the Baodun cultures and it is possible that the rice remains come from different directions during the Bronze Age of this region.

The Baodun culture had no obvious connection with predate Daxi culture and almost in the same time Qujialingculture in the middle Yangzi River (Wan and Lei 2013). The lack of evidence makes this claim from the middle to upper Yangzi River difficult to evaluate. Therefore, studying rice agriculture around the Middle Yangtze River provides only an important background for understanding the uptake and spread of cultivated rice in Chengdu plain. The origins of domesticated millet in the Baodun culture may point us in the direction of the origin of rice and allow us to understand regional interaction and cultural contact in this important late Neolithic period.

### **The origin of cultivated rice into Southwest China**

Above, a combined system of rice and millet was recovered in Chengdu Plain and the millet is with the expansion of the Majiayao culture (Guedes 2011; Guedes et al. 2013). Is this routine possible for cultivated rice spread? The key to become whetherwas existence of cultivated rice in late Neolithic archaeological culture southeast Gansu.

In another academic article (Zhang and Chen et al. 2015), we discussed detail two possible spread routine of cultivated rice into the upper Yellow River. The first spread routine along the Han Rivers to south of Qinling Mountain to southeast Gansu province. The second probably westward expanded with the typical

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<sup>4</sup>Gu, H. (2012). Characteristics of charred rice remains from archaeological sites in Human. The Origins of Sedentism and Agriculture in Early China. Stanford Archaeology Center, Stanford University.

Yangshaoculture along Wei River. The very important evidence is from Xishanping (Li et al. 2007) and Qingyang (*Japonica*) in southeast Gansu (Zhang and Wang 2000).

In addition, domestication process of rice toward *japonica* represented by Longqiuzhuang (Tang et al. 1996; Zhang 1999) in the Huai River finished about *ca.* 6,000 B.P.

During the 6,000-5,500 B.P., the Yangshaoculture integrated part regional archaeological culture in the Huai and Han Rivers, made the *japonica* expanded in the typical Yangshao culture area, eventually to southeast Gansu in *ca.* 5,500 B.P. (Zhang and Chen et al. 2016). "In the middle Yangtze, archaeobotanical evidence is rather diverse, from Bashidang and Chengtoushan, but we once again lack clear domestication indicators" (Fuller et al. 2011).

As to the millet in the Chengdu plain, it is likely linked with the Guiyuanqiao culture. The phase 1 of the Guiyuanqiao site dominated by millet, but with little rice, rice remains appears in phase 2 and proportion gradually rises (Wan and Lei 2013). Rice recovered from the Baodun site was also *japonica* rice (Guedes et al. 2013:766). Therefore, we argued that the origin of cultivated rice in the Baodun culture is possibly caused by southward expansion of the late Neolithic culture in southeast Gansu. Cultivated rice and foxtail millet together spread into the Sichuan basin.

To the south of the Chengdu Plain, in Yunnan province, rice has been found in the Neolithic phases of the Haidong site of the Shizhaishan culture which dates to approximately 4,500 B.P. (charred rice, husk and rice powder) (Zhang and Hong 2010). In addition, rice remains have been found in this region from Haimenkou (charred rice, 4,300-3,900 B.P. by charcoal) (Min 2009), Dadunzi (charred rice were identified for *Japonica*, dated to 3,210±90 B.P. by charcoal) (Kan 1977), Yingpanshan (charred rice were identified for *japonica*, dated to 3,304±82 B.P. by charcoal) (Wang 1991; Xiang et al. 2015), Baiyangcun (rice husk and stem, 3,370±85 B.P. by charcoal) (Kan 1981), and much further south in the site of Shifodong (charred rice were identified for *Japonica*, 3015±50 B.P. by charred rice) (Kan 1983; Zhao 2010). In Guizhou Province, rice remains were found in the site of Jigongshan (dated to 3115±40 a B.P. by charred rice) (Zhang et al. 2006).

Recently, the finds and analyses of rice remains at the site of Gantuoyan in western Guangxi province show that millet (dated to *ca.* 3,400 B.P.) together with rice

(dated to 2,900 B.P.), spread into this region (Wei and He 2003; Guangxi 2014). The rice from Gantuoyan may be classified as japonica type rice (Wei and He 2003). The index of identification function and the data from tubercule distance measurements all cluster in the Japonica category. In addition, the rice morphology is identified for Japonica.

Many artifacts were found in the site of Gantuoyan. Among these finds, the worked ivory seal is important in indicating that the site of Gantuoyan had a close relationship with archaeological cultures in the Central Plain of China.

The dates of all of these sites are later than that of the Baodun culture, and some of them are even later than the Sanxindui period (ca 4,800-2,800 B.P.). Most rice remains occur during the Bronze Age. The dates of rice remains were later and later from north to south. The type of rice was Japonica. A combined system of rice and millet widely expanded in southwest China. This suggests that cultivated rice could not spread from the south into Sichuan Basin. At the same time, we also noted that most of the sites to the south of the Chengdu Plain found almost rice and millet together. Interestingly, all of these sites are distributed on the crescent-shaped cultural development along the border region from Northeast to Southwest China. (Fig. 2)

### **The crescent-shaped cultural development along the border region from Northeast to Southwest China**

Tong (1990) borrowed the concept of cultural elements from cultural anthropology and described many archaeological elements such as artifact type, style, architectural remains, burial goods, and burial customs from the Stone Age to the Bronze Age. Based on his analysis of cultural elements and many artifacts in this region, Tong argued that there is a crescent-shaped cultural development along the border region from northeast to southwest China. (Fig. 3) This crescent-shaped cultural development had inner connections among archaeological cultures distributed in this region, as similarities in microliths, stone coffins, and large stone tombs. This region begins south of Greater Khingan, is bounded to the north by the Great Wall, occurs across the western loess plateau of the middle Yellow River, as far west as the Hehuang region, and stretches in a southerly direction from the eastern Tibetan plateau to Yunnan.

Tong (1990) also indicated that the elevation of the crescent-shaped region formed in a series of staggered steps. At 40°north the elevation above sea level is 1,000-1,500m. Westward of the Liupan mountain and Hehuang region, namely near 37°north, the elevation of the loess plateau is about 2,000m above sea level. However, in the southeast of the Tibetan plateau between 33°and 26°north, the average elevation is more than 3,000m above sea level.

The different elevations likely affected the ability of local people to grow and irrigate crops. This region possessed conditions seasonally suitable for agriculture including solar radiation, temperature, precipitation, humidity and the length of the growing season. In addition, from the early Neolithic onwards subsistence in this region is thought to have been based around agriculture and animal husbandry.

### **The spread of cultivated rice into Southeast Asia**

The rice evidence that was identified for japonica (dated to 2,500 ca B.P.) from Thailand (Webber et al. 2010) provided more possibility that spread of cultivated rice into the Indo-China Peninsula through Southwest China. It's worth noting that rice and foxtail millet (dated to ca 3,800 B.P.) grew together, and many examples of rice and millet together occurred in this region (Weber et al. 2010).

Combine analysis above, we argued the cultivated rice spread into the Baodun culture from southeast Gansu with millet together, and developed in Chengdu Plain then to Yunan, Guizhou and Guangxi region, eventually into the Indo-peninsula. No direct evidence were found along long-distance dispersal (trade) indicated by proto-indica hybridization hypothesis (Fuller et al. 2011). The spread of cultivated rice into Indo-peninsulaprobablyillustrated a more likelihood pathway of japonica to India from large scope origin area in China, to support important proto-indica hybridization hypothesis(Fuller et al. 2010; Kingwell-Banham and Fuller 2011). When Japonica spread into India, cross-breeding between the two types of rice improved local Indica rice genes (Fuller and Qin 2009; Fuller et al. 2010).

### **Conclusion**

As spread into southeastern Gansu province, cultivated rice and millet most likely with southward expansion of the late Neolithic archaeological culture into the lower elevation of the Chengdu plain through the crescent-shaped cultural



development along the border region from Northeast to Southwest China. When the model of rice and millet agriculture developed in Chengdu Plain, it rapidly spread into northwest Yunnan, Guizhou, and Guangxi, ultimately into Southeast Asia via the Hengduan Mountain range pass.

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### **Competing Interests**

The authors declare that they have no competing interests.

### **References**

#### **Figure1 Pottery found in the sites of Guiyuanqiao and Yingpanshan**

1. Painting bottle (2000H81)
2. Painting basin (2000H82)
3. Double lips bottom-pointed bottle (TN07E08④):3)
- 4.Double lips bottom-pointed bottle (TN07E08④):10)
- 5.Painting basin (2000H125)

#### **Figure2 Plant Remains along the Southward Spread of Rice Cultivation**

1. Qingyang
2. Xishanping
3. Lijiaping
4. Yingpanshan
5. Guiyuanqiao
6. Baodun
7. Karuo
8. Jigongshan

9. Haimenkou
10. Baiyangcun
11. Dadunzi
12. Shifoudong
13. Shizhaishan
14. Gantuoyan
15. Non Pa Wei/Non Khok Wa/Nom mak La

**Figure3 Acrescent-shaped cultural development along the border region from northeast to southwest China**

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