Front. Earth Sci. 2022, 16(3): 809−818
https://doi.org/10.1007/s11707-021-0956-z

RESEARCH ARTICLE

The history of agriculture in the mountainous areas of the lower Yangtze River since the late Neolithic

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Abstract Understanding the role of agriculture in the development of human societies around the world is an important field of study with many unanswered questions. As a step toward that greater understanding, we have studied the archeobotanical remains at the Jingshuidun site in the mountainous areas of the lower reaches of the Yangtze River in southern Anhui Province which are part of the core area of rice cultivation today. Our analyses of macrobotanical remains and phytoliths formed the basis for the reconstruction of the subsistence economy of ancient humans at the Jingshuidun site from the late Neolithic to early historical times. When our data are combined with that of previous archeobotanical work, we obtain a clearer picture of the development of rice and millet agriculture in the southern Anhui Province region, as well as the spread of millet cultivation. Macrobotanical remains and phytoliths of domesticated rice are present in layers at the Jingshuidun site dated to 4874–4820 cal. yr B.P. (middle-late Liangzhu Period) and 2667–2568 cal. yr B.P. (late Western Zhou Dynasty to the early Spring and Autumn Period). Moreover, macrobotanical remains and phytoliths from the site document the earliest remains of foxtail millet (*Setaria italica*) in southern Anhui Province, from a layer dating to the late Western Zhou Dynasty and the early Spring and Autumn Period (2667–2568 cal. yr B.P.). These results suggest that the people occupying the Jingshuidun site used single rice farming as far back as 4874–4820 cal. yr B.P., and they began to plant millet by at least 2667–2568 cal. yr B.P., documenting the spread of millet agriculture to the southern area by that time.

Received September 12, 2021; accepted October 15, 2021

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Keywords southern Anhui, Jingshuidun site, rice, millet, phytolith

1 Introduction

The emergence and spread of agriculture in the Neolithic had a revolutionary impact on the development of human society (Li et al., 2007), and it provided a solid economic basis for the origin and development of human civilization (Diamond, 2002; Iriarte et al., 2004; Jones et al., 2011; Chen et al., 2015; He et al., 2017). China's main agricultural production areas today are separate by the Qinling Mountains and Huai River, which demarcate the geographic boundary between northern and southern China. The northern region mainly cultivates xerophytic crops, the southern region is dominated by rice agriculture (Crawford and Shen, 1998), and there is a mixture of cultivation on the border between these regions (He et al., 2017). This hybrid agriculture system, which includes rice, wheat and millet, is the result of a long-term process involving climate change, cultural transmission, and historical development (Zhang et al., 2012; He et al., 2017; Wang et al., 2018). For example, people at many sites on the middle Yellow River cultivated only millet and other xerophytic crops in the middle Neolithic (Zhao et al., 2004a; Chen et al., 2018; Tang et al., 2020). However, rice cultivation spread northward when summer monsoons strengthened during the mid-Holocene, resulting in mixed agriculture in this area (Zhang and Wang, 1998; Zhang et al., 2010b). In southern China, the original crop was rice (Yan, 1997; Yang and Jiang, 2010; Zhao, 2014; Liu, 2016), but over time, millet cultivation gradually spread (Miller et al., 2016; Deng et al., 2018; Gao et al., 2020; Dai et al., 2021). Affected by these various environmental and social developmental factors, there are still many issues about spatiotemporal detail of agriculture development in southern Anhui Province, China, with most information currently deriving from historical documents and rather limited archeological evidence.

During the Zhou Dynasty, ancient documents and the excavation of bronze material points to a close link between southern Anhui Province and the Central Plains (Sima, 2008). While millet was the main agricultural products of the Central Plains at that time (He et al., 2017; Wang et al., 2018), it is not known when millet cultivation spread to southern Anhui Province.

In the last two decades, analyses of macrobotanical and phylolith remains has illuminated early plant utilization in the region, and the origin, development, and spread of millet and rice cultivation (Piperno, 2014; Lu, 2017; Wang et al., 2018; Li et al., 2021). While still in its infancy, initial archeobotanical research in southern Anhui Province indicates that rice cultivation has been dominant in this area since the middle Neolithic (Yang et al., 2016). However, relevant details about the transmission and development of millet agriculture in southern Anhui Province are still unclear in early period.

Southern Anhui Province is characterized by complex geography and diverse cultures (Su and Yin, 1981). Based on previous archeological investigations and excavations, many sites in southern Anhui Province have only one period accumulation, with commonly thin and short-lived cultural layer (Gong and Cheng, 1998; Chen and Hao, 2013). These results in great difficulties in reconstructing archeological culture and the development of archaeobotany. Jingshuidun site is located at the intersection of the lower reaches Yangtze River Plain and the mountainous area in southern Anhui Province, which preserves thick archeological strata and a rare superpositional relationship of multiple occupational periods, allowing for the study of cultural stages and archaeobotany. Here, we use macrobotanical remains, phytolith analysis, and published archeological data to explore the development and status of the changes in rice and millet agriculture in the middle-late Liangzhu Period, the late Western Zhou Dynasty and the early Spring and Autumn Period in southern Anhui Province.

2 Methods and materials

2.1 Background of the site

The Jingshuidun site (31°48′3″N, 117°11′50″E) is located in Xindu village, Dingjiaqiao town, Jing County, Xuancheng, Anhui Province (Fig. 1), 150 m north of the Qingyi River adjacent to the rural road in the south, and approximately 1 km west of Dingjiaqiao town. The local terrain is dominated by low hills, with an average elevation of 64 m, which decreases gradually from southwest to northeast. The southeast and northwest regions are relatively higher hills and mountains, set within a belt valley and alluvial plain formed by the Qingyi River and its tributaries. The site can be divided into the Yangtze River Basin and Qingyi River Basin in Anhui Province. From April to October 2018, the Anhui Provincial Institute of Cultural Relics and Archaeology and the Jing County Bureau of Cultural Relics carried out rescue excavations at the Jingshuidun site. Before excavation it was destroyed by a pond in the east and paddy fields in the west and the north. The excavation area of the Jingshuidun site is approximately 102 m^2 and contains 37 unified layers (Fig. 1). Layer 1 is a modern disturbed layer, layers 2–7 (0–100 cm) were formed during the Tang Dynasty, layers 8–35 (100–230 cm) were deposited during the late Western Zhou Dynasty to the early Spring and Autumn Period, and layers 36–37 (230–335 cm) correspond to the middle-late Liangzhu Period. In addition, 41 relics from the middle-late Liangzhu period, late Western Zhou Dynasty and early Spring and Autumn Period were recovered. The archeological remains from the middle-late Liangzhu Period include pottery, lithic artifacts, and jade articles, and the quantity and variety of pottery and lithic artifacts are abundant. Most of the relics from the Western Zhou Period are pottery, and include tripods, yans, li, spinning wheels, and other objects. Lithic artifacts are relatively less abundant than other remains, but include adzes, shovels, sickles, and other implements.

2.2 Stratigraphy and sample collection

Before excavation, the eastern and western parts of the Jingshuidun site were seriously damaged, and only the southwestern corner remained. In this area, the accumulated sediments are thick, and most of the bedding is near horizontal, except for a few overlying layers which dip to the west.

Given the conditions of the Jingshuidun site, this study adopted the section sampling method (Zhao, 2004b). Samples were collected from the layers corresponding to each depth interval at the site, including the middle-late Liangzhu Period, the late Western Zhou Dynasty, the early Spring and Autumn Period and the Tang Dynasty. To comprehensively understand the plant remains at the Jingshuidun site, we collected 64 paleosol samples for recovery of macrobotanical remains, and 44 samples for phytolith analysis. We also obtained 20 paleosol samples from layers at different depths for phytolith collection and extraction to avoid the impact of macrobotanical remains on the phytolith diversity here.

Given the different thicknesses of the cultural layers across the different periods, the proportion of 64 samples collected at different depths of the site varied greatly. The Western Zhou Dynasty layer was thicker and had the largest number of samples. The cultural layers of the

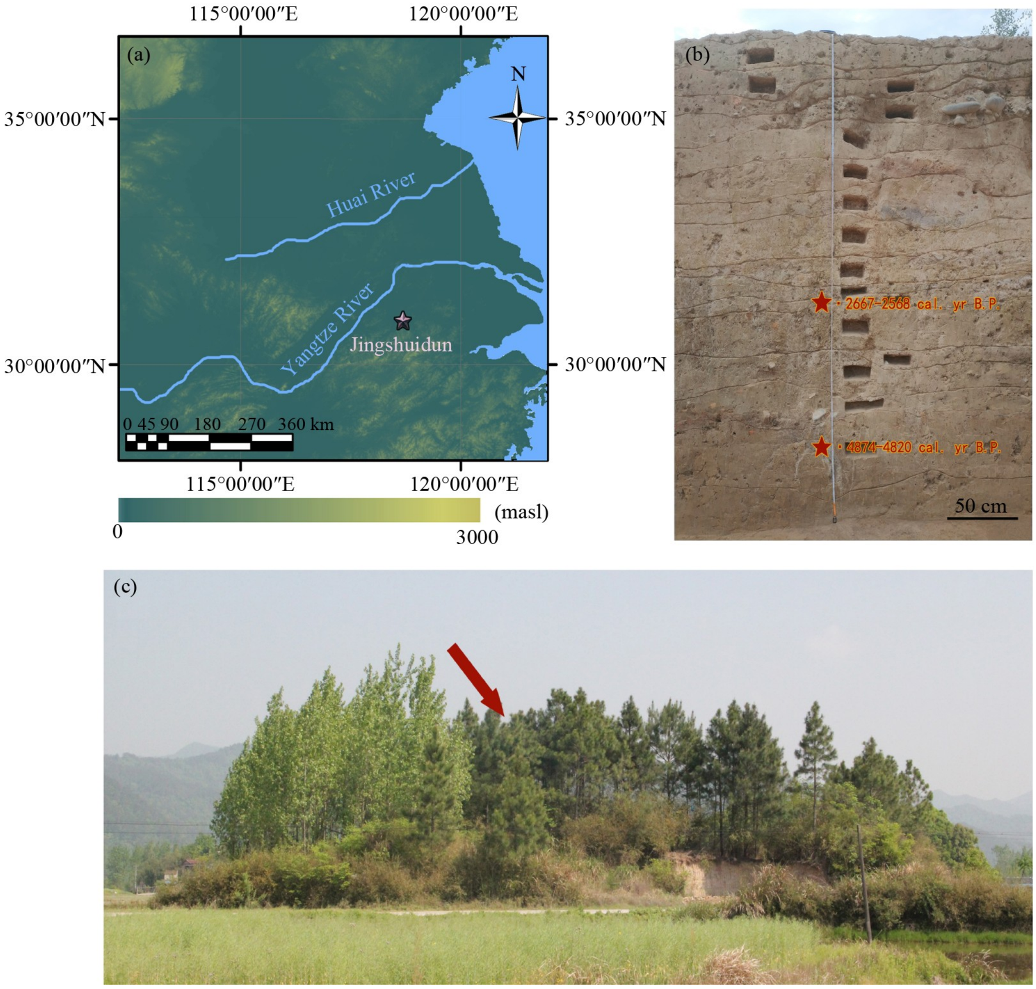

Fig. 1 Geographic location of the Jingshuidun site in Xuancheng, Anhui. (a) Location of the Jingshuidun site. (b) Stratigraphic profile of the T0202 south section and the AMS ^{14}C result. (c) Panoramic view of the Jingshuidun site.

middle-late Liangzhu period and Tang Dynasty were relatively thin, and as a result the number of samples was small.

2.3 Experimental methods

Flotation was done at the excavation site. The dried samples were taken back to the Key Laboratory of Vertebrate Evolution and Human Origins in the Institute of Vertebrate Paleontology and Paleoanthropology of the Chinese Academy of Sciences in Beijing for classification and identification. Some of the carbonized millet from strata deposited during the late Western Zhou Dynasty to the early Spring and Autumn Period was sent to the A.E. Lalonde AMS Laboratory in Canada and the BETA Laboratory in the United States for accelerator mass spectrometry (AMS) ^{14}C dating analysis.

The samples taken for phytolith analyses were dried, ground, and sieved in the laboratory before proceeding in order to reduce the impact of sand and gravel impurities in the samples. Phytoliths were extracted using heavy liquid flotation. The general process was as follows: 5 g of a soil samples was placed in a clean beaker, 30 mL hydrogen peroxide (H_2O_2) was added, and the mixture was placed on a hot plate to react for approximately 20 min in order to remove organic matter. After allowing the sample to cool, dilute hydrochloric acid (10% HCl) was added, and the sample was boiled to remove minerals. After the sample cooled and stood for 24 h, distilled water was added, and the sample was centrifuged for 3 min to remove any hydrochloric acid. Afterwards, the heavy liquid 2.3–2.4 specific gravity zinc bromide was added, and the supernatant was absorbed and centrifuged three times to purify the sample. Finally, the extracted phytoliths were placed in the oven to dry. We used Canadian gum as the final preparation to fix all phytolith samples before observation, identification, statistics collection, and photography under a Nikon Eclipse LV100P0L microscope (500 ×). Five hundred phytoliths were counted randomly from each sample, and the percentage of each type was calculated by TILIA software (Grimm, 1991). Phytolith nomenclature follows the terminology of the International Code for Phytoliths Nomenclature 2.0 (Neumann et al., 2019).

3 Results

3.1 Chronological results

Three charcoal samples from different strata were sent to the BETA Laboratory in the United States, and one carbonized millet sample was sent to the A.E. Lalonde AMS Laboratory in Canada for dating (Table 1). Laboratory numbered Beta-511211 are Neolithic, Beta-511207 and Beta-511208 are from the late Western Zhou Dynasty to the early Spring and Autumn Period. The AMS ^{14}C dates show that Neolithic remains is 4874–4820 cal. yr B.P.. The result of the dated sample from the late Western Zhou Dynasty to the early Spring and Autumn Period is 2667–2568 cal. yr B.P. (No. UCO-10575), which are highly consistent with previous results based on pottery typology.

3.2 Flotation results of macrobotanical remains

The macrobotanical remains at the Jingshuidun site can be divided into two categories: charcoal and carbonized seeds (fruits). We identified two kinds of crops from the flotation samples at this site, rice (*Oryza sativa*) and foxtail millet (*Setaria italica*).

Given the limitation of the sample volumes, we classified and identified only 2 stratigraphic samples from the middle-late Liangzhu Period, 40 stratigraphic samples from the late Western Zhou Dynasty to the early Spring and Autumn Period, and 2 stratigraphic samples from the Tang Dynasty time period. In total, 156 carbonized seeds (fruits) were identified among 32 samples. We divided the identified carbonized seeds into crop and non-agricultural crop seeds, of which crop seeds are the majority. There were 138 carbonized crop seeds, accounting for 88% of the total number of identified seeds. Among them, 46 were grains of rice (*O. sativa*), and 87 were grains of foxtail millet (*S. italica*). Weed seeds such as broomcorn, legumes, Urticaceae, Chenopodiaceae and Compositae are commonly found in fields. Twenty-two seeds could not be identified (Table 2).

During the carbonization process, the millet embryos fall off and leave “U”-shaped pits. The length and thickness of most caryopses also are significantly expanded, but the width changed only slightly. Millet is the most abundant crop remain found in the site, followed by rice. Complete rice caryopses are 3.74–4.93 mm long, 2.02 to 2.98 mm wide, and 1.32 to 2.24 mm thick. Most caryopses are incomplete because of the preservational environment (Fig. 2 and Fig. 3). Carbonized rice first appears in the 36th stratigraphic layer which was deposited during the middle-late Liangzhu Period, and carbonized foxtail millet first appears in the 34th layer, corresponding to the late Western Zhou Dynasty to the early Spring and Autumn Period.

3.3 Results of phytolith identification

In this study, we assessed phytoliths from 20 samples numbered 1–20 from different layers of the Jingshuidun site in the middle-late Liangzhu Period, late Western

Table 1 AMS ^{14}C dates from the Jingshuidun site in Anhui Province

Laboratory No.	Sample name	Type	Age/(yr B.P.)	Calendar calibration/(cal. yr B.P.)
Beta-511211	2018JJT020122	Charcoal	4270±30	4874–4820
Beta-511207	2018JJT020211	Charcoal	2590±30	2769–2703
Beta-511208	2018JJT020224	Charcoal	2580±30	2763–2699
UCO-10575	FX54T020312	Charred millet seeds	2529± 25	2667–2568

Table 2 Taxonomic diversity and amount of charred plant remains identified by flotation at the Jingshuidun site

Taxa	Middle-late Liangzhu Period	Late Western Zhou Dynasty to early Spring and Autumn Period	Tang Dynasty	Total
Rice (*Oryza sativa*)	1	44	1	46
Foxtail millet (*Setaria italica*)	0	92	0	92
Panicoideae	0	8	0	8
Fabaceae	0	4	1	5
Asteraceae	0	1	1	2
Urticaceae	0	1	0	1
Solanaceae	0	1	0	1
Chenopodiaceae	0	1	0	1
Total	1	152	3	156

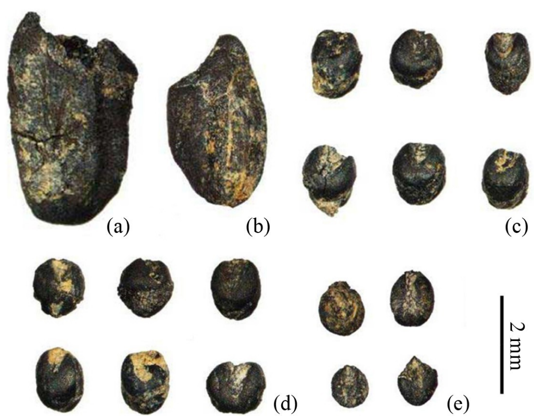

Fig. 2 Main types of charred crop remains identified at the Jingshuidun site. (a) Layer 13, rice caryopsis; (b) Layer 19, rice caryopsis; (c) Layer 12, foxtail millet caryopsis; (d) Layer 19, foxtail millet caryopsis; (e) Layer 12, Panicoideae caryopsis.

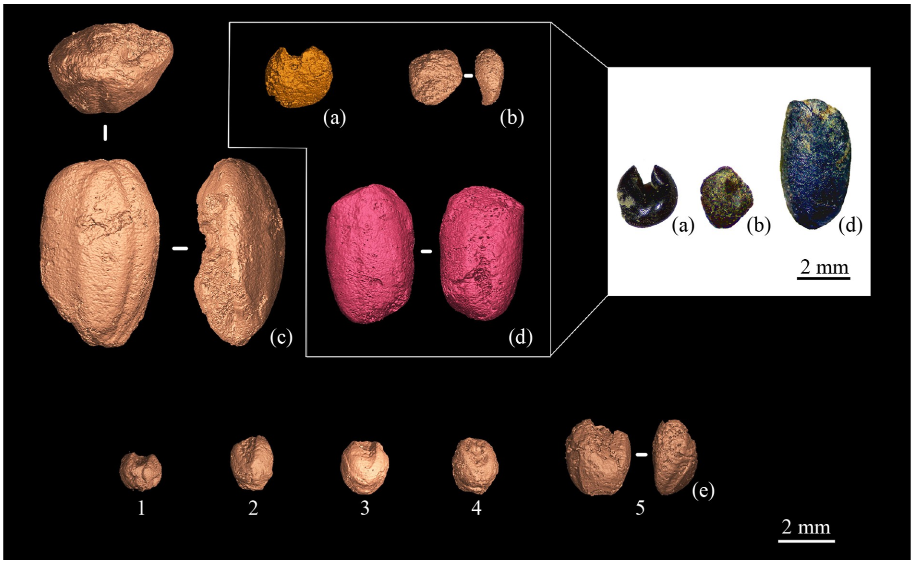

Fig. 3 3D model of major charred plant remains identified at the Jingshuidun site. (a) Layer 25, Chenopodiaceae caryopsis; (b) Layer 27, Solanaceae caryopsis; (c) Layer 27, rice caryopsis; (d) Layer 32, Fabaceae caryopsis; (e)1–4: Layer 25, 5: Layer 26, foxtail millet caryopsis.

Zhou Dynasty to early Spring and Autumn Period, and Tang Dynasty (Fig. 6). More than 20 phytolith types were identified from a total of more than 10000 individual phytoliths counted.

The common phytolith types include bilobate, long saddle, short saddle, rondel, elongate echinate, smooth elongate, bulliform flabellate, square, rectangular, acicular, and others (Fig. 3). In addition to the common phytolith types, a number of phytolith forms that can be identified to particular species are present (Fig. 4). A few crops have particular phytolith morphologies, such as bulliform flabellate phytoliths present in rice leaves, multicellular phytoliths with double-peaked glume in rice glume, Ω-undulating forms in *S. italica*, *η*-undulated forms in *P. miliaceum*, and implanted silica (Fig. 5). In addition, there are bulliform flabellate phytoliths from bamboo leaves and multilateral cap phytoliths from Cyperaceae (Neumann et. al, 2019).

As can be seen in the phytolith abundance diagram (Fig. 6), rice (*O. sativa*), broomcorn millet (*Panicum miliaceum*), and foxtail millet (*S. italica*) are common in the layers of the Jingshuidun site from the Tang Dynasty and late Western Zhou Dynasty to the early Spring and Autumn Period, but their proportions vary greatly. Rice is the only crop found in the oldest layer (dated to 4874–4820 cal. yr B.P.). Depending on the stratigraphic level, the proportions of rice and millet at the Jingshuidun site vary between ~1.5%–18.3% and 0–1.6%, respectively. Rice phytoliths are more common in each layer, and millet is less common. The percentage of rice in the middle-late Liangzhu Period is lower than that of the late Western Zhou Dynasty to the early Spring and Autumn Period and the Tang Dynasty layers. The percentages of rice (*O. sativa*), broomcorn millet (*P. miliaceum*), and foxtail millet (*S. italica*) in the layer from the late Western Zhou Dynasty to the early Spring and Autumn Period (2667–2568 cal. yr B.P.) is higher than those of the middle-late Liangzhu Period (4874–4820 cal. yr B.P.) and Tang Dynasty. The maximum proportions of these three crops are in the layers dated to 2667–2568 cal. yr B.P. Rice has the highest occurrence rate of 100%, followed by foxtail millet (55%), and broomcorn millet has a lower occurrence rate of 10%. This phytolith abundance diagram indicates that the square, rectangular, bilobate, and saddle phytoliths indicate warm environments, and a small number of miscanthus bulliform and sponge spicules indicate a moist environment with a higher percentage than the phytoliths indicating cool and dry climates (Wang and Lu, 1993; Wu and Wang, 2011; Wu et al., 2016).

4 Discussion

4.1 Agricultural activities and plant utilization at the Jingshuidun site

The flotation samples from the Jingshuidun site are derived from layers dated to 4874–4820 cal. yr B.P. and produced. two kinds of crops, rice (*O. sativa*) and foxtail millet (*S. italica*). Crop seeds dominate the samples as ~88% of all seeds recovered. This indicates that crop areas were largely cleared of other plants. Rice (*O. sativa*) is present in the layers corresponding to the middle-late Liangzhu Period (4874–4820 cal. yr B.P.), the late Western Zhou Dynasty to the early Spring and Autumn Period (2667–2568 cal. yr B.P.), and the Tang Dynasty. Millet (*S. italica*) is in the layers corresponding to the late Western Zhou Dynasty to the early Spring and Autumn Period and the Tang Dynasty (Table 2). Double-peaked

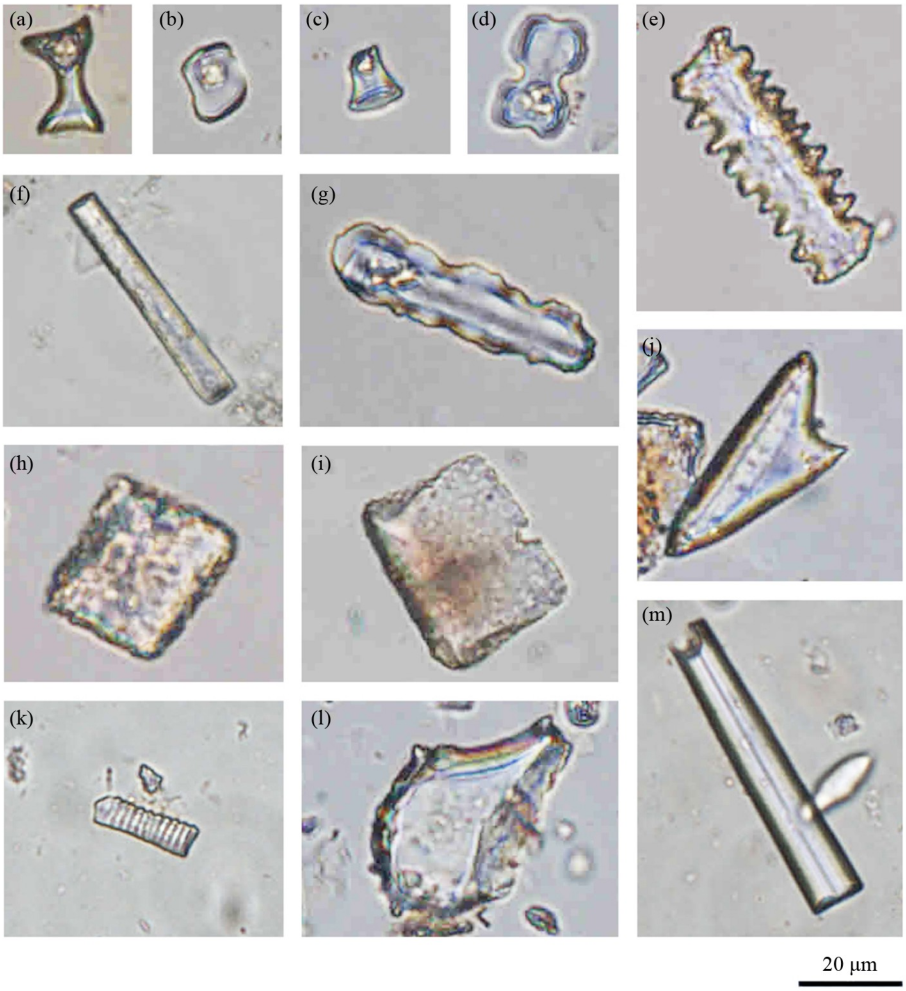

Fig. 4 Photographs of common phytolith morphologies and sponge spicules at the Jingshuidun site. (a) Layer 15, long saddle; (b) Layer 5, short saddle; (c) Layer 13, rondel; (d) Layer 15, bilobate; (e) Layer 14, elongate echinate; (f) Layer 4, smooth-elongate; (g) Layer 16, festucoid; (h) Layer 15, square; (i) Layer 5, rectangular; (j) Layer 33, acicular; (k) Layer 36, silicious vessel; (l) Layer 25, bulliform; (m) Layer 36, sponge spicule.

phytoliths from rice husks and *Oryza*-type bulliform phytoliths from the epidermis of rice leaves are mostly typical domesticated forms. *Oryza*-type bulliform phytoliths have a fish scale pattern, and the patterns' number that were ⩾ 9 (Fig. 4(g)) derive from cultivated rice (Lu et al., 2002; Lu, 2017). The percentage of typical phytoliths in rice is approximately 12 times higher than the typical phytoliths of millet based on the analysis of phytoliths and carbonized macroremains. Rice has a long history in southern Anhui Province and held an important position in the diet of people there. Considering that the seed setting rate of millet is much higher than that of rice (Bao et al., 2018), the weight of 1000 millets is about 2–5 g, and the weight of 1000 rice caryopses is about 22–26 g (Li, 1979). The mass of a single caryopsis of rice is approximately 10 times that of a single millet seed, and the energy produced by a rice caryopsis is much greater than that of a single millet seed. Therefore, the number of millet grains produced by floatation was greater than that of rice, and cannot form the basis for examining the amount of dry cultivation in this region. In addition, phytolith evidence demonstrates that rice phytoliths are more abundant than those of millet in the layers from the late Western Zhou Dynasty to the early Spring and Autumn Period and Tang Dynasty. Based on the data above, it appears that rice cultivation was dominant in these periods. Millet agriculture spread to southern Anhui Province, by at least the late Western Zhou Dynasty, demonstrating the acquisition of mixed agriculture in southern Anhui Province.

4.2 The emergence and change in the status of rice in southern Anhui Province

Rice cultivation originated in China, and its record in the middle and lower reaches of the Yangtze River dates back ten thousand years (Yan, 1997; Huang and Zhang, 2002). The remains of cultivated rice have been recovered from the Shangshan site of Pujiang, Zhejiang Province, Xianrendong and Dandonghuan sites of Wannian County,

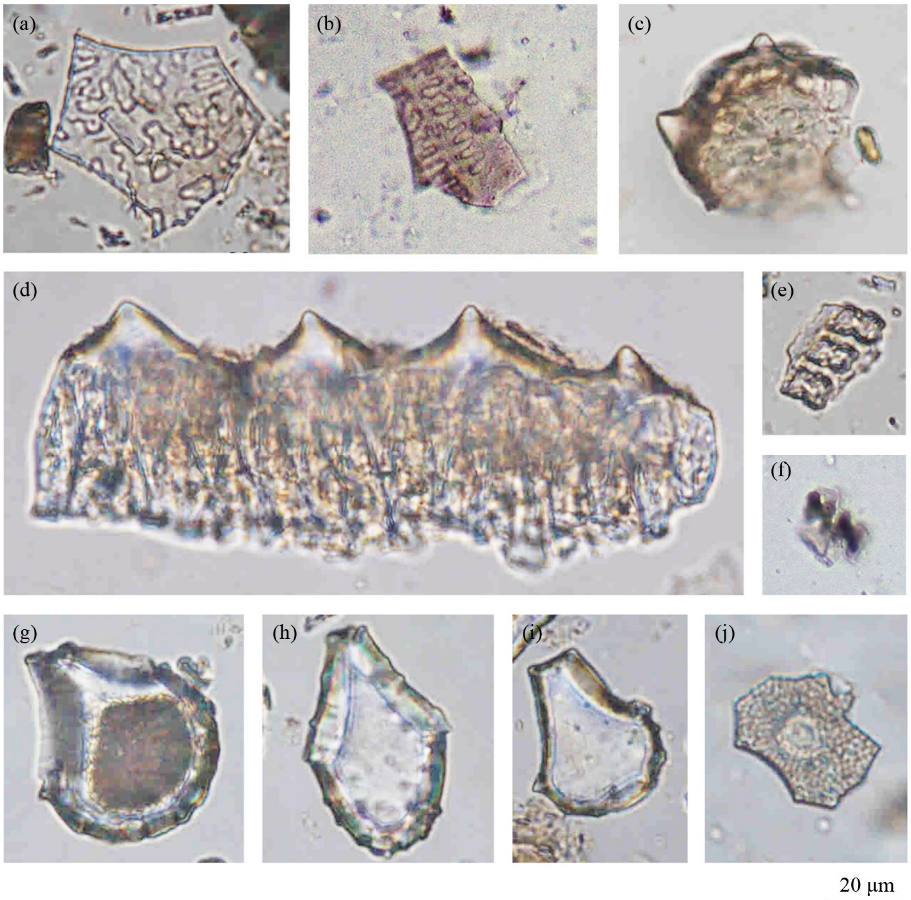

Fig. 5 Photographs of identified phytolith types at the Jingshuidun site. (a) Layer 8, Ω-undulated form in *S. italica*; (b) Layer 16, η-undulated form in *P. miliaceum*.; (c) Layer 5, double-peaked glume cells; (d) Layer 16, multicellular phytolith with double-peaked glume; (e) Layer 16, parallel bilobates with scooped ends; (f) Layer 33, parallel bilobates with flat ends; (g) Layer 14, rice bulliform; (h) Layer 26, bulliform flabellate; (i) Layer 15, bulliform flabellate; (j) Layer 14, Cyperaceae.

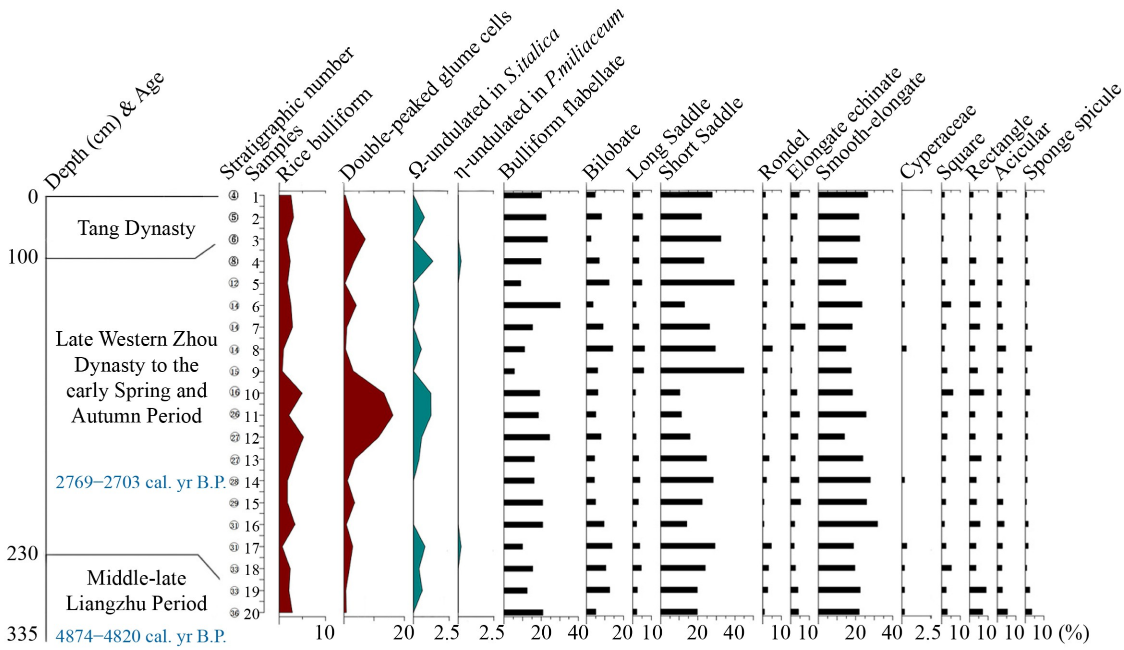

Fig. 6 Phytolith abundance diagram from the Jingshuidun site.

Jiangxi Province, and Yuchan site of Daozhou, Hunan Province (Liu, 2016). In the mountain, rice remains have been found at the Miudun site (7060–6890 cal. yr B.P.) in the middle Neolithic (Yang et al., 2016). As early as the 1980s, the origin of rice in the lower reaches of the Yangtze River gradually became the mainstream view of researchers (Yan, 1989; Qin, 2012; Zhao, 2018). The subsequent discovery of paddy fields of the Majiabang culture in the lower reaches of the Yangtze River, such as the Caoxieshan site and Choudun site, indicated that the lower reaches of the Yangtze River played a key role in the origin and development of rice cultivation, which was the birthplace of rice cultivation and domesticated rice (Ding, 2004). At present, it is recognized that rice domestication was close to 6500–6000 cal. yr B.P. in the middle-late Neolithic period (Fuller, 2011). Southern Anhui Province is located in the lower reaches of the Yangtze River, in the core area for the origin of rice agriculture. Although the number of macro and micro rice remains is relatively rear in the layer dated to 4874–4820 cal. yr B.P. at the Jingshuidun site, but still demonstrates the possibility that rice cultivation was being carried out widely in southern Anhui Province during this period. The preservation of carbonized and phytolith rice remains points to the abundance of rice cultivation and the interlinked importance of this crop in the diet and lifeways of the people in the region. It does not appear that the production and utilization of rice was affected by the southern spread of millet agriculture as indicated by the continued presence of carbonized rice and rice phytoliths in the youngest Tang Dynasty layers. Moreover, New history of the Tang Dynasty and Peace world Record said Xuanzhou is suitable for growing rice. These record shows that rice is one of the important crops here in Tang Dynasty (Ouyang and Song, 1975; Le et al., 2007). Rice cultivation has a long history in southern Anhui Province, and it likely is related to the warm and humid climate in this region.

4.3 The emergence and change in the status of millet in southern Anhui Province

Broomcorn millet (*P. miliaceum*) and foxtail millet (*S. italica*) starch grains were found at the Houjiazhai site (6.2–5.6 ka B.P.) near southern Anhui Province, and evidence of xerophytic crop cultivation has been reported in the middle reaches of the Huai River (Luo et al., 2020). The remains of millet were found at the Western Zhou Dynasty aged Huoqiu site in Lu’an, Anhui Province, and rice cultivation also continued to be a major part of life at that site (Wu et al., 2007; Liu, 2017). In our study of the Jingshuidun site, there were many traces of carbonized millet remains in layers dated to 2667–2568 cal. yr B.P., which is the earliest direct dating of millet remains in southern Anhui. Evidence of macrobotanical remains at the Jingshuidun site shows that dry cultivation techniques from northern China had spread to southern Anhui by 2667–2568 cal. yr B.P., and that mixed cultivation of rice and millet occurred.

Historical records show that when Wu Taibo (3165–3074 cal. yr B.P.; the son of King Taibo of the Zhou Dynasty) lived in Guanzhong, millet was the main agricultural crop. Representative sites in the Guanzhong area, such as Longgansi, Banpo, Yuhuazhai, and Zhouyuan, produce a large amount of millet remains (Tan, 1982; Zhao and Xu, 2004a; Sima, 2008; Chen et al., 2018; Tang et al., 2020). The Zhou Dynasty moved its capital to the Central Plains in 2771 B.P., and the sites in that area such as Jiazhuang and Zhangdeng site since Neolithic ages, Wangchenggang site since Zhou Dynasty exhibit a mixture of rice and millet since the Neolithic (Zhang, 1998; Zhang et al., 2010a; He et al., 2017; Cheng et al., 2020). Archaeological data show that the bronzes of Wu have the characteristics of typical Zhou culture (Yang, 1991) demonstrating the existence of cultural exchange between southern Anhui Province and Guanzhong during the Western Zhou Dynasty (Fig. 7), affirming historical records. That communication between the Zhou and native Anhui cultures may have extended to agricultural practices such as the cultivation of millet, resulting in its spread to southern Anhui Province.

According to historical documents (Zhao, 1992; Sima, 2008), the State of Wu ruled its people according to the Zhou Dynasty, they developed rice cultivation according to local customs, and the people of Wu became rich and prosperous (Zhao, 1992). Many copper agricultural tools from the Western Zhou Dynasty were unearthed in this area, and large amounts of grain are known from tombs (Liu, 1982). Both lines of evidence indicate that the Wu State attached great importance to and effort in agricultural production.

The carbonized millet unearthed in the cultural layers dating to 2667–2568 cal. yr B.P. in southern Anhui Province likely is the long-term product of the communication between the Central Plains and local cultures in southern Anhui Province. The introduction of millet agriculture to a certain extent likely improved the productivity of this region, and aided in creating a material foundation for Wu Kingdom to dominate southeastern China.

5 Conclusions

Our exploration of the archeobotanical evidence at the Jingshuidun site of southern Anhui Province using macrobotanical and phytolith remains begins to fill in gaps in our knowledge about the spread and importance of different aspects of early agriculture. The macrobotanical rice remains and phytoliths from the Jingshuidun site are dated to 4874–4820 cal yr B.P. and 2667–2568 cal. yr B.P., and those of foxtail millet (*S. italica*) date to

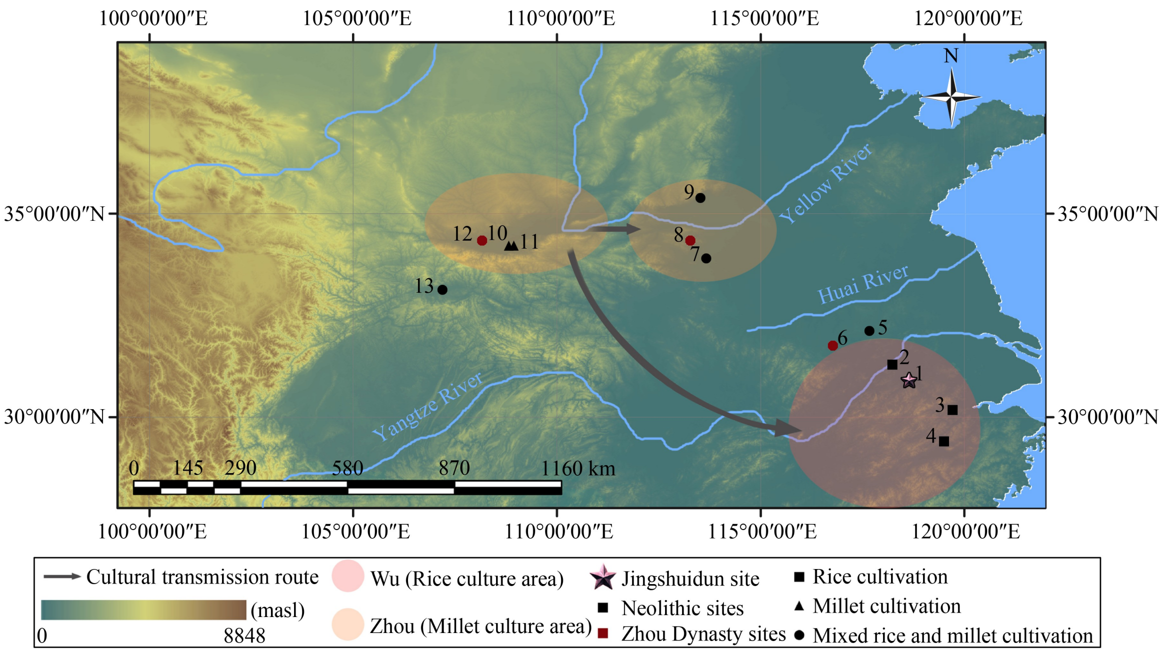

Fig. 7 Location of archeological sites preserving records of millet and rice cultivation. (1) Jingshuidun, (2) Miudun, (3) Liangzhu, (4) Shangshan, (5) Houjiazhai, (6) Liuan, (7) Jiazhuang, (8) Wangchenggang, (9) Zhangdeng, (10) Yuhuazhai, (11) Banpo, (12) Zhouyuan, (13) Longgangsi.

2667–2568 cal. yr B.P.. This site preserves the earliest direct dating of millet remains in southern Anhui Province (2667–2568 cal. yr B.P.). Our data show the continued importance of rice cultivation in the area since the Neolithic, but also documents the spread of millet and mixed rice/millet cultivation into southern Anhui Province likely as the result of communication with the Western Zhou Dynasty.

Acknowledgments This work was supported by the Strategic Priority Research Program of the Chinese Academy of Science (No. XDB26000000), the National Natural Science Foundation of China (Grant No. 41877427), and the Youth Innovation Promotion Association of the Chinese Academy of Sciences (No. 2018099). We also thank the reviewers for valuable comments on an earlier draft of the manuscript, and Thomas Stidham provided valuable and extensive editorial feedback on a previous draft.

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