Survey and Preliminary Study of Rice Farming Remains on the Yangjiajuan Site in Qixia County, Shandong

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One of the important issues in the study of early cultural diffusions in East Asia concerns rice migrations from the Mainland to Korean Peninsula and Japanese Archipelago. One of the questions often being asked is in what form of rice agriculture was learned and continued in foreign lands. In order to explore this issue, ongoing archaeological surveys and excavations at either dry-rice field or paddy-rice field sites as well as the use of field landscape will contribute to our understanding of rice diffusion in East Asia.

So far there are several Neolithic sites in Shandong Peninsula with rice remains. With the objectives of investigating the timing, routes, and contexts of rice agriculture diffusion, in 2004 a joint team of Chinese and Japanese scholars conducted archaeological surveys in East Coastal areas. The team later decided to focus on one of such sites – the Yangjiajuan site in Qixia County and its surrounding area for further test excavations to obtain study samples.

The Yangjiajuan site is located in the east of the Yangjiajuan Village, which belongs to the administrative district of Qixia County of Yantai Municipality, Shandong Province. The State Highway 204 runs through the east side of the site, leaving the remaining site about one hectare undisturbed. The topography of the site is in general of hilly and valley landscape, as the site is situated in the west edge of a basin. To the east is the Qingshuihe River running from the northwestern to southeastern site, while a small creek joins into the Qinshuihe River each at northern and southern sides of the site, respectively; thus the site is situated on the terraces between two creeks at 130m above sea level (Figure 1). The site was initially excavated in 1981, revealing multiple cultural layers. The Lower Layer is affiliated with the later phase of Dawenkou Culture, while the Upper Layer is of Longshan Culture. The 1981 excavation discovered husk

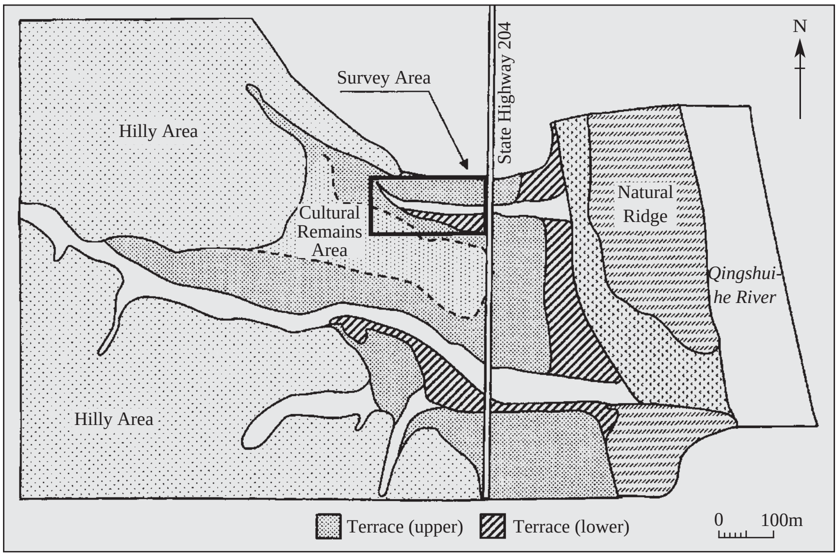

Figure 1. The Topography of the Vicinity of Yangjiajuan Site and the Surveyed Area for Rice Farming Remains

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remains of rice and millets and impressions of plant stems, leaves and roots in burned clays of the Longshan deposit.

The Defining of Research Method and Survey Area

1. Defining Research Method

Our investigation started with identifying the topographic features surrounding the site in order for us to define a survey area in the region being studied. Then through grilled coring survey, we systematically collected soil samples and conducted Phytolith Quantitative Analysis (PQA) from the collection extracted from the soil sample, so as to allow us to identify deposits where phytoliths were concentrated. Combining these data along with stratigraphic features, we would be able to understand general areas related to ancient rice cultivation. Such method has been practiced quite successfully in Japanese archaeology. The same method was applied to the archaeological investigations at the Caoxieshan site, resulting in some exciting data.

2. Defining Survey Area

In general, the field for rice cultivation should be in lowlands or valleys where water sources are affluent. However, to the west of Yangjiajuan site is modern village on high terrace without sufficient water sources; to its south was a modern development zone, resulting in a severe damage to the site. To the east of the highway is an apple orchard, causing difficulties for the operation of the survey.

In the north side of the site there is a creek, whose riverbed was much wider and more curved in the 1960s. The distance from the bank of the creek to the site was about several dozen meters and suitable for cultivation. Therefore, we decided to concentrate our surveys in the area to the north of the creek.

Identification of Coring Grid and Collection of Soil Samples

First of all, we surveyed the area to produce a general topographic map surrounding the site. We then set due direction grid coring system to collect soil samples, in rows of due east-west and due north-south with 10–25m in intervals. During the surveys, we also needed to adjust the distance between coring to less than 10m in order to justify the distribution of same types of sediments. The random coring intervals near the highway are set to record the impact of the constructions to the site (Figure 2).

The coring tool employed in our survey is 1.5m long gouge spades, with attachable extension to 3m. The diameter of the gouge ranges from 1.6 to 2.2cm. The tip of the gouge was specially modified into a 50cm long holding compartment. Therefore, coring would extract 50cm soil samples in length each time from the surface left in previous time and continued to the sterile sediment layer.

We would then collect the soil samples from the connected soil column of each coring based on textures, color and granulation density of the sediment. The sample was then numbered and placed in Ziploc plastic bags, along with the detailed records. For the purpose of visual comparison, the recording notebook may be designed to contain small grains of soil sample. If the soil sample contains potsherds, burned clays, and plant remains etc., extended recording will be necessary for future use.

Soil Analyses

The soil collection is then processed for testing according to the requirement of the PQA. The PQA is referred to a special procedure to test the quantity of the phytoliths with aids of tiny glass balls; that is, the process will add 300,000 such tiny glass balls in each one gram soil. The glass balls have the similar size to the phytoliths of the motor cell with a diameter of 30–40μm, so does the composition. Therefore, during the testing process, these glass balls react to the impact of physical and chemical conditions in the same way as the phytoliths do. Therefore, the testing is based on the assumption that

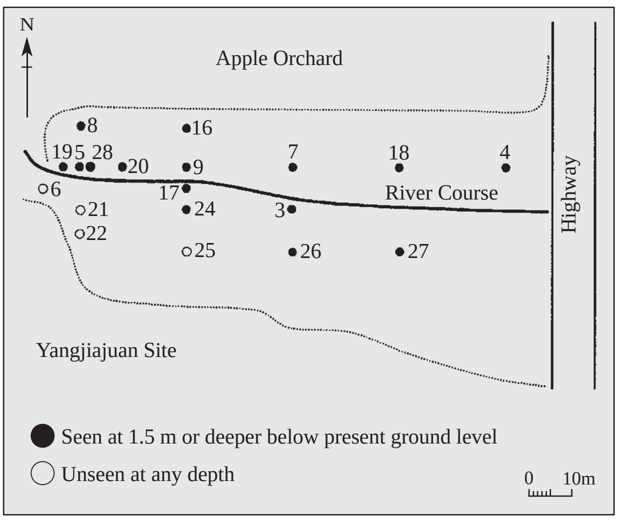

Figure. 2 The Distribution of Coring and the Discoveries of Rice Phytoliths

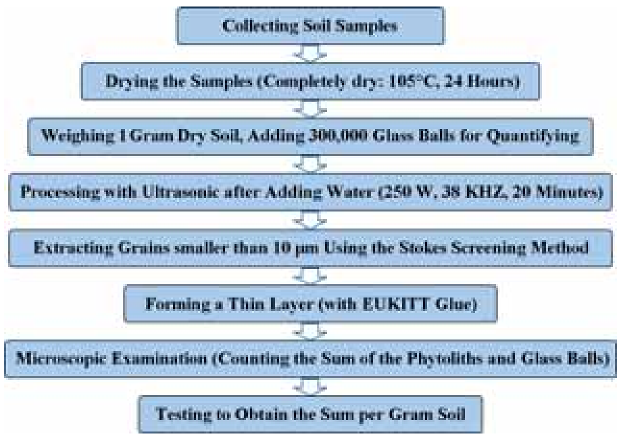

Figure 3. Flow-chart of the PQA

quantity of glass balls and the phytoliths will not change after the process of testing.

Based on such assumption, if one can count the sum of the phytoliths and glass balls, then the sum of rice phytoliths per gram soil can be calculated (Figure 3).

It must be pointed out that the glue applied to forming the thin layer for testing sample needs to use the EUKTT type glue which has the refractive index same as the volcanic glass, providing clear visual for identification of the phytoliths. However, in assistance to identifying the plant species of the phytoliths, a high-power optical microscope with 100–400 x magnifications should be employed to examine the size, shape, and structure of the phytoliths.

We have examined 225 soil samples from the Yangjiajuan site. The PQA reveals the plants belonging to rice (*Oryza sativa L.*), reed (*Phragmites*), bamboo (*Bambusoideae*), silver grass (*Miscanthus*) and millet (*Panicum*).

Results

1. The Correlations between Reconstructed Soil Layers and the Deposit Layers

If we connect No. 16 and No. 25 coring along the north-south line, and No. 4 and No. 19 along the east-west line, then we can obtain a reconstructed soil accumulation sequence: A. plough zone, commonly appearing; B. sandy sediment, containing a few sub-layers; C. sandy and silty sediment; D. black soil and dark-brown sediment containing organic materials and E. Sterile sediment (Figures 4 & 5).

Correlating with the deposit layers, it appears that the north-south line soil deposit has remained the same

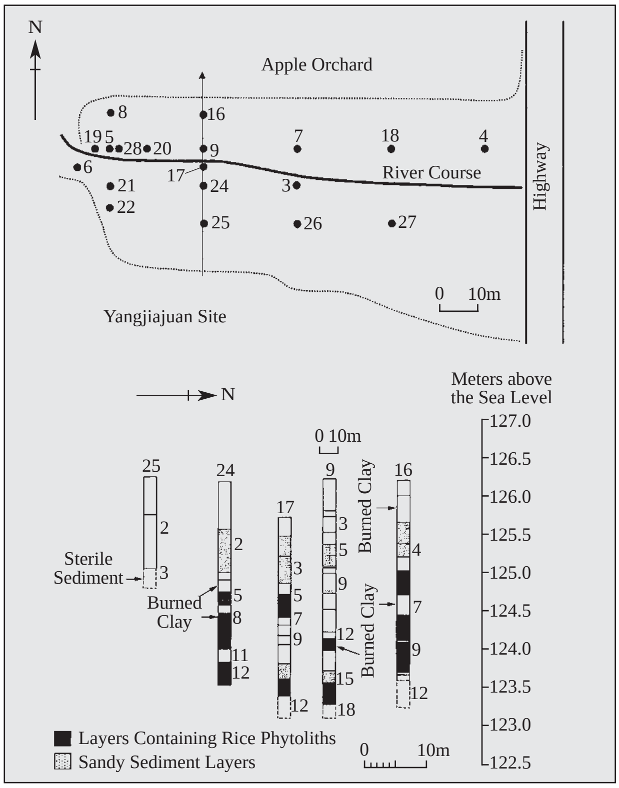

Figure 4. The Array of Coring Positions along N-S Direction and Detecting Results (Diagram Showing the Sequences of Cores)

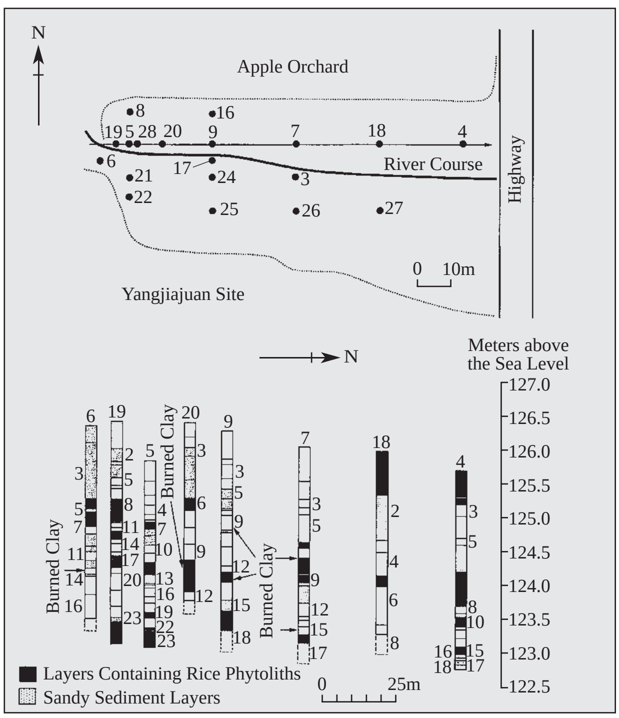

Figure 5. The Array of Coring Positions along W–E Direction and Detecting Results (Diagram Showing the Sequences of Cores)

stratigraphy at present without dramatic changes. Along the east-west line paralleling the riverbed, the stratigraphy layers are very close to those in the north-south line, except a few sections where the correlation is hard to match.

2. Examination of Rice Phytoliths

During our examination of soil collection, we identified phytoliths of rice motor cells as well as that of husks. Meanwhile, we also identified reedy plant phytoliths, which grow only in relatively-moist eco-environment (Figures 6–11). The following is the information about the rice phytoliths from the Yanjiajuan site.

First, stratigraphic deposit of rice phytolith. As shown in Figures 4 and 5, the layers where the rice phytoliths were identified are below the sandy layers, about 1.5m below the present surface. The coring samples also contain burned clay blocks and grains, which were found above the layers of rice phytoliths. Although we do not have dates for burned clay deposits, the presence of a large cluster of burned clay might be related to cultural activities. This indicates that the rice phytoliths should be no later than the cultural remains of the site. Thus we believe that rice fields had existed at this Neolithic site.

In addition, we also identify rice phytoliths from soil samples of upper sandy layers and the plough zone, which we believe should have something to do with pilling-up rice straw activities at this location in the 1950s. We were told that in the 1960s a large quantity of earth had been transferred from western edge of south part of the site to this location to straighten the river course. That probably caused the change in the amount of rice phytoliths.

Second, the distribution of the rice phytoliths. Rice phytoliths at 1.5m below the surface were found well-

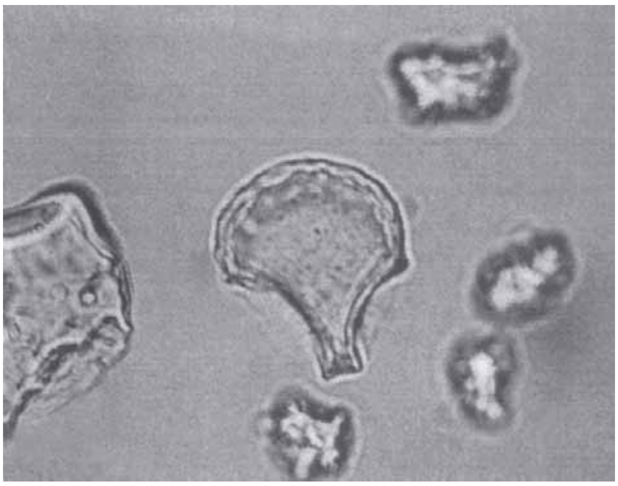

Figure 6. Phytoliths of Rice (Oryza Sativa L.)

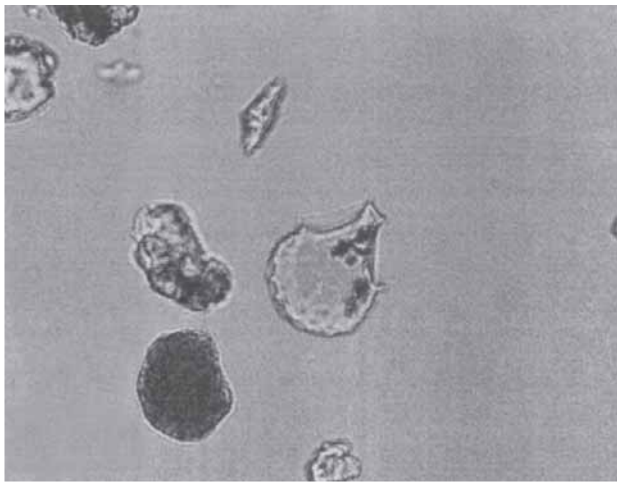

Figure 7. Phytoliths of Rice (Oryza Sativa L.)

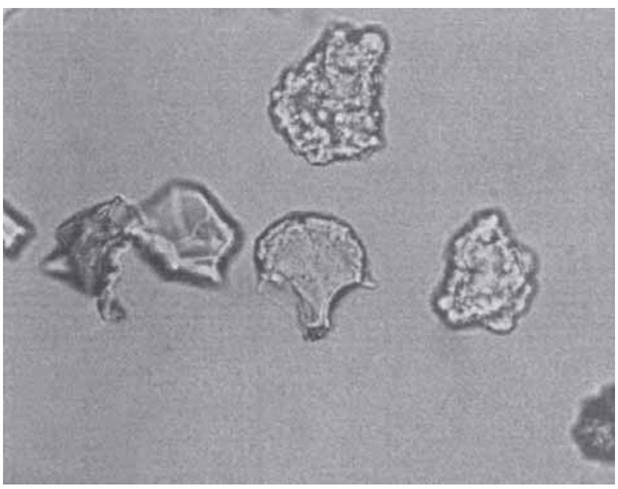

Figure 8. Phytoliths of Rice (Oryza Sativa L.)

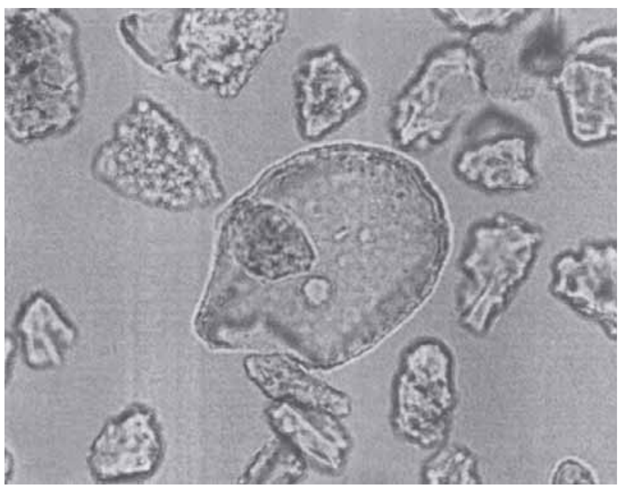

Figure 9. Reed Genus (Phragmites)

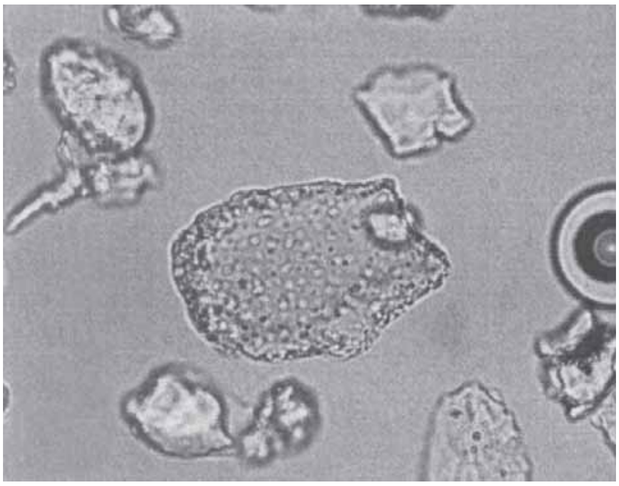

Figure 10. Reed Genus (Phragmites)

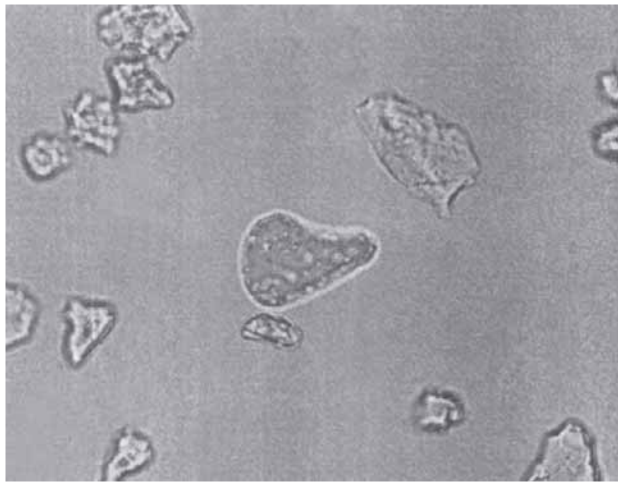

Figure 11. Sorghum Tribe (Andropogoneae)

distributed across the site except the southwestern area where happens to be the poorly preserved part of the site (Figure 2). However, the quantity and density of rice phytoliths were found in difference: some 3,500 grains of rice phytoliths per gram dry soil at the most, while some producing less than 500 grains per unit (Figure 12).

The density of rice phytolith was probably resulted from the verifiability of duration of rice cultivation as well as the timing of accumulation of the sediment. Thus it is understandable that the difference exists in identifying rice phytoliths. The similar situation was widely observed in rice-field archaeology of Japan, where the differences in quantity of rice phytolith per gram soil sample range from 1,000 to 10,000 per unit. In general, one believes that if one area produces 5,000 grains per gram soil, then the location could be regarded as ancient paddy-rice field remains. However, according to recent archaeological investigations on paddy-rice field from the Late Jomon sites, Japanese archaeologists consider it is also appropriate to use 1,000 grain per unit as the criterion for identifying the paddy-rice field site.

The locations yielding rice phytoliths over 1,000 grains per unit represented by coring Nos. 7, 24 and 26 are relatively concentrated in one area. Therefore, we believe that these highly-concentrated rice phytolith locations, as the oval area shown in Figure 12, might represent an area where rice cultivation could have taken place for a relatively long period in the past.

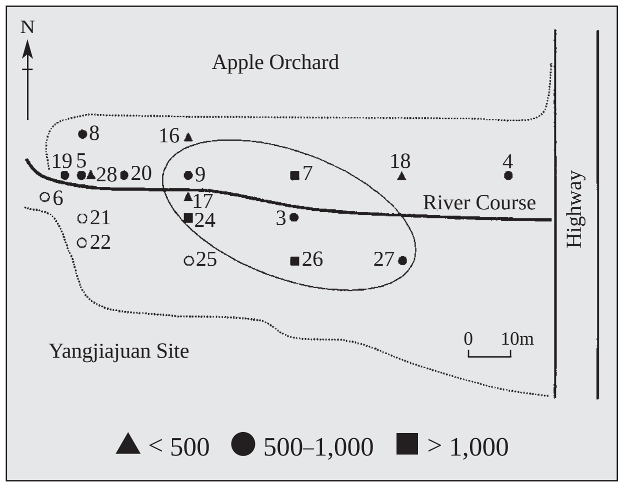

Figure 12. Density of Rice Phytoliths

Conclusion

The result of the archaeological survey and examination of phytolith from soil collection suggests that rice cultivation fields had probably existed in the surrounding area of the Yangjiajuan site. According to the density and distribution of rice phytoliths, these rice fields should be located in the lowlands of the river valley at the north side of the site. Especially the center of the valley could be most likely the loci of rice cultivation. Based on the sediment correlations among the coring samples, the chronological reference for the rice field probably is of the Neolithic. Thus, it is important to consider future investigations in this area to obtain samples for accurate dating sequences as well as to verify the nature of deposit.

In addition to the identification of paddy-rice field near the site, the result of our investigation also suggests that the study area was of moist-to-wet environment, which would be the ideal ecological setting for rice cultivation. Of course, it is insufficient to prove the mode of rice cultivation in paddy-rice field based on only the rice phytolith and moist environment. It could be also possible that, wet rice cultivation occurred when water sources were sufficient, while dry-rice cultivation were also likely to happen in low water seasons.

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