Report on the 2001 Flotation Results from the Site of Jiahu

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Key words: Neolithic Jiahu Site Flotation Paleoethnobotany

Jiahu is an early Neolithic habitation site situated in the upper Huai River valley in the Wuyang County. According to radiocarbon dating the site dates to between 9000-7800 BP. The site of Jiahu was the object of six different excavations by the Henan Provincial Institute of Archaeology and large amounts of precious relics were unearthed at the site, including over 10,000 grains of carbonized rice which were determined to be cultivated.

In 2001, an additional excavation was carried out at the site of Jiahu which employed systematic flotation at the site. 125 samples were gathered, each of which had an average volume of 38 liters. Flotation samples were retrieved from ash pits, house remains, graves and strata, with those retrieved from ash pits being the most numerous. Samples were taken from almost every area of the excavation and can thus be considered to be representative of the ancient plants found in this excavation.

Flotation was carried out at the site using small scale bucket flotation and a sieve of 80 Mesh or 0.2mm was used to capture the seeds. After the samples were dried in the shade, they were transported back to the Paleoethnobotany Lab of the Institute of Archaeology, CASS in order to determine the genus and species of the plants contained in the samples.

The goal of this research was to perform quantitative analysis on the ancient plant remains preserved at the site of Jiahu and to understand the relationship between the ancient inhabitant's subsistence and the plants preserved at the site of Jiahu, namely what were the status of the different plant foods in the lives of the inhabitants at Jiahu. We also aimed to gain a better understanding of the production and economic activities of the people of Jiahu as well as of their lifestyle.

I. Results of the Flotation Project

Four different types of plant remains were recovered from the site of Jiahu: charred wood, fragments of tubers, nut shells and seeds (Table 1).

1. Charred Wood: each of the 125 samples contained charred wood most of which were very small fragments. Larger pieces of charcoal were selected and sent to a specialist for further analysis. Remains of charcoal larger than 1mm were weighed and quantified. The results showed that on average each sample contained roughly 0.03g of charred wood.

2. Tuber Fragments: over 200 samples of tuber fragments were found in the flotation samples. We were only able to identify one of the species which was lotus root (*Nelumbo* sp.). Out of those which were well preserved, entire cross sections were visible with a diameter of between 1–1.5cm. 8–9 holes were distributed across the surface of the specimen (Figure 1).

3. Nut Shells: the majority of nut shells recovered belonged to water caltrop (*Trapa* sp.). We were also able to identify acorns in the collection. *Trapa* sp. is an aquatic species and the shape of its fruit is highly particular. It has a triangular shell which has two *(T. bispinosa* Roxb) horns or four (*T. quadrispinosa* Roxb) horns. The quantity of *Trapa* sp. remains at the site was astonishing and we recovered over 7000 pieces of shell or horn of different sizes. However no intact specimen was unearthed from the site (Figure 2). The individual *Trapa* species found at the site were rather small with a thick shell and are very similar to the wild *Trapa* species found today. Although a large number of acorn shells (*Fagaceae*) were also found at the site, the fact that these shells were very

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Table 1. The Flotation Results in Jiahu Site

		Phase I (34)	Phase II (63)	Phase III (28)	Total (125)
Seeds	Cultigens				
	Oryza sativa	324	78		402
	Weedy Grasses				
	Pooideae	7	3		10
	Digitaria sp.	1247	958		2205
	Echinochloa sp.	53	53		
	Weedy Plants				
	Leguminosae	89	11		100
	Glycine soja	548	32	1	581
	Polygonum sp.	13	14		27
	Amaranthus sp.	129	129		
	Fleshy Fruit				
	Vitis spp.	92	10	8	110
	Others				
	Broussonetia payrifera	23	2	1	26
	Abutilon theophrasti	1			1
	Nelumbo sp.		1	1	2
	Zelkova sp.	2			2
	Cyperaceae	2			2
	Compositae	306	1		307
	Unknown	156	8		164
Tubers/Roots	*Nelumbo* sp.	75	1		76
	unknown	43	82	27	152
Nuts	*Quercus* sp.	267	97	1	365
	Trapa sp.	116	7307	6	7429
	Carya cathayensis		59		59
	unknown	6	23		29

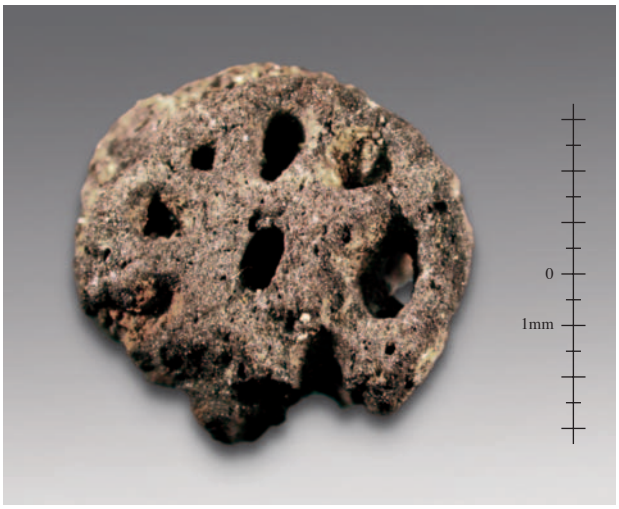

Figure 1. Lotus Root (Nelumbo spp.)

Figure 2. Water Caltrops (Trapa spp.)

fragmentary and the acorn cups were not found means that we were not able to further determine their species (Figure 3). Fragments of hickory nuts (*Carya cathayensis*) were also unearthed the majority of which came from ash pit H453.

4. Seeds: 4121 carbonized seed remains from various different plants were unearthed at the site of Jiahu. We were able to identify 16 different taxa. This included cultigens, weeds, fleshy fruits as well as other categories of seeds. In terms of the cultigens one of the most important finds was that of rice *Oryza sativa* of which 402 specimens were uncovered. Most of these specimens were very fragmentary with only 24 intact specimens. The average length of the 24 intact specimens was 4.39mm and their average width was 2mm with an average breadth of 1.51mm. Overall the size of the rice grains at the site of Jiahu was on the small side and the morphological characteristics of each were rather different and there was a large amount of variability within the assemblage. This reflects the fact that characteristics of early cultivated rice had not yet stabilized. Given the age of the site it is not surprising that these rice grains show these rather primitive characteristics (Figures 4 and 5).

A total of 581 wild soybeans (*Glycine soja*) were found at the site. Measurements taken from a random sample of 200 grains yielded an average grain length of 2.33mm and a breadth of 1.98mm (Figure 6). Seeds of the legume family undergo shrinkage following carbonization. Experimental studies have shown that

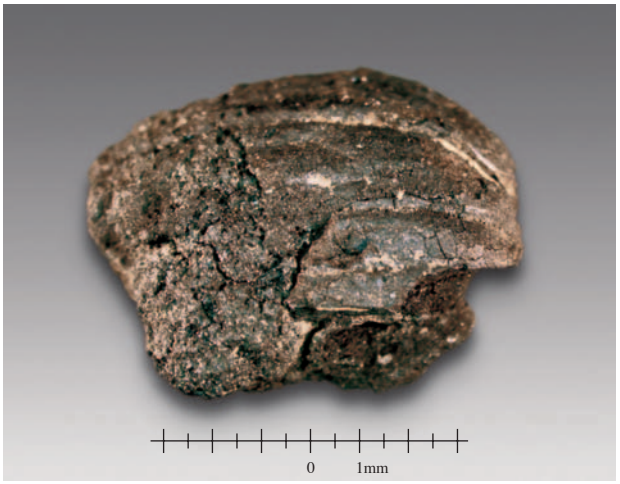

Figure 3. Acorn Shell (Quercus spp.)

Figure 4. Rice Seeds (Oryza Sativa)

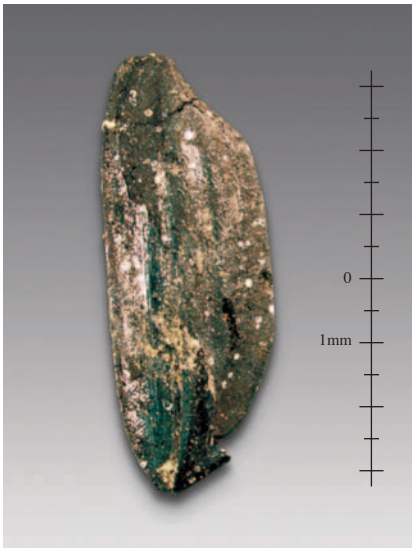

Figure 5. Husked Rice Seed

Figure 6. Wild Soybeans (Glycine Soja)

Table 2. The Comparison of the Measuring Data of Wild Soybeans

	No.	Length		Width	
		Average (mm)	STDEV	Average (mm)	STDEV
Collected from south of Anhui	20	3.81	0.49	2.77	0.33
Collected from Far East of Russia	20	3.49	0.30	2.60	0.25
Recovered from Jiahu	200	3.28	0.47	2.33	0.35
Adjusted Measurement of Jiahu data	200	3.78	~	2.68	~

they undergo shrinkage of 10–20% following carbonization. Less shrinkage affects the width with an average shrinkage ratio of over 10%. After compensating for a 15% shrinkage ratio, it was discovered that the actual measurements of these beans were larger than Far Eastern Russia's yet are still smaller than Southern Anhui's modern wild soybean (Table 2). If we go only according to measurements then the soybeans discovered at the site of Jiahu should be considered wild. However it is worth noting that the main difference between wild and domesticated soybeans lies not in their size or morphological characteristics but in the timing and the extent of pod dehiscence. As no complete soybean pod was recovered during this series of flotation it is difficult to establish whether these were wild or domesticated. However, given the large number of soybeans unearthed at the site we should not exclude the possibility that the people of Jiahu had already started cultivating the soybean. We should also not exclude the possibility that these soybeans (even though wild) may have already begun to show some domesticated characteristics.

The largest quantity of weeds belonged to the *Poaceae* family, the vast majority of which were Digitaria Haller (*Digitaria* sp.) at a total of 2205 seeds. Small amounts of Banyard grass (*Echinochloa* sp.) were also found (53 seeds). Generally, when large quantities of these weeds are found in archaeological sites, this represents a situation where fields are tilled. In the flotation results from Jiahu large amounts of *Digitaria* sp. and *Echinochloa* sp. were uncovered and these were concentrated in a small amount of samples. For example, all of the *Digitaria* sp. came from only four samples and in all of these samples rice was discovered. The situation for Banyard grass was largely similar. From this one can infer that the Banyard grass and *Digitaria* sp. found at the site of Jiahu linked to a lifestyle which included tilling of the soil. It is very likely that these weeds come from field and it is likely that these were brought in with a harvest of rice and thus deposited at the site of Jiahu.

Fruits of the grape family (*Vitis*) were the only example of fleshy fruit uncovered at the site, however a large number of seeds (110) were found in the samples (Figure 7). This shows that the fruits of the grape family were closely linked to the daily life activities of the people at Jiahu. Most of the fruits of the *Vitis* family can either be eaten or used to brew alcohol; researchers have indeed previously cited the discovery of grape family seeds at the site of Jiahu as evidence of China's alcohol making industry as going back to 8000 BP.

Other seeds which we were able to identify in the assemblage at Jiahu which included: paper mulberry (*Broussonetia payrifer*), Indian mallow (*Abutilon theophrasti*), *Polygoneceae*, *Chenopodiaceae*, *Compositae*, *Cyperaceae* etc.

Figure 7. Seed of Grape Family (Vitis spp.)

II. Discussion

The samples from Jiahu can be divided into three different phases however the quantities of samples from each of them are unequal. As one can see from table 1, the samples from Phases I and II are rather rich whereas those from Phase III are relatively scarce. It would be difficult to get statistically significant results from such different sample sizes. We will thus discuss the samples from Phase III along with the rest of the samples and will seek to understand the general state of plant use at Jiahu without specific regard to the dates. The proportion of samples containing plant remains was not high and out of 125 samples only 59 yielded carbonized plant remains: which is less than 50% of the total number of samples. From a closer examination of the context from which samples were taken, it was clear that samples taken from ash pits yielded a much higher concentration of plant material than those from house remains and strata. Almost no plant remains were retrieved from burials. The habits of inhabitants of Jiahu had a great influence on how plant remains were preserved in the site. Many of the so called ash pits in the archaeological remains were in fact ancient rubbish pits. These ancient rubbish deposits were often re-used after they were abandoned as houses and storage pits and it is thus not surprising that these features contained a wide variety of carbonized plant material. The plant materials deposited in tombs are in sharp contrast to those found in ash pits as these were placed in the tomb intentionally. It is also rare for plant remains placed in tombs to become carbonized and often decayed quickly after being buried. Hence plant remains recovered from burials were close to none. Numbers further demonstrate that plant remains were not equally distributed across both tombs and ash pits. Whereas in samples taken from 18 tombs only one seed was recovered, in those samples recovered from 81 ash pits over 3000 seeds were found. On average each of these samples from ash pits yielded roughly 40 seeds. Therefore in order for the samples from Jiahu to have statistical reliability we decided to not take into account the samples from tombs. The 107 samples analyzed here thus only contain data from ash pits, strata and dwelling remains.

The plant remains unearthed at the site of Jiahu can be divided into two major types. The first are plants used as foods by the people of Jiahu: such as rice, wild soybean, grapes, lotus, water caltrop, other fragments of tubers, as well as nutshells. Another category of finds at the site were those that were not used for human consumption such as members of the *Poaceace, Polygonaceae, Chenpodiaceae, Compositae, Cyperaceae*, as well as seeds of Indian Mallow (*Abutilon theophrasti*) and Paper Mulberry (*Broussonetia papyifera*).

Plants related to human activity can also be divided into two types: the first are those related to agricultural activities and tillage such as rice and associated weeds. Other plants are related to gathering activities such as water caltrop and lotus. The case of wild soybean is rather particular. Although we cannot eliminate the possibility that these wild soybeans were cultivated it is likely that these seeds were from wild plants thus we classify these among the plants which were foraged by the inhabitants of Jiahu.

As the goal of our research was to understand how the inhabitants of the Jiahu obtained their wild foods. We thus focused mostly on plants of economic importance or weeds associated with agricultural activities.

Before carrying out the quantification of the plant remains found at the site it is essential to pay attention to another issue: the comparability of the different numbers of seeds recovered. For instance, rice and soybean are both seeds, whereas the pieces of lotus and other roots discovered at the site are fragmentary pieces of one larger element. To directly compare their numbers would not be revealing of anything. Fragments of *Trapa* sp. shell are also not the entire seed and are the discarded remains of the shell discarded after exploitation. Directly comparing these remains to those listed above would also not be meaningful. We thus used ubiquity to quantify these remains. Ubiquity is calculated by looking at the total number of samples in which a given plant appears and its results reflect the distribution of plant remains across a given site. Most the plant remains deposited in the archaeological site can be said to be linked to cultural phenomena. They were introduced to the site via either intentional means (such as agricultural products) or unintentional means (such as weed seeds). They were then either intentionally discarded or unintentionally introduced to the plant record preserved at the site. In theory, plants which were most closely linked to human activities and consumption should be those which are the most likely to be brought back to the settlement. The probability of these remains being deposited in the site is thus also higher. It is also expected

that they will be scattered over a greater area of the site in question. The probability of these remains appearing in samples should therefore also be greater. On another note, ubiquity does not look at the absolute numbers of a given species in a sample but rather looks simply at absence/presence. In this sense the absolute numbers of grains or pieces recovered was irrelevant. Using ubiquity to determine the probability that a certain plant species would be unearthed in the site can not only reduce error but also allow one to compare the distribution of plant remains which cannot be compared using other means. Figure 8 is a bar chart showing the ubiquity of 10 different kinds of plant remains found at the site of Jiahu. It is clear from this chart that the three species associated with agricultural activities do not have a high ubiquity throughout the site. The ubiquity of rice was only 15% and the two seeds associated with agricultural fields had a ubiquity of less than 5%. On the other hand, plants which were foraged had a much higher ubiquity.

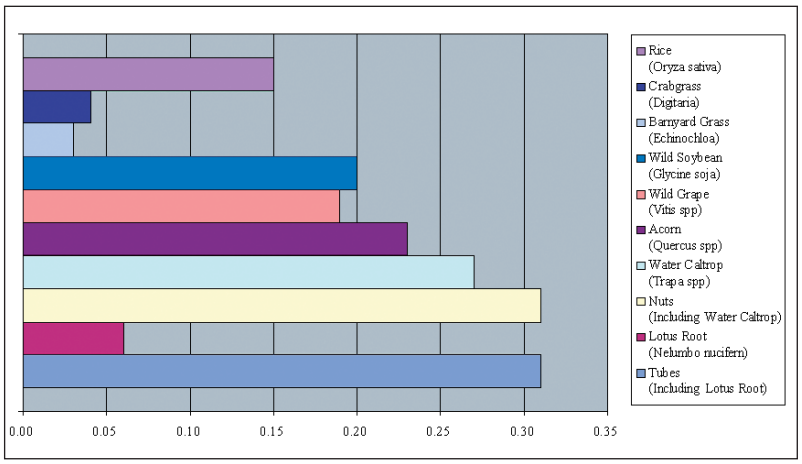

Figure 8. The Ubiquity of the Plants Recovered by Flotation From Jiahu Site (107 Samples)

It appears from this chart that tubers formed the principal source of starch for the inhabitants of the population in this area. However since the whole tuber can be consumed, from the skin to the pulp, we would expect that the quantity of tuber remains deposited in the cultural deposits of site should be relatively small. Hence the amount of tubers recovered through flotation should always be lower than what their quantities were in reality and cannot be representative of how important they were to the lives of past peoples. Nuts are a good source of nutrition, however their shells are very hard and are not edible and it is highly likely that they will be discarded and deposited in an archaeological site. In a sample of Paleoethnobotanical remains in given site it is thus often the case that nutshells are over represented. Individual seeds are generally rather small and it is necessary to eat a large quantity of these seeds in order to satiate ones hunger which increases the likelihood of them being deposited in the archaeological site. In addition, grains like rice must undergo threshing and husking in order to become edible. If these activities were carried out at the archaeological site, then the number of grains counted will certainly have higher number. Hence, for the 10 species shown in Figure 8 it is likely that the proportion of these grains to other plants uncovered at the site such as lotus root were lower than even ubiquity suggests.

Even if we did not correct for the error present in the number of root remains uncovered at the site, a statistical analysis clearly shows that there is no preponderance of remains associated with agriculture and cultivation such as rice and weeds associated with agricultural fields over those acquired through gathering. This shows that rice did not play a dominant role in the diet of the people of Jiahu. According to the quantification of Paleoethnobotanical remains, plants acquired from gathering such as lotus, water caltrop and acorns played the most important role in the lives of the inhabitants of the site.

During the term of the 2001 excavations, water sieving recovered large quantities and high ubiquities of fish bones and mollusk shells indicating that fishing played an important role in the subsistence activities of the inhabitants of Jiahu. Given the large amounts of water caltrop and lotus uncovered from flotation, it appears that the ancient inhabitants of Jiahu mostly relied on aquatic resources. It appears that they did not yet have developed agricultural techniques, however even though agriculture may only have formed a small proportion of the economic activities of the inhabitants of Jiahu, its primary purpose still must have been to sustain the inhabitants of the village.

III. Conclusion

Using scientific methods of sampling and systematic

flotation, large quantities of ancient plant remains were recovered from the site of Jiahu. Among these agricultural crops such as rice were recovered, possibly cultivated soybean, as well as common field seeds such as *Digitaria* sp. and *Echinochloa* sp., Acorns, water caltrop and lotus figured among the foraged remains along with *Broussonetia payrifer* and *Abutilon theophrasti*. Given the results of our quantification, we believe that despite the fact that in 9000–7800 BP the inhabitants of Jiahu may have begun to cultivate rice that their primary economic activities centered on hunting and gathering. Rice cultivation was an auxiliary and secondary production activity. Agricultural production systems are born from foraging based systems. In the course of their transformation, the place of foraging in peoples daily lives took an increasingly smaller place while that of agriculture increased, eventually to replace foraging as the primary means of subsistence. Over the course of this slow and gradual process, it is expected that during the earliest stages of transformation societies' resources will be characterized primarily by hunting and gathering (or fishing and gathering) activities with cultivation playing an auxiliary role. The results of flotation from the site of Jiahu show that the site should be representative of one of the earliest stages of rice cultivation in China.

Postscript: The original article was published in *Kaogu* 考古 (Archaeology) 2009.8: 84–93 with one illustration, one plate and two tables. The authors of this report are Zhao Zhijun 赵志军 and Zhang Juzhong 张居中; the abridged version is prepared by Zhao Zhijun and translated into English by Jade D'Alpoim Guedes 黛玉.