ON THE EARLIEST EVIDENCE FOR RICE CULTIVATION IN CHINA

Chen Xingcan

The Institute of Archaeology, Chinese Academy of Social Sciences, Beijing 100710, People's Republic of China

ABSTRACT

This paper discusses the contexts of early rice discoveries in China, focusing on the sites of Xianrendong, Diaotonghuan, Yuchanyan, Bashidang and Jiahu. Available radiocarbon dates are presented and it is suggetsed that there were two developmental stages in the domestication of rice in China.

Prehistoric rice remains were found by archaeologists in China as early as 1921, when Professor J. Gunnar Andersson excavated the first Neolithic site of China at Yangshao village, Henan province, in the middle Yellow River valley (Andersson 1934). Swedish botanists G. Edman and E. Söderberg recognized rice husks (*Oryza sativa* L.) from a thick ceramic fragment with numerous imprints of plants when they examined the Yangshao artifacts in Stockholm (Edman and Söderberg 1929). Before this find, Andersson had assumed that the main crop of the Yangshao people was wheat, which came from the West associated with painted ceramics. The discovery changed his view, and Andersson then believed that rice was cultivated at Yangshao village by the late Stone Age people. He valued the discovery as "in a high degree sensational not only because it sets back the history of rice an immense distance in time, but also because it points, not to dry Central Asia, but to rainy Southern Asia, which is the homeland of rice" (Andersson 1934:335-6). However, this important discovery did not attract much attention at the time (Chen 1997a).

Since the 1950s, a large number of prehistoric sites have been discovered nationwide. However, since most archaeological studies have been culture-historically oriented, information about palaeoenviroment, palaeoclimate and ancient subsistence relating to these settlements was not obtained. The 1950s witnessed the finding of rice remains at the Qujialing site in the middle Yangzi River valley (IACASS 1965), but few people paid attention to this discovery because the Yangzi valley used to be treated as an uncivilized and backward area, thus its main cultural elements were believed to have been transplanted from the Yellow River valley, or at least to be influenced by the latter region (Chang 1977; An 1979; Yan 1987; Chen 1997b). The Hemudu culture, excavated in 1973 in the lower Yangzi River valley and dated to 7000 BP, promoted revolutionary understanding of the prehistory of this region (Chang 1986). Some scholars came to believe that the lower Yangzi and its neighboring areas might have been one of the centers where rice agriculture originated. This is because (1) the form of rice discovered at Hemudu was very similar to that of modern cultivated rice; (2) it was the earliest cultivated rice known in the world at the time; (3) the quantity of rice found was very large; and (4) numerous agricultural tools were also found at the site (Zhejiang Provincial Committee for the Protection of Cultural Relics and the Zhejiang Provincial Museum 1978; Hemudu Archaeological Team 1980; Yan 1991). Since the Hemudu excavation, increasing interest in archaeological research has turned to questions relating to the origins of rice cultivation in China (Underhill 1997; Lu 1999).

At the beginning of the 1980s, fewer than 40 prehistoric sites had been found containing rice remains, most being rice husks or imprints on pottery. The number of sites on the list has significantly increased, with about 70 in 1989 and more than 140 known by the end of 1993 (Yan 1990, 1997). In recent years, more archaeologists have focused on this research topic, employing new techniques in both excavation and laboratory studies, including the flotation method and pollen and phytolith analysis. More scientists from other disciplines have also been involved in this study. As a result, much progress has been made, although many questions and problems still remain to be answered and resolved (Wu and Chen 1993; First Henan Archaeological Team 1994; Wang, Z. 1995; Chen *et al.* 1995; Zhao *et al.* 1995; Lu 1999).

In the 1980s, rice remains were discovered in the Pengtoushan, Chengbeixi, and Lower Zaoshi cultures in the middle Yangzi River valley. These changed the entire

picture of early rice cultivation, since all these cultures are dated to 7000 years ago, which is earlier than the dates of the Hemudu culture (Hunan Provincial Institute of Archaeology and Lixian Bureau for the Management of Cultural Relics 1990; Yan 1991; IACASS 1991; Lin and Hu 1993; Chen and Hedges 1994; Yuan 1996). The middle Yangzi valley began to be regarded as either an important center for origins of rice cultivation, or as an inseparable part of the entire lower and middle Yangzi valley, from which rice agriculture originated (Yan 1991, 1997; Bellwood *et al.* 1992; Bellwood 1996; Lu 1999).

In addition to these discoveries made in the Yangzi River valley, more than ten sites associated with early rice remains have also been found in the Yellow River and Huai River valleys (Zhang *et al.* 1994; Wu 1996; Underhill 1997). The rice remains from the Laoguantai culture yielded by excavation at Hejiawan and Lijiacun in Southern Shaanxi province indicate that rice might have been cultivated in areas north of the Yangzi River valley even before 7000 BP (Wei *et al.* 1986; Wu 1996). During my excavation at Lilou in 1991-1992 in the Ru River valley, a tributary of the Huai River, an area which belongs to the northern culture system, more than 100 carbonized rice grains, including both cultivated and wild, were recovered by employing flotation techniques (Wu and Chen 1993; The First Henan Archaeological Team 1994). The find is especially important, not because it yielded the largest quantity of rice remains known at the time in northern China, or because it was the first time that the flotation technique was employed in archaeological excavations in China, but because wild rice was first found in this area. This suggests that wild rice might have had a greater distribution 4000 years ago than it does at present (Lu 1999).

The most astonishing finding of rice was from the Jiahu site (8000-9000 BP) on the bank of the Sha River, also a tributary of the Huai River (Zhang *et al.* 1994; Chen. *et al.* 1995). Since the site was contemporary with the Pengtoushan culture in the Yangzi River valley, but was culturally more advanced than the latter, some scholars believe that rice cultivation may have begun earlier at Jiahu than at Pengtoushan. The Huai River valley, therefore, might have been the center of the origins of rice agriculture; or, at least, one such center in ancient China.

The 1990s have witnessed some great discoveries in the Yangzi valley. Four prehistoric sites containing early rice remains were excavated in Hunan and Jiangxi provinces. Bashidang, a Pengtoushan culture site dated to 8000 to 9000 BP, has yielded more than 15,000 rice grains and other rice remains (Zhang and Pei 1997; Pei 1998). At the Yuchanyan cave site, in the early Holocene layers, both rice grains and rice phytoliths were found. These have been regarded as some the earliest evidence of rice cultivation in China (Yuan 1996; Lu 1999). A Sino-American team excavated the Xianrendong and Diaotonghuan sites in Jiangxi province in 1993 and 1995, in which phytoliths of domesticated rice grains have been identified from the early Neolithic deposits. This suggests that rice might have been cultivated there 10,000 years ago. Since phytoliths of wild rice have been found in the pre-ceramic layers at Xianrendong, it is likely that the collection of wild rice might have started as early as the late Palaeolithic period (Zhao *et al.* 1995; MacNeish and Libby 1995; Liu 1996). Because of these discoveries made in the past several years, the Yangzi River valley, especially the middle portion, has attracted much attention worldwide. Increasing numbers of specialists have come to believe that the middle Yangzi valley was an important area in which rice agriculture originated (Bellwood 1996; Underhill 1997; Lu 1999).

My primary purpose here is to present and interpret the archaeological data on early rice remains in China, which may not be available to archaeologists working outside China. To be brief, I will mainly present the information about the sites mentioned above, including Xianrendong, Diaotonghuan, Yuanchanyan and Bashidang in the Yangzi River valley and Jiahu in the Huai River valley.

THE XIANRENDONG-DIAOTONGHUAN (WANGDONG) ASSEMBLAGE

The Xianrendong site is located on the slope of a small hill in northeast Jiangxi province. With a river and flat land in front of the cave, the habitat is suitable for human habitation. Four excavations have been carried out since 1962. The latest ones in 1993 and 1995, conducted by a Sino-American team, have yielded exciting results although the details are still to be published (Jiangxi Provincial Committee for the Protection of Cultural Relics 1963; Jiangxi Provincial Museum 1976; MacNeish and Libby 1995; Liu 1996). The Diaotonghuan rock shelter site is about 800 m away from Xianrendong and according to the 1993 excavation report it contains the same cultural-chronological components (MacNeish and Libby 1995; Liu 1996; Yan 1997). It is thus considered to be a camp site of the residents living at Xianrendong.

The reporters of the first excavation realized that the site consisted of two cultural-chronological components. The lower occupation was early Neolithic and the upper one late Neolithic. The researchers of the second excavation of 1964, however, believed that both occupations belonged to the early Neolithic. Although archaeologists had different opinions on the chronology of the deposits, they all agreed that the two occupations had chipped and polished stone tools and potsherds. The only difference is that the lower one had fewer polished stone tools and less varied ceramics, while the upper one was dominated by polished stone tools and more varied ceramics (Jiangxi Provincial Committee for the Protection of Cultural Relics 1963; Jiangxi Provincial Museum 1976; Liu 1993).

The most recent excavations revealed four horizons; the third and fourth thought to belong to the lower occupation and the second one to the upper occupation (Liu 1996). However, the cultural strata are very complicated, as seen in the preliminary report of the 1993 excavation (MacNeish and Libby 1995). The cultural remains of the two occupations are stated to be different because the lower one has only chipped stone tools but the upper one has not only chipped and polished stone tools, but also potsherds. The lower occupation is considered to be late Palaeolithic, while the upper one is Neolithic. The report of the most recent excavation has not yet been published and the available reports are far from detailed. There are discrepancies between the reports of these excavations, for instance it is impossible to compare deposits yielded from different excavations. However, it seems that the upper occupation of the last two excavations can be further divided into different periods, which correlate with the lower occupation of the first two excavations (Chen 1998a).

The Diaotonghuan site includes more than 13 occupations, roughly divided into two periods: Epipalaeolithic (Zones F-M) and Neolithic (Zones A-E). There are eight carbon 14 dates available from the two sites, with the oldest ones being 19770±360 (Diaotonghuan Zone H) and 18110±270 (Xianrendong Zone 3C2) and the youngest one 8825±240 (Xianrendong Zone 2B) (see Table 1). Based on these dates and the analysis of artifacts, a tentative chronological sequence has been made. While the Epipalaeolithic complex has been assumed to date from approximately 25,000 to 14,000 BP, the four Neolithic periods are from 14,000 to 11,800 BP (Neolithic 1), 11,800 to 9,600 BP (Neolithic 2), 9,600 to 7,700 BP (Neolithic 3), and 7,700 to 6,500 BP (Neolithic 4), respectively (see Table 2) (MacNeish and Taylor 1995). However, it should be noted that the areas excavated in the two caves are rather small and the samples of artifacts and ecofacts are woefully inadequate, the discrepancies between the reports of different excavations are obvious, and the results are only preliminary. Therefore we are still a long way from really understanding the processes of early rice cultivation (MacNeish 1995a; Lu 1999; Chen 1998a). Tentative dates for zones at Xianrendong and Diaotonghuan are illustrated in Table 1 and Table 2 (MacNeish and Libby 1995).

Based on the 1993 excavation, the lithics at the two sites can be divided into two categories: a pebble tool industry primarily of sandstone and mica schist, and a small flake industry of chert and quartz. Pebbles were used for heavy-duty tools such as choppers and hammers, while small flakes were made into various scrapers, points and spokeshaves (MacNeish 1995b; Lu 1999). From the Epipalaeolithic to the early Neolithic (Neolithic 1 and 2), even though it is said the chipped industry was gradually replaced by a pebble industry in which flat river or mica schist pebbles were pecked into usable forms (MacNeish 1995b:87-88), the whole assemblage seems rather stable and few polished stone tools have been found in the early Neolithic strata (MacNeish 1995b:23-34). Some perforated pebble disks and flat pebble adzes have been found in the early Neolithic period. While the former are considered as digging stick weights, the latter are suggested to be planting and/or land clearing tools (MacNeish 1995:88). Some organic implements have been found both in the 1960's and 1990's excavations, the perforated shells merit special attention. Perforated shells used to be interpreted as net sinkers rather than harvesting tools (Liu 1993). However, based on her observation of the shells, Tracey Lu believes that some perforated shell edges were polished by usage. This suggests, according to Lu (1999), that these shells may have served as tools for rice harvesting. In spite of these discoveries, it is clear that most stone, shell, and bone tools were made for hunting and fishing (MacNeish 1995b; Liu 1996), although use-wear observation and residue analysis are needed if any further conclusions are to be drawn (Lu 1999).

Ceramics appeared in the Neolithic 1 period, characterized by flowerpot-shaped vessels with smooth or grass-wiped and/or paddled surfaces and limited decoration (Hill 1995). Cord marked pottery appeared in the Neolithic 2, but flourished in the following period. Plain pottery occurred as early as Neolithic 1, but reached its peak in Neolithic 3. Almost all ceramics were tempered with crushed rock, usually white quartzite. The pottery is mostly red or red-brown in color, the walls of the sherds are uneven and thick, the texture is brittle and loose and the pottery shapes are simple, mainly round-bottomed jars. All these features are similar to those of the early pottery from other sites in South China (Chen 1998a). However, the manufacturing method is dominated by coiling throughout the entire assemblage. This is contradictory to our previous knowledge about the development of ceramic technology in prehistoric China, since the coiling method occurred much late than the moulding technique in both southern and northern areas, but the characteristics of surface treatment, decoration (except plain ceramics), temper and even ceramic shapes are similar to those of the other early finds in south China or even in East Asia (Chen 1998a; Wang, X. 1995; Yuan 1996; Fu 1998; Zhushchikhovskaya 1997).

No rice grains or rice husks have been found based on the available reports. However, pollen analysis and phytolith studies show that incipient cultivation of rice may have been practiced during the early Neolithic period. In 1993, archaeologists collected 18 samples of sediments from Xianrendong and 11 samples from Diaotonghuan for phytolith studies. Diagnostic phytoliths of the genus *Oryza* were present in both Epipalaeolithic and Neolithic strata in the two caves. But double-peaked glume cells (produced by species of *Oryza*) occurred only in zones

Table 1. Radiocarbon dates for the Xianrendong and Diaotonghuan assemblages

(Note: ZK: Institute of Archaeology, CASS, Beijing. BA: Beijing University. UCR: University of California, Riverside. AA: University of Arizona) (Based on MacNeish and Libby, 1995)

Site	Lab. No.	Material	Source	C14 Dates (BP)
Diaotonghuan	BA-93179	Charcoal	Zone H	19770±360 (AMS)
Xianrendong	BA-93182	Charcoal and burned bone	Zone 3C2	18110±270 (AMS)
Diaotonghuan	BA-93180	Charcoal	Zone G	17040±270 (AMS)
Xianrendong	UCR-3300	Human bone	Uncertain, possibly Zone 3C1B or 3C2?	15180±90 (AMS)
Xianrendong	AA-15008	Flotation Sample	Zone 3C1B	17420±130 (AMS)
Xianrendong	ZK-39	Charcoal	Zone 3B2?	10870±240
Xianrendong	BA-93181	Charcoal ?	Zone 3B1	14610±290
Xianrendong	ZK-92	Charcoal	Zone 2B?	8825±240

Table 2. Relationships between rice remains and archaeological phases in the Xianrendong-Diaotonghuan assemblage (Based on MacNeish and Libby 1995)

Archaeological Period	Cultural Stratum	Estimated date (Uncal BP)	Radiocarbon Dates (Uncal BP)	Rice Remains
Epi-Palaeolithic	XRD Zone 6-3C2 DTH Zone M-F	25000-15200	19770±360,18110±270,17040±270,15180±90	Genus *Oryza*, wild *Oryza*
Neolithic 1	XRD 3C1B DTH E	14000-11900	17420±130	Genus *Oryza*, *Oryza sativa*, wild *Oryza*
Neolithic 2	XRD 3C1A,3B2,3B1 DTH D, C2	11900-9700	14610±290,10870±240	Genus *Oryza*, *Oryza sativa*, wild *Oryza*, large grass rice pollen
Neolithic 3	XRD 2C,2B DTH C1	9600-8825	8825±240	Genus *Oryza*, *Oryza sativa*, wild *Oryza*, large grass rice pollen

Table 3. The proportion of deer in the animal remains of the Xianrendong cave site

Zone	Deer Bone	All Animal Bone	Deer/All Animal	Note
1A/1B	17	46	37.0%	The total amount of all animal bones is 375 rather than 358 which the report counted. (Redding 1995)
2A/2B	30	78	38.5%	
3B1/3B2/3C1A/3C1B/3C	163	196	83.2%	
4A/4B	51	55	92.7%	
Total	261	375	70.0%	

3B1 and 3C2 at Xianrendong and in the four upper zones (B-E) at Diaotonghuan. Further studies showed that the glume cell observed in zone 3B1 and B-E may have been produced by domesticated rice (*O. sativa*), and that found in zone 3C2 was possibly by wild rice (see Table 2). Thus, it is suggested that rice may have been domesticated in the Neolithic 1 period and wild rice may have been collected during Epipalaeolithic times (Zhao *et al.* 1995). Pollen analyses support this hypothesis (Wang et al 1995). Isotopic studies show that possibly wild rice was consumed

Table 4. The proportion of deer in the animal remains of the Diaotonghuan cave site

Zone	Deer Bone	All Animal Bone	% Deer	Note
A	59	68	86.8%	The total amount of all animal bones is 1699 rather than 1677 which the report counted. (Redding 1995)
B	69	85	81.2%	
C	59	79	74.7%	
D	672	746	90.1%	
E	351	475	73.9%	
F	157	249	63.1%	
Total	1367	1699	80.5%	

in Epipalaeolithic times (MacNeish *et al.* 1995). But, for a variety of reasons, this result is very preliminary and more work on absolute and cross-dating, pollen, phytolith, isotopic analysis is still needed (MacNeish and Libby 1995; Lu 1999).

No domesticated animals were found in the early Neolithic period in the 1993 excavation. But a large number of bones from turtles, birds, deer, pigs, rabbits, cats, weasels and possibly chicken were found in both caves. Deer bones were found everywhere, especially in the early Neolithic strata (see Tables 3 and 4) (Redding 1995). These phenomena support the hypothesis that inhabitants at Xianrendong and Diaotonghuan focused animal procurement on wild taxa, particular deer (Redding 1995). All evidence shows that hunting, fishing and collecting still played an important role even if incipient rice domestication may have been practiced. However, the domesticated rice phytoliths found in the two caves remain the earliest evidence of rice cultivation in the world to date (MacNeish and Libby 1995; Yan 1997; Liu 1996; Lu 1999).

THE YUCHANYAN (HAMADONG OR FROG CAVE) ASSEMBLAGE

This cave site is located at Baishizhai village in Dao county, Hunan province. Five meters above the surrounding ground level, with its entrance facing southeast and an open flat land in front of the cave, it is believed to have been an ideal place for human occupation. In 1993 and 1995, archaeologists from Hunan Provincial Institute of Archaeology excavated the cave twice. It consists of cultural deposits of about 120 to 180 cm in depth, with hearth remains, abundant animal bones, and a large number of artifacts including tools made of stone, bone, antler, animal teeth, and shell. All stone tools are chipped, including cores, flakes, choppers, scrapers, knives and hoe-like tools. The stone tools are very coarse, and few microliths were found. It is believed that the characteristics of the lithic industry are similar to those of the Huangyandong and Dushizhai assemblages, two late Palaeolithic sites in Guangdong province (Olsen and Miller-Antonio 1992; Yuan 1996), as well as to the unifacial Hoabinhian tools of northern mainland Southeast Asia (Lu 1999). But details remain unknown because the excavation report has not been published. It is suggested that hoe-like stone tools, unifacially flaked from one end and two sides, may have been used as digging tools (Yuan 1996), and that some shell tools may have been employed as cutting implements (Lu 1999:167). However, most of them seem clearly to have been used as hunting and fishing tools (Lu 1999). Without use wear and residue analysis, no firm conclusions can be drawn.

The ceramic assemblage from this component is predominantly small fragments of body sherds. The ceramic paste is coarse, tempered with sand and plant fiber. The color is brown, indicating that the firing temperature was low. The walls of the ceramics are as thick as 2 cm. However, the texture is very brittle because of the low firing temperature and non-plastic temper. In some sherds two or more layers can be observed in the cross section, and basket-like marks can be seen on both inner and outer surfaces (Yuan 1996). These may be related to manufacturing techniques such as use of a mould. Experimental study in forming ceramic vessels over a hard mould has shown that small pieces or disks of clay can be applied around the mould in order to form a vessel (Yu 1987; Zhushchikhovskaya 1997; Chen 1998a, 1998b).

Animal bones from more than 20 species were found, but none of them was identified as domesticated. As at Xianrendong and Diaotonghuan, deer bones make up the majority of the assemblage. Bones of birds, fish, turtles, and shells were remarkably abundant in the deposits, suggesting that hunting and fishing played an important role in the subsistence of the inhabitants (Yuan 1996).

Plant remains from several dozen species, including seeds and kernels, have also been found. The most astonishing discovery is the finding of four rice husks and rice phytoliths. The results from studies of these remains show that the two husks from the 1993 excavation are wild rice with incipient human interference, while the other two

from the second excavation are domesticated rice with some characteristics of wild rice (Yuan 1996). Morphological and phytolith analyses demonstrate that the Yuchanyan rice has both features of domesticated (both subspecies *japonica* and *indica*) and wild forms. It is thus thought to be a newly cultivated plant, which may have constituted a less important resource than hunting, fishing and collecting for people at the time (Yan 1997).

Several AMS and conventional radiocarbon dates have been obtained for the Yuchanyan assemblage, ranging from 16,000 to 12,000 BP (Yuan 1996, from Lu 1999). The AMS dates for temper samples obtained from the potsherds are said to be 15,000 to 14,000 BP (Yuan 1996, from Lu 1999: 87). But details of the dates are not yet available. It seems that Yuchanyan may have been occupied for a long period and might be contemporary with that of the upper occupation of the 1990 excavations at both Xianrendong and Diaotonghuan (Chen 1998a). Three recently announced conventional radiocarbon dates place Yuanchanyan between approximately 10,000-8000 BP (see Table 5) (IACASS 1997). It is too early to evaluate these dates because details on the stratigraphy are not available (Lu 1999). However, it is believed that the Yuchanyan assemblage dates to about 12,000 BP (Yan 1997), or prior to 10,000 BP (Yuan 1996). More work on both dating and other aspects is needed before we make any further inferences about this site.

Table 5. Beijing (IA, CASS) radiocarbon dates for the Yuchanyan assemblage. (Based on IA, CASS, 1997)

Lab, No.	Material	Source	C14 Dates (cal. BC)
ZK-2901	Animal Bone	95T9(2b5)	7931±413
ZK-2902	Animal Bone	95T9(3b2)	9076±399
ZK-2903	Animal Bone	95T9(3e)	8432±610

THE BASHIDANG ASSEMBLAGE

This site is located on Liyang Plain, which is one of the alluvial plains of the middle Yangzi River valley in northwest Hunan province. It occupies a total area of about 30,000 square meters. From 1993 to 1997, a total area of 1200 square meters was excavated at this site in six seasons by the Hunan Provincial Institute of Archaeology. Numerous artifacts and faunal and floral remains were found from a well-preserved river deposit in the northwest part of the site. More than 15,000 rice grains were discovered from the early Neolithic strata, making this the largest quantity of prehistoric rice remains ever found in China. This discovery is thus extremely important for our understanding of the origins and early development of rice cultivation (Zhang and Pei 1997; Pei 1998).

The Bashidang site belongs to the Pengtoushan culture, an early Neolithic culture in the middle Yangzi River valley dated to 8000-9000 BP (Yan 1991; He 1996). Unlike the cave site occupants mentioned above, the Pengtoushan people had a rather sedentary way of life (Hunan Provincial Institute of Archaeology and Lixian Museum 1990; Pei 1998; Lu 1999). Four types of house remains have been found at Bashidang, classified as semi-subterranean, ground level, pile-dwelling, and platform. These houses were usually associated with ovens or fire places, with floors hardened and damp-proofed by red fired-earth. The only platform house foundation looks like a starfish, 40 cm high above the surrounding ground level, with a big pole in the center standing on a bovid mandible. It may have not been built for daily life occupation but perhaps served some special purpose. Over 100 tombs have been found, mainly around the living area. Most are secondary burials associated with a few grave goods, including pottery vessels and stone tools. A moat and a wall occurred in the middle phase of the site. This is a new phenomenon which has never been seen in the early Neolithic period in any other area of China (Pei 1996, 1998).

It is briefly stated that three categories of stone tools were found, including heavy-duty flaked pebble tools, small flake implements made of chert, and a few polished tools. The tool assemblage is extremely similar to that of the Pengtoushan site, 25 km south of the Bashidang (Hunan Provincial Institute of Archaeology 1996; Lu 1999). According to a brief report of the 1993-1994 excavation, only one piece of polished stone axe was found, while most polished stone artifacts were ornaments rather than tools (Hunan Provincial Institute of Archaeology 1996). In addition to lithics, a large number of tools made of bone, wood and bamboo have been uncovered (Pei 1998). Among these items, wooden shovels, spades and pestles, probably associated with agricultural activities, merit special attention. While the wooden shovels and spades might have been used for rice farming, the pestles might have been employed for rice processing.

Before the excavation of Bashidang, few implements were identified as agricultural tools. This is incongruous, given the large quantity of rice remains found in the Pengtoushan culture. Therefore, the discovery of these bone, wooden and bamboo implements is very significant for our understanding of the initial phase of plant domestication. However, since no excavation report is yet available, further inferences cannot be made at this stage.

Pottery vessels from Bashidang are mainly round-bottomed jars or urns with cord marks. A small number of urns have paired "cattle-nostril" lugs, similar to counterparts from the Peiligang culture in the Yellow River valley. This may indicate cultural contact between the two areas. The pottery is mostly red or red-brown in color. The ceramic paste is coarse and tempered with plant fiber (Hunan Provincial Institute of Archaeology 1996; Pei

Table 6. Beijing university radiocarbon dates for the Bashidang assemblage (Based on Pei 1996)

Lab. No.	Material	Source	C14 Dates (BP)
BK94112	Charcoal	8T4(11)H5	7540±80
BK94111	Charcoal	8T5(9)	6990±70
BK94110	Charcoal	8T8G3	7185±70

Table 7. Beijing University conventional radiocarbon dates for the Pengtoushan assemblage (Based on Pei 1996; Chen and Hedges 1994)

Lab. No.	Material	Source	C14 Dates (BP)
BK87022	Potsherd	Surface	9100±120
BK87050	Charcoal	T1(4)	8200±200
BK89016	Charcoal	T14(2)	7815±100
BK89017	Peat	T13(3)	7745±90
BK89018	Bamboo charcoal	T14(6)	7945±170
BK89109	Peat	T 3D6	7770±110
BK89020	Peat	T1H1	7945±100
BK89021	Peat	T10D22	8385±115
BK891022	Peat	T3F2	8135±90

1996). But, compared with the Yuchanyan assemblage, there is a great improvement in ceramic manufacture, with more variety of pottery forms. Many pottery stands have been found, indicating that some pots might have been used as cooking vessels, though results of residue analysis are not yet available.

Faunal remains from both domesticated and wild species are rich. Several kinds of deer and fish make up the largest proportion of the faunal assemblage, suggesting that hunting and fishing might have still played an important role in subsistence. But cattle, pig and chicken are believed to have been husbanded by the Bashidang inhabitants. Cattle bones were used to make tools such as knives or spades (Pei 1998). About twenty different species of plants have also been uncovered, but the details remain to be reported (Pei 1998).

The most important discoveries at Bashidang are the rice remains. Concealed in ancient river deposits, the rice grains were preserved extremely well. Preliminary studies on some 373 grains unearthed in 1996 have been carried out (Zhang and Pei 1997; Pei 1998). Phytolith analysis shows that the glume epidermal phytoliths of the Bashidang rice grains are similar to those of cultivated Indica rice (*Oryza sativa indica*). But the length of the Bashidang rice grains is smaller than that of *O. sativa indica* and closer to subspecies *O. sativa japonica.* The widths are smaller than both modern cultivars and contemporary wild rice. The ratio of length/width is quite similar to that of *O. sativa indica* (Zhang and Pei 1997; Lu 1999). Therefore, the Bashidang rice remains have mixed characteristics of *indica* and *japonica*, perhaps closer to *indica* (Zhang and Pei 1997). This result makes researchers believe that these remains represent an ancient species of cultivated rice, called "Bashidang ancient rice", from which the two different sub-species were later to be developed (Zhang and Pei 1997; Pei 1998; Lu 1999).

Only three radiocarbon dates from Bashidang have been released (see Table 6) (Pei 1996). All fall into a period from 6900 to 7500 BP (uncalibrated), which is slightly later than the Pengtoushan assemblage. But, cross-dating puts the early occupation of Bashidang into a period contemporary with the early phase of the Pengtoushan culture. The middle and late occupations of Bashidang are coexistent with the middle and late phases of Pengtoushan culture (see Tables 7 and 8) (Pei 1996; He 1996). It seems, therefore, that the Bashidang assemblage lasted for a long period of time. However, we do not know if the rice remains were recovered from only one period or throughout the entire occupation. This may not be clarified until the excavation report becomes available. Based on the preliminary report, the observed 373 rice grains were unearthed from the early occupation, which belongs to the early Pengtoushan culture (Zhang and Pei 1997; Pei 1996; Lu 1999). Most radiocarbon dates from Pengtoushan are around 8000 BP (see Tables 7 and 8). These equate with a calibrated date of about 7000-5500 BC for the Pengtoushan assemblage (Chen and Hedges 1994; Yan 1991; He 1996). Since the above-mentioned 373 rice grains were all found in the lower strata of the Bashidang site, and a large quantity of rice remains was also uncovered from Pengtoushan, scholars believe that rice cultivation must have been practiced at 6000-7000 BC on the Liyang Plain (Zhang and Pei 1997).

THE JIAHU ASSEMBLAGE

This early Neolithic site was found at Jiahu village in Wuyang County, central Henan Province. Located on the eastern slope of the Funiushan Mountain and the southwestern edge of the North China Plain, its elevation is 68 metres above sea level. The Jiahu site was discovered in 1962, but the nature of its cultural characteristics was recognized only after the discovery of the Peiligang Culture in the late 1970s (Henan Provincial Institute of Archaeology 1989, 1998; Chen 1997b). Its significance gradually unfolded after six seasons of excavation from 1983 to 1987 by the Henan Provincial Institute of Archaeology.

The site measures 275 m east-west and 260 m north-south and is irregularly oval in shape. It occupies a total area of 55,000 m^2. The excavations revealed cultural deposits of 1.5-2.5 m in thickness. While the first and second strata are historical occupation, the third and the fourth levels comprised Neolithic remains (Henan Provin-

Table 8: Oxford AMS radiocarbon dates for the Pengtoushan assemblage (Based on Pei 1996; Chen and Hedges 1994)

Lab. No.	Material	Source	AMS C14 Dates (BP)
OxA1274	Lipoid	Potsherd	7055±100
OxA1275	Humic acid	Potsherd	8005±80
OxA1277	Fulvic acid	Potsherd	6250±110
OxA1280	Coarse charcoal grain	Potsherd	9785±180
OxA1281	Fine charcoal powder	Potsherd	7890±90
OxA1282	Very fine charcoal powder	Potsherd	8455±90
OxA1273	Very fine charcoal powder	Potsherd	9065±300
OxA2210	Rice husk charcoal and straw	T1H2 potsherd	7775±90
OxA2211	Fulvic and humic acid	T1H2 potsherd	7520±90
OxA2212	Charcoal grain	T1H2 potsherd	8550±80
OxA2213	Charcoal grain	TIH2 potsherd	9220±80
Ox2214	Rice husk charcoal and straw	T14(3) potsherd	7250±40
OxA2216	Charcoal grain	T14(3) potsherd	8390±80
OxA2217	Charcoal grain	T14(3) potsherd	8490±80

cial Institute of Archaeology 1998).

More than 40 house foundations, 300 storage pits, about 10 pottery kilns, 300 burials, several thousand sherds, stone and bone remains were recovered from the excavations, over an area of 2400 m^2. The settlement layout shows that the residential, cemetery and workshop areas were closely spaced. Semi-subterranean house foundations were either circular or oval in shape. Houses were surrounded with post-holes, and some of the houses had associated hearths. The majority of houses had only one room, but there were a few multi-roomed houses resulting from expansion.

The Jiahu cemetery could be divided into several groups. All of the graves were pit burials, some with ledges. Most of the graves were oriented towards the west or southwest. There were various burial treatments, including single primary burial, single secondary burial, multiple primary burial, multiple secondary burial, and collective burial of multiple single and secondary interments. The skeletons in single burials were mostly placed in extended supine position. Most of the burials were associated with grave goods ranging from one to several dozen items. The grave goods were dominated by subsistence and domestic tools, personal ornaments and religious items. Most of the burial goods were made of pottery, bone and stone. Among them, bone objects were the most frequent. A small number of graves contained sets of turtle shells with drilled holes, and small pebbles were often found inside the shells. Some turtle shells showed inscribed signs. Bone flutes were found in a small number of graves. All these characteristics evidently suggest that Jiahu people had a sedentary way of life and developed a society more complex than ever before (Henan Provincial Institute of Archaeology 1989, 1998; Zhang *et al.* 1994; Chen *et al.* 1995).

The stone tools recovered from the site were mostly well-ground. The most frequently found tool types include stone axes, curve-bladed or shouldered stone shovels, denticulated stone sickles, four-legged grinding stone mortars, square or prismatic stone grinding pestles, turquoise ornaments, bone harpoons, arrowheads, needles, awls, and fork-shaped bone implements. While the stone shovels and sickles may have served for planting and harvesting, stone mortars and pestles may have been used for food processing. There is little doubt that these large stone implements were agricultural tools, even though more analysis of use wear and residue is needed.

In addition, a large number of animal bones was recovered from the site. Zooarchaeological study revealed that the Jiahu faunal assemblage included domesticated pig, dog, cattle, deer and fish. Faunal, phytolith and pollen studies showed that people of the Jiahu site were living in a warm and wet environment dotted with lakes and marshes. Most striking of all was the recovery of a large quantity of rice phytoliths, rice husks and carbonized rice seeds. This indicates that the prehistoric subsistence of Jiahu community was dominated by rice agriculture, heavily supplemented by various food procurement strategies such as fishing, hunting, gathering and animal husbandry (Zhang *et al.* 1994; Henan Provincial Institute of Archaeology 1998).

A large quantity of ceramic vessels was recovered from Jiahu. Sandy red or reddish brown pottery dominated the earlier ceramic assemblage. Fine red pottery gradually increased in quantity from the late early phase into the middle and late phases. There was also a considerable amount of pottery tempered with rice husks, shell,

Table 9. Radiocarbon dates for the Jiahu assemblage

Provenance	Cultural Phase	C14 Dates (BP)	Calib. Dates (BP)	Note
Zone 4	Early	7960±150, 7920±150, 7561±125	8942~8338	Based on Chen *et al.* 1995; Henan Provincial Institute of Archaeology 1998.
Zone 3C	Middle	7137±128, 7105±122	7919~7907	
Zone 3B	Late	7017±131	7870, 7868, .7801	

bone and mica fragments. The firing temperatures varied between 600 and 1000°C. The ceramics were poorly made and fired unevenly; the resistance to stress was low. The Jiahu pottery vessels were made by either moulding or coiling techniques, mostly with burnished and red-slip surfaces. The most frequently seen surface decorations are cord marks, incision, nipple patterns, comb dotted patterns and comb patterns. The majority of the pottery shapes are flat-bottomed; nevertheless, round-bottomed, tripod, and ring-footed vessels also occur. Typical pottery forms include various types of *ding* tripod supporting basin-shaped and jar-shaped vessels, and all kinds of bowls. Urns are decorated with paired "cattle-nostril" lugs, which are similar to counterparts in the Pengtoushan culture in the middle Yangzi River valley.

A large quantity of rice husks, carbonized rice and rice phytoliths have been found throughout the entire deposit. Studies suggest that rice agriculture was a very important subsistence strategy of the Jiahu people. Given the early date of occupation and the advanced cultural complexity of the site of Jiahu, it has been suggested that the Huai River Basin was another important center for the origin of rice cultivation (Zhang *et al.* 1994; Kong *et al.* 1996). Moreover, it might also have been the origin region for *japonica* rice. But it should be noted the studies of rice remains are preliminary, and no agreement on the subspecies of the rice remains has been reached to date (Zhang *et al.* 1994; Chen *et al.* 1995; Kong *et al.* 1996; Yan 1997).

The excavators divided the Jiahu assemblage into early, middle and late phases. The site has yielded a total of 19 radiocarbon dates ranging from 7400 to 8300 BP, or 8000 to 9000 BP after calibration (Table 9). These dates indicate that the site was occupied for a long period of time. The Jiahu inhabitants may have practiced a sedentary way of life, mainly based on rice cultivation and supplemented by fishing, hunting and gathering (Zhang *et al.* 1994; Kong *et al.*, 1996; Henan Provincial Institute of Archaeology 1998).

CONCLUSIONS

The four assemblages mentioned above represent two developmental stages of rice cultivation. While the Xianrendong-Diaotonghuan and Yuchanyan occupants were just in the process moving from rice collecting to rice cultivation, the Bashidang and Jiahu people may have been primarily engaged in rice agriculture. In the first stage, hunting, fishing and collecting might still have played a dominant role in the subsistence strategy of those people. This inference is made based on the types of tool kits, which are similar to those of the late Palaeolithic (e.g., chipped stone tools and bone and shell implements), accompanied by a lack of firmly identified agricultural implements.

In the second stage, the people of Bashidang and Jiahu had made great progress towards food production and sedentism. Unlike their predecessors sheltered in natural caves, these people constructed houses and built walls and moats around villages for protection. They husbanded animals and manufactured a variety of tools of ground stone, bone, wood and bamboo, used for rice farming, harvesting and processing. They also developed a specific mortuary ritual to treat the dead. It seems that both the Bashidang and Jiahu people lived a fairly sedentary way of life. Nevertheless, the Jiahu people probably relied more heavily on rice agriculture than the Bashidang inhabitants (see Table 10).

Rice remains from these assemblages have mixed characteristics of both domesticated (*O. sativa japonica* and *O. sativa indica*) and wild rice, indicating that rice domestication was a very complex process, even though in theory the transformation from wild to domesticated rice may have only taken 200 years (Lu 1999). In fact, the process of rice domestication cannot be understood without multi-discipline cooperation between archaeologists and specialists from other fields.

Culture-historically oriented studies are still the dominant theme for most Chinese archaeologists. But the situation is changing gradually as new theories and methods have been introduced from abroad (Chen 1997b). Archaeologists have realized that they have a long way to go, even if cultural-historical reconstruction is still the major concern (Chen 1997b). For the study of origins of rice cultivation, more carefully designed field projects must be carried out by archaeologists. More samples need to be collected from excavations, more flotation should be employed, use wear and residue analysis must be carried out, and interdisciplinary cooperation between archaeologists and specialists on dating, palaeoclimates, palaeoenvironments

Table 10: Comparison between the four assemblages discussed in the text.

Site	Xianrendong and Diaotonghuan	Yuchanyan	Bashidang	Jiahu
Location	117°13'E, 28°4'N	111°30'E, 25°30'N	110°45'E, 29°40'N	113°40'E, 33°37'N
Region	Lower Yangzi	Middle Yangzi	Middle Yangzi	Upper Huai Valley
Tentative Timespan	20000-8000 BP (Epi-Palaolithic to Neolithic 3)	12000-8000 BP	9000-7500 BP	9000-8000 BP
Settlement type	Cave and rock shelter, with hearths or fire places	Cave, with fire places and burned animal bones and plant remains	Open air village, semi-subterranean, ground level and pile-dwelling houses, with a moat and wall around the settlement. Burials surrounded the habitation area	Open air village, semi-subterranean houses with hearths; multi-roomed houses. Habitation, cemetery and workshop areas were relatively concentrated
Subsistence Strategy	Rice cultivation occurred in Neolithic 1	Rice cultivation	Rice cultivation played an important role	Rice cultivation dominated the economy
Rice remains	Wild rice phytoliths found in Epi-Palaeolithic, *O. sativa* phytoliths occurred at Neolithic 1	Wild and domesticated rice husks and rice phytoliths	Rice grains, rice straw and husks, rice phytoliths and pollen	Rice grains, rice husks and rice phytoliths and pollen, rice straw imprints in pottery
Faunal remains	Mainly deer, birds, no domesticated animals	Mainly deer, fish and shellfish, no domesticated animals	Mainly deer and fish, but domesticated cattle, pig and chicken appeared	Mainly deer and fish, but pigs and dogs may have been domesticated
Tool kits	Pebble tools and flake tools before Neolithic 3, no certain agricultural implements	Pebble tools and flake tools, no certain agricultural implements	Pebble, flake and ground tools. Bone, wood and bamboo implements probably used for rice cultivation, harvesting and processing	Well-ground stone implements dominated. Shovels and mortars and pestles are clear evidence of agriculture
Ceramics	Ceramics occurred in Neolithic 1. Coarse, tempered with sand, round-bottomed jars made by coiling. Thinning by hand smoothing or with a handful of grass fibers. Cord-marked ceramics occurred in Neolithic 2	Brown or red-brown ceramics, tempered with sand and plant fibers, made by moulding techniques	All kinds of ceramic types occurred, but mainly round-bottomed jars or urns decorated with cord marks and tempered with plant fiber. Moulding techniques dominated pottery making	Kilns appeared. Sandy red-brown pottery dominated in the early phase, but a fine clay red pottery increased through the following phases. Moulding technique in use, with coiling
Social complexity	Simple	Simple	Complex	More complex

and rice agriculture must be conducted. Moreover, as much research relating to the origins of agriculture has been accomplished in other areas of the world, and new theoretical models proposed by Western scholars, it is necessary for Chinese scholars to keep up with these new developments (Gebauer and Price 1992; Lu 1999). In fact, through cooperation between archaeologists and scientists from other fields, studies on the origins of rice cultivation have proved to be more successful than ever before.

ACKNOWLEDGMENTS

I am deeply indebted to Dr. Li Liu, Dr. Tracey Lie-dan Lu, Mr. Zhang Juzhong and Mr. Ming Wei for stimulating discussions, insight, advice, and other generous help relating to the completion of this paper. Dr. Li Liu has helped extensively in improving the English. Dr. Tracey Lie-dan Lu's comprehensive and insightful work on the origins of agriculture in China has further improved my knowledge on many issues. Mr. Ming Wei has taken a painstaking effort in making the slides for the Melaka presentation. I also thank Dr. Peter Bellwood for his encouragement and unfailing support in providing such a great opportunity for me to participate in the 16th Congress of the Indo-Pacific Prehistory Association in Melaka. However, any errors in this paper are my own responsibility.

REFERENCES

An, Zhimin 1979. (Peiligang, Cishan and Yangshao). *Kaogu* (Archaeology) 4:335-46 (in Chinese).

Andersson, J.G. 1934. *Children of the Yellow Earth*. London: Kegan Paul, Trench, Trubner & Co., Ltd.

Bellwood, P., Gillespie, R, Thompson, G.B., Ardika, I.W. and Ipoi Datan 1992. New dates for prehistoric Asian rice. *Asian Perspectives* 2:161-70.

Bellwood, P. 1996. The origins and spread of agriculture in the Indo-Pacific region: gradualism and diffusion or revolution and colonization? In David R. Harris (ed.) *The Origins and Spread of Agriculture and Pastoralism in Eurasia,* pp. 465-89. London: UCL Press.

Chang, K.C. 1977. *The Archaeology of Ancient China* (Third Edition). New Haven: Yale University Press.

------ 1986. *The Archaeology of Ancient China* (Fourth Edition). New Haven: Yale University Press.

Chen, Baozhang *et al.* 1995. (The discovery of rice phytoliths at Jiahu Neolithic site in Henan and its significance). *Kexue Tongbao* (Chinese Science Report) 4:339-42 (in Chinese).

Chen, Tiemei and Hedges, R.E.M. 1994. (Accelerator-mass-spectrometry radiocarbon dating of pottery from Pengtoushan and Hujiawuchang sites and the earliest rice remains in China). *Wenwu* (Cultural Relics) 3:88-94 (in Chinese).

Chen, Xingcan 1997a. (*The History of Prehistory Archaeology in China).* Beijing: Sanlian Press (in Chinese).

------ 1997b. (Some problems on the development of Chinese prehistoric archaeology). *Shixue Lilun Yanjiu* (Studies on Historical Theory) 4:54-60 (in Chinese).

------ 1998a. Searching for the earliest Neolithic cultures in China from the perspectives of ceramics. Paper presented at The Fifth International Seminar on the Neolithization of Europe and Asia: Regional Approaches, Ljubljana 11-17, May, 1998.

------ 1998b. (Paper basin, fire basin and the origin of pottery). *Wenwu Tiandi* (World of Cultural Relics) 4:31-3 (in Chinese).

Edman, G. and E. Söderberg 1929. Auffindung von Reis in eine tonscherte aus einer etwa fünftausendjahrigen chinesischen siedlung. *Bulletin of the Geological Society of China* Vol. VIII, No. 4, pp. 363-65.

First Henan Archaeological Team, IA, CASS 1994. (Excavation of the Lilou Site at Ruzhou, Henan). *Kaogu Xuebao* (Acta Archaeologica Sinica) 1:63-94 (in Chinese).

Fu, Xianguo 1998. (Important results from the excavation at Dingshishan midden site). *Zhongguo Wenwu Bao* (News of Chinese Relics). December 14. Front page (in Chinese).

Gebauer, A.B. and Price, T.D. (eds) 1992. *Transition to Agriculture in Prehistory*. Madison, Wisconsin: Prehistory Press.

He, Jiejun 1996. (On primitive cultures of the middle Yangzi river district). In He Jiejun (ed.), (*Essays on Prehistoric Cultures of the Middle Yangzi River Valley and the Second Meeting on Asian Civilization)*, pp. 183-209. Changsha: Yuelu Press (in Chinese).

Hemudu Archaeological Team 1980. (Important results from the second excavation at the Hemudu site in Zhejiang). *Wenwu* (Cultural Relics) 5:1-15 (in Chinese).

Henan Provincial Institute of Archaeology 1989. (Excavations of the Neolithic sites at Jiahu in Wuyang, Henan, 2nd-6th seasons). *Wenwu* (Cultural Relics) 1:1-20 (in Chinese).

------ 1998. (*Jiahu Site at Wuyang*). Beijing: Science Press (in Chinese).

Hill, D.V. 1995. Ceramic Analysis. In Richard S. MacNeish and Jane G. Libby (eds), *Origin of Rice Agriculture-The Preliminary Report of the Sino-American Jiangxi (PRC) Project*, pp. 35-45. El Paso: University of Texas Centennial Museum Publications in Anthropology No. 13.

Hunan Provincial Institute of Archaeology and Lixian Bureau for the Management of Cultural Relics 1990. (Preliminary Report on the excavations at the early Neolithic site of Pengtoushan, Lixian, Hunan). *Wenwu* (Cultural Relics) 8:17-29 (in Chinese).

------ 1996. (Excavation of an early Neolithic site at Bashidang, Mengxi Lixian, Hunan). *Wenwu* (Cultural Relics) 12:26-39 (in Chinese).

IACASS (Institute of Archaeology, Chinese Academy of Social Sciences) 1965. (*Qujialing Site of Jingshan County*). Beijing: Science Press (in Chinese).

------ 1991. (*A Compilation of Radiocarbon Dates in Chinese Archaeology, 1965-1991*). Beijing: Wenwu Press (in Chinese).

------ 1997. A radiocarbon dating report). *Kaogu* (Archaeology) 7:345-52 (in Chinese).

Jiangxi Provincial Committee for the Protection of Cultural Relics 1963. (A trial excavation at Xianrendong, Dayuan, Wannian county, Jiangxi province). *Kaogu Xuebao* (Archaeologica Sinica) 1:1-17 (in Chinese).

Jiangxi Provincial Museum 1976. (The report of the second excavation at Xianrendong, Wannian, Jiangxi province). *Wenwu* (Cultural Relics) 12:23-30 (in Chinese).

Kong, Zhaochen *et al.* 1996. (The discovery of rice remains prior to 8000 BP from Jiahu site, Wuyang county, Henan, and its significance in environmental archaeology). *Kaogu* (Archaeology) 12:78-83 (in Chinese).

Lin, Chun and Hu, Hongbao 1993. (The Chengbeixi and Pengtoushan cultures and early paddy rice agriculture in China). *Nongye Kaogu* (Agricultural Archaeology) 1:116-122 (in Chinese).

Liu, Shizhong 1993. (An exploration on the Neolithic cultures of Jiangxi). *Kaogu* (Archaeology) 12: 1061, 1099-1109.

------ 1996. (Important achievements in the excavation of Xianrendong and Diaotonghuan, Jiangxi Province). *Zhongguo Wenwu Bao* (News of Chinese Relics). January 28. Front page (in Chinese).

Lu, Tracey Lie-dan 1999. *The Transition from Foraging to Farming and the Origin of Agriculture in China.* Oxford: BAR International Series 774.

MacNeish, R.S. 1995a. Lithic typology. In Richard S. MacNeish and Jane G. Libby (eds), *Origin of Rice Agriculture-The Preliminary Report of the Sino-American Jiangxi (PRC) Project,* pp. 23-34. El Paso: University of Texas Centennial Museum Publications in Anthropology No. 13.

------ 1995b. Summary of SAJOR initial endeavor. In Richard S. MacNeish and Jane G. Libby (eds), *Origin of Rice Agriculture-The Preliminary Report of the Sino-American Jiangxi (PRC) Project,* pp. 87-93. El Paso: University of Texas Centennial Museum Publications in Anthropology No. 13.

MacNeish, R.S. *et al.* 1995. Isotopic analysis to determine ancient diet in the Neolithic-Epipalaeolithic of China. In Richard S. MacNeish and Jane G. Libby (eds), *Origin of Rice Agriculture-The Preliminary Report of the Sino-American Jiangxi (PRC) Project,*.pp. 69-76. El Paso: University of Texas Centennial Museum Publications in Anthropology No. 13.

MacNeish, R.S. and Libby J.G.(eds) 1995. *Origin of Rice Agriculture-The Preliminary Report of the Sino-American Jiangxi (PRC) Project.* El Paso: University of Texas Centennial Museum Publications in Anthropology No. 13.

MacNeish, R.S. and Taylor R.E. 1995. Chronometrics. In Richard S. MacNeish and Jane G. Libby (eds), *Origin of Rice Agriculture-The Preliminary Report of the Sino-American Jiangxi (PRC) Project,* pp. 77-88. El Paso: University of Texas Centennial Museum Publications in Anthropology No. 13.

Olsen, J.W. and Miller-Antonio, S. 1992 The Paleolithic in southern China. *Asian Perspectives* 2:129-60.

Pei, Anping 1996. (On Pengtoushan Culture). In He Jiejun (ed.) (*Essays on Prehistoric Cultures of the Middle Yangzi River Valley and the Second Meeting on Asian Civilization*), pp. 81-104. Changshan: Yuelu Press (in Chinese).

------ 1998. (A large number of valuable artifacts unearthed from Bashidang site in Li County). *Zhongguo Wenwu Bao* (News of Chinese Relics). February 8. Front page (in Chinese).

Redding, R.W. 1995. Preliminary report on faunal remains recovered from the 1993 excavations. In Richard S. MacNeish and Jane G. Libby (eds), *Origin of Rice Agriculture-The Preliminary Report of the Sino-American Jiangxi (PRC) Project,* pp. 53-58. El Paso: University of Texas Centennial Museum Publications in Anthropology No. 13.

Underhill, A.P. 1997. Current issues in Chinese Neolithic archaeology. *Journal of World Prehistory* 2:103-60.

Wang, Xianzheng 1995 Palynology and paleo-climate in the Dayuan Basin. Richard S. MacNeish and Jane G. Libby (eds), *Origin of Rice Agriculture-The Preliminary Report of the Sino-American Jiangxi (PRC) Project,* pp. 59-67. El Paso: University of Texas Centennial Museum Publications in Anthropology No. 13.

Wang, Xiaoqing 1995. The occurrence of pottery in China and the development of technology. In *Higashi Ajia Keketonodoku No Kigen* (The Origin of Ceramics in Eastern Asia), pp. 77-92. Sendai: Tohoku Fukushi Press (in Japanese).

Wang Zengling 1995. (Application of phytolith analysis in the study of the site at Yuchisi). *Kaogu* (Archaeology) 1:88-90 (in Chinese).

Wei, Jingwu *et al.*1986. (Archaeological materials on the development of agriculture in Shaanxi). *Nongye Kaogu* (Agricultural archaeology) 1:45-60 (in Chinese).

Wu, Yaoli and Chen Xingcan 1993. The first use of flotation in Chinese archaeological excavation). *Wenwu Tiandi* (World of Cultural Relics) 3:10-12 (in Chinese).

Wu, Yaoli 1996. Prehistoric rice agriculture in the Yellow River Valley. *Bulletin of the Indo-Pacific Prehistory Association* 15: 223-4.

Yan, Wenming 1987. (On the unity and diversity of prehistoric cultures in China). *Wenwu* (Cultural Relics) 3:38-49 (in Chinese).

------ 1991. China's earliest rice agriculture remains. *Bulletin of the Indo-Pacific Prehistory Association* 10:118-126.

------ 1997. (New development in the studies on the origin of rice cultivation). *Kaogu* (Archaeology) 9:71-76 (in Chinese).

Yu, Weichao 1987. (Moulding techniques of pottery-making in early China). *Wenwu Yu Kaogu Lunji* (Essays on Cultural Relics and Archaeology) Beijing: *Wenwu* Press (in Chinese).

Yuan, Sixun 1996. (Report of Carbon 14 dates). *Wenwu* (Cultural Relics) 4 (in Chinese).

Zhang, Juzhong *et al.* 1994. (Paddy rice at a prehistoric site in Wuyang and prehistoric agriculture in the Huang and Huai River regions). *Nongye Kaogu* (Agricultural Archaeology) 1:68-77 (in Chinese).

Zhang, Wenxu and Pei, Anping 1997. (The study on the ancient rice from Baoshidang, Mengxi in Li County). *Wenwu* (Cultural Relics) 1:36-41 (in Chinese).

Zhao, Zhijun *et al.* 1995. Analysis of the phytoliths from Xian Ren Dong and Wang Dong. In Richard S. MacNeish and Jane G. Libby (eds), *Origin of Rice Agriculture-The Preliminary Report of the Sino-American Jiangxi (PRC) Project*, pp. 47-52. Publications in Anthropology No.13, El Paso Centennial Museum. El Paso: The University of Texas.

Zhejiang Provincial Committee for the Protection of Cultural Relics and the Zhejiang Provincial Museum. 1978. (Report on the first excavation at Hemudu site). *Kaogu Xuebao* (Archaeologica Sinica) 1:39-107 (in Chinese).

Zhushchikhovskaya, I. 1997. On early pottery-making in the Russian Far East. *Asian Perspectives* 2:159-174.