CHINA'S EARLIEST RICE AGRICULTURE REMAINS

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In October of 1988, in response to an invitation by the Japanese Archaeological Society, I was able to participate in a symposium held in Shizuoka on the origin and spread of rice agriculture. I presented a lecture there entitled "The origin and development of rice agriculture in China" (Yan 1988). In this lecture, after analyzing about 70 places within China's borders where prehistoric remains of rice have been found, I proposed that a large region in Central China was probably an area in which agriculture originated. Within this region the lower Yangtze River merits particular attention.

THE PENGTOUSHAN DISCOVERIES

In November and December of 1988, a group from the Hunan Provincial Culture Relics Archaeology Research Institute excavated the Pengtoushan site in Li County, northern Hunan Province (Anon. 1989). The Department of Archaeology of Beijing University sent a graduate student to participate in this project, and here were found the earliest remains of cultivated rice known to date. In May 1989 specimens of this rice and other associated artifacts were shown in Changsha at the Seventh Annual Meeting of the Chinese Archaeological Society, arousing great interest. After the meeting, several delegates and I immediately drove out to investigate Pengtoushan and several nearby sites, where we were deeply impressed.

The Pengtoushan site is located in present day Dapingxiang Village, Li County, and is situated on the Liyang Plain on the northwest shore of Dongting Lake. To the south it overlooks the Li River and nearby to the north are the foothills of the Wuling Mountains. The surrounding area is a plain. The site itself is a low earth mound, three to four meters above the surrounding land, with an existing area of approximately 10,000 square meters, most of which is now occupied by a modern village. Excavations indicate that this is a relatively pure neolithic site. Although cultural remains of the various strata have some differences, their overall appearance is still basically the same and all belong to one archaeological culture. This culture is known as the Pengtoushan Culture.

At present, Pengtoushan is one of the earliest in a series of neolithic sites found in the middle Yangtze valley. The Department of Archaeology of Beijing University has carried

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out carbon-14 determinations on some specimens from the site. The preliminary results are seen in Table 1.

Laboratory No.	Samples	Provenance	C14Date(BP)
BK87002	Potsherd	Surface	9100±120
BK87050	Charcoal	T1(4)	8200±120
BK889016	Charcoal	T14(2)	7815±100
BK89018	Charcoalized Bamboo, small amt. charcoal	T14(6)	7945±170

TABLE 1: BEIJING RADIOCARBON DATES FOR PENGTOUSHAN

Pengtoushan pottery was, in part, made from peat. Because of this, the carbon in the pottery was formed much earlier than the pottery itself so the date of the first sample cannot represent the date of the sherd. The last sample comes from the earliest stratum but it includes a large amount of bamboo charcoal. Bamboo is a C4 plant and so may give a carbon-14 date that is slightly younger than it actually should be. Therefore, the pooled carbon-14 date for the site represented by Table 1 is most probably 7800-8500 years before present.

Laboratory No.	Carbon Group	C-14 Date (BP)
OXA1274	Lipoid	7055 ± 100
OXA1275	Humic Acid	8005 ± 80
OXA1277	Fulvic Acid	6250 ± 110
OXA1280	Coarse Charcoal Grain	9785 ± 180
OXA1281	Fine Charcoal Powder	7890 ± 90
OXA1282	Very Fine Charcoal Powder	8455 ± 90

TABLE 2: OXFORD AMS RADIOCARBON DATES FOR PENGTOUSHAN POTTERY

In order to make a comparison with carbon-14 dates determined in China, the director of our departmental laboratory, Professor Chen Tiemei, brought a Pengtoushan potsherd to the Oxford University Archaeology Laboratory. There, the carbon-containing materials in the sherd were first divided into six separate groups, then age determinations were made using AMS techniques for each group. The results are shown in Table 2, from which it can be seen that the different carbon-containing groups of this one potsherd have a range of dates. Among these, the coarse charcoal grain is a material from the peat used in the ware; the determination is thus on the old side and ought to be eliminated. Fulvic acid is a product of corrosion of the sherd by humic material after it has been buried in the stratum, so its date is obviously more recent than that of the sherd itself. The rest of the dates are from the period of about 7000-8500 years before present, relatively close to the dates obtained using conventional carbon-14 dating techniques.

However, carbon-14 dates and calendar dates are not the same thing. Generally speaking, if we want to get the calendar date we need to use a dendrochronological calibration. Although the dates determined here are beyond the range of existing dendrochronological tables, we know that the deviation of any carbon-14 date from the corresponding actual date is due mainly to changes in the earth's magnetic field. This type of deviation, on the whole, follows a sine curve. Therefore, although we cannot use dendrochronological calibration directly for such early carbon-14 dates we can infer the corresponding calendar dates by extending the sine curve. Using this technique we can arrive at a date of about 7000-5500 B.C. for the Pengtoushan Culture. This is more or less contemporary with, or slightly earlier than, Cishan and the Cishan-Peiligang Culture of the Central Plains. In a chronological table of the Chinese neolithic the Pengtoushan Culture would fall in the range of the middle neolithic (Yan 1989a).

In the lowest level at Pengtoushan, house foundation remains, ash pits and graves were found. Houses were constructed on level ground, floors were covered with yellow sandy soil and the walls carried columns inside. According to the arrangement of post holes, the area of one dwelling was about thirty square meters. These are the earliest remains of a house foundation yet found in China. The construction style is different from the pile-dwelling architecture of the Hemudu Culture and Majiabang Culture of the lower Yangtze, but it is rather similar to that of cultures that followed Pengtoushan in the middle Yangtze, such as the Daxi and Qujialing Cultures.

Lithics excavated at Pengtoushan as a whole can be divided into three categories. The common chipped stone implements are relatively large in form and include choppers and plate-shaped tools. The second category includes small flint tools that are much like microliths, but very few have been re-worked. Basic types include scrapers, points, and gravers. The third category, of polished stone tools, includes small axes, adzes, and chisels. There are also many club, tube, and bead-type ornamental objects of stone.

The fact that there are more chipped than polished stone implements shows that the level of skill in lithic manufacture was far lower than that of the Cishan Culture. The Cishan Culture not only had a comparatively large number of stone tools, but also stone

agricultural tools re-worked by polishing, such as shovels, sickles, saddle-querns and rollers. The Cishan Culture had relatively advanced agriculture.

Among the Pengtoushan stone implements there are none that can definitely be called agricultural tools. This seems to be incongruous in view of the large amount of rice found in the site. However, in the fourth level at the Hemudu site, which is later than Pengtoushan and contains much more rice, there also are very few stone tools that are considered to be agricultural implements. The agricultural tools that were found at Hemudu were mainly bone and wooden spades and other implements suitable for rice field cultivation. Because the soil at Pengtoushan is slightly acidic and the groundwater level is not as high as at Hemudu, bone and wood materials are generally not preserved. Therefore, just because we have not yet discovered agricultural tools at the site we should not conclude that there never were any.

Pengtoushan produced a large amount of pottery. Vessel forms were simple, with four main types: bowls, urns, cauldrons, and vessel stands. Except for the vessel stands, almost all vessels had round bottoms. Functionally, the pottery included food and drink vessels, storage vessels and cooking vessels. Vessel stands and smaller vessels were made directly by a pinching technique. Other vessels seem to have been made by forming clay pieces around a mould.

Generally, Pengtoushan vessel bottoms are very thick; some are three to four times as thick as the walls at the mouth. Vessel interiors have pressed-in, shallow indentations, presumably the result of paddle and anvil manufacture. A small number of urns have paired "cattle-nostril" lugs. The pottery is mostly red or red-brown in colour. Fabrics, which sometimes contain peat, are mostly black inside, and some wares have mixed-in rice husks and other plant pieces. Much of the pottery is decorated on the exterior with very thick, criss-crossing cord-marks, and punctate and incised types of decoration also occur. The characteristics are rather similar to the pottery of the Chengbeixi Culture of western Hubei Province.

The most important discoveries at Pengtoushan are the remains of rice. Some pieces of red fired-earth contain many rice husks. Some pottery also was made by mixing rice husks into the clay as temper before firing. Preliminary observations of the rice husks show that the grains were rather large, in form very close to grains of modern cultivated rice. Without a doubt these are remains of cultivated rice, but the variety has yet to be formally determined.

PENGTOUSHAN IN ITS REGIONAL CONTEXT

In the past, the earliest remains of rice in China were those from Hemudu. Now, with the discovery of the Pengtoushan rice we can suddenly push back the start of rice cultivation one or two thousand years. This, of course, is quite an important achievement for research into the origins of rice agriculture.

At Lijiagang (HPCRARI 1989), Bashidang, Xialiujiawan, Huangmagang and other locations in Li County, Hunan, other sites similar to Pengtoushan have been found and these are now all included in the Pengtoushan Culture. In Hubei, sites such as Chengbeixi

and Zhichengbei (AWSH 1988) in Yidu County, Liulinxi and Chaotianzui (SATNCRB 1989) in Zigui County, and others, are now classified in the Chengbeixi Culture. Actually these cultures are neighbors, and although their cultural traits are not identical they are on the whole quite similar. Furthermore, they are both the predecessors of the Daxi Culture. Very probably these are two local phases of the same archaeological culture, together representing the middle neolithic culture in the middle Yangtze. Also worth mentioning is that in the fall of 1983, a graduate student from the Department of Archaeology at Beijing University, while doing fieldwork in western Hubei, collected both sherds and red fired-earth that contained rice husks at the Zhichengbie site in Yidu County. This is quite like the situation at Pengtoushan, only Zhichengbie is somewhat later, belonging to the late Chengbeixi Culture.

This also causes us to remember what Wei Jinwu wrote in a general discussion of agricultural archaeology in Shaanxi: "In recent years during our excavations at the Lijiacun and Hejiawan sites in Xixiang County, in some red fired-earth pieces dating to the Lijiacun-Laoguantai Culture we have found traces of rice husks." (Wei *et al.* 1986). The "Lijiacun-Laoguantai Culture" is more generally called the Laoguantai Culture. Its distribution covers the confluence of the Wei and Yellow Rivers and one part cuts across the Qinling Mountains and is distributed along the middle reaches of the Han River, which is part of the Yangtze River system. Lijiacun and Hejiawan are both in the Hanzhong Basin, which is in the middle Han River valley. Culturally, the Laoguantai Culture has many similarities with the Cishan Culture. Both belong to the middle neolithic with dates of around 6000 to 5000 BC; thus they are later than Pengtoushan but still earlier than Hemudu.

The discoveries of rice at Pengtoushan, Zhichengbei, Lijiacun, Hejiawan and several other sites prove that there actually are remains of rice in China much earlier than those from Hemudu. Furthermore, they show that at a very early period rice cultivation spread northward to the southern slope of the Qinling Mountains.

WHERE DID RICE CULTIVATION COMMENCE IN CHINA?

When rice was found at Hemudu it was the earliest cultivated rice then known in the world, dating to 4000-5000 BC. However, because the rice found at Hemudu was much like modern cultivated rice in form, because the amount found was incredibly large, and because there were a large number of agricultural tools associated with it, many people conjectured that the Hemudu area ought to have had an even older history of rice cultivation. The lower Yangtze and its neighboring areas were thus possibly one center of origin of rice agriculture (Yan 1982).

So far, there still has not been any great headway made in finding earlier remains of rice farming in the lower Yangtze, but breakthroughs have been made following the discovery of a series of middle neolithic cultures in the middle Yangtze. Does this necessarily mean that the original assumption about the lower Yangtze is wrong and should be changed? I think, at least for the time being, we cannot say this for several reasons. First, the climatic conditions, geographical environment and ecosystems of the

lower and the middle Yangtze are basically the same. Both areas have historical records of once having had wild rice, and in a recent survey of the range of wild rice in China common wild rice (*Oryza sativa* var. *spontanea*) was found growing in both Hunan and Jiangxi (CGNIWRR 1984). In Jiangxi the common wild rice was found in Dongxiang Country; since this is to the east of the dividing line between the middle and lower Yangtze at Jiujiangkou this rice was actually found in the lower Yangtze region. Therefore, the lower and middle Yangtze both have the natural conditions necessary for the domestication of cultivated rice from wild rice.

Secondly, although the neolithic cultures of the middle and lower Yangtze were definitely in contact, these two areas were two independent systems. The lower Yangtze was mainly the focus of the Hemudu-Majiabang-Songze-Liangzhu cultural system. The level of development in corresponding phases between the two areas was very close. In the lower Yangtze, the earliest site, Hemudu, is just old enough to be classified as belonging to the latest stage of the middle neolithic, with an earliest date of around 5000 B.C. From its start, the Hemudu Culture took on a developed form that already had the distinctive features of the lower Yangtze neolithic cultures and so it naturally had not moved in from another area. This means that preceding Hemudu there must certainly be a period of development - a period that is now a "missing link" in the archaeological record. This is most likely due to insufficient archaeological discoveries and not to some gap inherent in the cultural development process. After this "missing link" is filled by new discoveries it will become clearer just how far back we can trace rice cultivation in China.

Thirdly, judging from remains of rice grains and agricultural tools found at Hemudu, we can see that its rice farming was already very advanced, much more so than that of the Pengtoushan and Chengbeixi Cultures. Not until the period of the Daxi Culture can we say that rice farming was notably developed in the middle Yangtze, and this occurred at a later period than Hemudu. From this we can infer that in the lower Yangtze, the level of rice agriculture in the period before Hemudu, that is, the period corresponding to Pengtoushan in the middle Yangtze, ought to be higher than, or at least not any lower than, the level of agricultural development in the middle Yangtze region. This, of course, also means that the start of rice agriculture in the lower Yangtze cannot be later than that of the middle Yangtze.

Thus we can see that the discovery of earlier rice remains at Pengtoushan and other areas does not mean that previous hypotheses concerning the origin of rice farming in the lower Yangtze and its vicinity should now be considered incorrect. On the contrary, the fact of early rice farming in the middle Yangtze ought to strengthen our confidence in being able to find earlier remains of rice in the lower Yangtze region. Of course, in light of these new data we should slightly relax our restrictions on the scope of our search for the origins of rice agriculture in China and include the entire middle and lower Yangtze River, and the South China region as well. Although I have discussed this point many times before (Yan 1982, 1988, 1989b, 1989c), it now has gradually become more apparent.

Many people have focused on South China's position in the rise of rice farming. For example, Ando Kotaro even considered it to be one of the origin points (Sasaki 1959). Ding Ying, on the basis of the extensive distribution of wild rice and its "kinship" relationship to cultivated rice, held that the growing of cultivated rice originated in South China (Ding 1957). The discovery in recent years in Guangdong and Guangxi of some of the earliest Chinese neolithic sites has even more drawn the attention of scholars to the region.

At present, however, although many early neolithic sites have been found in South China, most are cave and shell mound sites; sites on level ground are lacking. The shell mound sites contain large numbers of mollusc shells; these are remains of gathered food. The cave sites also often have large quantities of shells. Besides shells, fish, soft-shelled turtle, deer, pig, cattle, elephant and other bone remains have also been excavated. Except for the bones of domesticated pig found at Zengpiyan in Guilin, Guangxi, all other bones are from wild animals.

Associated tools, besides stone axes, adzes, chisels and other handworking tools, mainly included *haolizhuo* (a chipped stone tool), stone spear points, stone net-sinkers, bone arrowheads and bone fishing spears. These show that the main economic activities were fishing, hunting, and gathering, and there are no clear traces of agriculture. Not until the time of the Shixia Culture is domesticated rice found, but this is already after 3000 BC.

Two opposing suggestions can be made from this situation. The first is that before 3000 BC there was no cultivated rice in South China. From the characteristics of these sites we can see that the main economic activities were hunting, fishing, and gathering of aquatic animals; there is no evidence of rice consumption. Even if rice was part of the diet, this requirement could have been completely met by gathering the wild rice commonly found growing in the area. Only when the population had grown to a point where it could no longer depend solely on fishing, hunting and gathering did people turn their attention to the artificial methods of rice cultivation. This resembles what we see during the Shixia Culture. The opposed suggestion is that as far back as the early neolithic period there possibly was rice cultivation in South China, but because other food resources were so plentiful rice farming underwent no marked development.

Whatever the answer for South China, the situation in the middle and lower Yangtze area was very different. By rough count there are over 80 sites in China where prehistoric remains of cultivated rice have been found. Among these, 64 are in the middle and lower Yangtze regions, 8 are in the region of the confluence of the Yellow and Huai Rivers, Yunnan, Fujian and Taiwan together have 7 sites, and only 2, both in Guangdong, are actually in South China. This, of course, may be related in part to the greater amount of archaeological work done in the middle and lower Yangtze, but this is not the whole story. Instead, to a very large degree it must reflect historical reality, and the reason for it is most likely related to the climate and ecological environment of the region.

If we compare the climates of the middle and lower Yangtze with those of the South China area, the most notable difference between the two regions is that the Yangtze area

has a much greater distinction between summer and winter. Summers are hot and wet and plant foods flourish, while winters are cold and dry. It is also difficult to maintain a stable, day to day supply of animal foods from hunting in this kind of climate. Following cultural development and population growth, these difficulties in the Yangtze basin became increasingly acute. It became necessary to select plants that were both edible and storable for cultivation. Since the middle and lower Yangtze already had wild rice that could be gathered, the people gradually would have understood its food value and storability. Because wild rice in the middle and lower Yangtze was much less common than in South China, this further increased the necessity and urgency to use artificial methods to propagate it. This is probably the basic reason for both the early emergence and rapid development of rice agriculture in the middle and lower Yangtze.

Furthermore, *Oryza sativa* subspecies *japonica*, one of the two basic subspecies of lowland rice, prefers a cool to warm ranging climate. Its character is far different from that of common wild rice so it is not very likely that it was first domesticated in South China. The lower Yangtze has two types of wild rice that are very close in character to *japonica*, namely *lu* rice and *fu* rice. With the many recent discoveries of very early remains of *japonica* rice in the Yangtze region we can infer that it was first cultivated here.

If the middle and lower Yangtze have such an important position in the rise of rice agriculture, why retain South China in the discussion? This is because although rice remains from Pengtoushan date back to around 7000 B.C., we still cannot say this is the earliest cultivated rice. Perhaps the history of rice growing started even earlier: we can probably trace it back at least to the basal Holocene. At that time the temperature in the Yangtze region was slightly lower than today and rainfall was somewhat less. Before this time, during the Dali glaciation of the late Pleistocene, the Yangtze valley certainly was not suitable for the growth of common wild rice. Only after the beginning of the Holocene and the gradual warming of the climate was common wild rice - the direct ancestor of cultivated rice - able to move into the Yangtze valley. This move was perhaps a natural process, but it is also possible that humans might have played a role.

If rice cultivation originated after wild rice transferred into the Yangtze valley, then, of course, the middle and lower Yangtze was the area of its origin and South China probably did not play an important role. If cultivation occurred before wild rice entered the Yangtze valley, then South China may have been the place of primary origin, and the middle and lower Yangtze was where further development and the cultivation of *japonica* rice occurred. Since, for the meantime, we are unable to solve this problem it is still best to view the middle and lower Yangtze and South China as one large area in which agriculture originated.

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