

THE TRANSITION FROM FORAGING TO FARMING IN CHINA

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ABSTRACT

The origin of agriculture in China is one of the most poorly understood topics in world prehistory. However, a considerable database has been accumulated since the 1920s on this issue. In recent years several important archaeological discoveries have shed new light on the origin of rice cultivation in the Yangzi Valley. Some of these discoveries are reviewed. But the origin of millet domestication in the Yellow Valley is still very poorly documented, mainly due to the lack of archaeological and archaeobotanic data. This paper discusses some observations concerning the domestication of foxtail millet.

The transition from foraging to farming in China occurred from the terminal Pleistocene into the early Holocene. This period, from about 20,000 to 7000 BP, witnessed significant palaeoenvironmental and palaeoclimatic changes. Pollen profiles, faunal data, physiographic and geological studies, mineralogical analyses and the study of sea level changes all suggest that the Last Glacial Maximum (LGM) had a significant impact in China, particularly in middle to higher latitudes. It has been proposed that the winter monsoon from the northern continental interior blew towards China, causing a dry and cold climate (Li 1987; An *et al.* 1991).

During the LGM, it is estimated that the mean annual temperature was about 7-8°C lower than that of the present in the Yellow Valley, and about 4-6°C lower in the Yangzi Valley (Lu 1999). Precipitation was reduced by up to 500 mm in the Yellow Valley (An *et al.* 1991) and by about 700 mm or even more in the Yangzi Valley (Lu 1999). Lakes and rivers shrank, deciduous and broad-leaved trees retreated southwards, drought-resistant herbs dominated the vegetation and animals adapted to temperate environments withdrew (An *et al.* 1991). Consequently, many edible nuts and fruits from the deciduous and broad-leaved trees disappeared in both the Yellow and the Yangzi Valleys, and so did many animals such as deer, rhinoceros

and small mammals (Lu 1999). The foragers in the Yellow and Yangzi Valleys during the LGM must have endured a cold and dry climate, a steppe environment dominated by herbs with sparse trees, and dramatically reduced floral and faunal resources.

To survive in such a harsh environment, foragers would have to adjust their economic strategies. Faunal composition in the Yangzi Valley altered less than in the Yellow Valley, where fast-running ungulates dominated the fauna. This faunal change would have forced hunters to adjust their hunting skills. Microblades occurred during this time in the Yellow Valley, suggesting the practice of new hunting techniques.

The LGM foragers in both the Yellow and the Yangzi Valleys would have had to increase their reliance on drought-resistant wild grasses, as these grasses would have been the dominant species during that time according to pollen profiles. This exploitation of wild grasses is documented in the Yangzi Valley by the archaeobotanical discoveries of wild rice in Yuchan and Xianrendong caves (Chen Xingcan this volume; Zhang Chi this volume). By 9000-8000 BP, rice was domesticated in the Yangzi Valley, documented by the discoveries of domesticated rice remains from Bashidang and Pengtoushan (Zhang and Pei 1997). Judging from the stone tools and pottery assemblages, it seems that there were cultural links between the Yuchan and/or Xianrendong assemblages and the early Holocene assemblages in the Yangzi Valley, suggesting a widespread and indigenous origin for rice cultivation in this region.

In the Yellow Valley, archaeobotanical evidence for the collection of wild grass seeds is yet to be found, but there is some indirect evidence based upon tool kit analysis, particularly of grinding slabs and stone flakes with gloss (Lu 1999). According to archaeological, archaeobotanical and ethnographic data, the presence of grinding slabs often occurs in association with seed collection. This argument is valid for the Middle East (Wright 1991) and Australia (Cane 1984). In the Chinese context, grinding slabs were first present during the terminal Pleistocene in

the Xiachuan assemblage in the middle Yellow Valley. The Xiachuan assemblage is dated to approximately 23,000-13,000 BP (The Institute of Archaeology CASS 1991). The presence of grinding slabs indicates that the Xiachuan foragers might have collected grass seeds during the terminal Pleistocene.

Apart from grinding slabs, flaked axes, arrowheads, microblades and microcores were also found at Xiachuan. These stone tools were new implements during this period in the Yellow Valley. Although the functions of these implements are not yet clear, their presence suggests that some new subsistence strategies might have been employed, which might have included the exploitation of wild grasses and hunting of the ungulates which were the major species found in the Yellow Valley during the LGM.

In the early 1990s an archaeological site dated to 10,000-9000 BP was discovered in Nanzhuangtou, Hebei province. A few stone tools, including a fragmentary grinding slab and a roller, were discovered in association with some wooden and antler implements (CPAM of Baoding District *et al.* 1992). The archaeological data from Nanzhuangtou site are very scanty. However, the presence of the grinding slab and roller should not be ignored, since it suggests that seed-collection was probably practised at the beginning of the Holocene in Central China adjacent to the Yellow Valley.

According to ethnographic and botanical studies, wild grasses have their advantages for human exploitation. Their reproductive ability is very high and their grains can be stored for long periods. Most importantly, many of these grasses can survive in a harsh environment, thus providing a valued resource for people living in hostile climates and less resource-rich environments.

Botanical study indicates that the progenitor of foxtail millet (*Setaria italica*) is green foxtail (*Setaria viridis*) (Li *et al.* 1945). My field observations in China in 1996 indicate that green foxtail is a tough, highly adaptive annual grass, which can survive in various environments and which is very drought-resistant (Lu 1998). In addition, green foxtail also has a high nutritional value. This grass would have been an ideal food resource for foragers living in the cold and dry Yellow Valley during the terminal Pleistocene.

The ancestor of cultivated rice (*Oryza sativa*) is arguably the perennial wild rice species *Oryza rufipogon* (Oka 1988). Seeds of wild rice are also nutritious, although this grass grows in a subtropical to tropical environment and is not very tolerant of dry and cold climates. In addition, the quantity of seeds produced by perennial wild rice is much smaller than that of domesticated rice (Oka 1975). However, wild rice seems to have been collected in the Yangzi Valley by the terminal Pleistocene.

As wild grasses, green foxtail and wild rice both differ significantly from their domesticated counterparts.

Briefly, the differences are as follows:

1. Both green foxtail and wild rice have varying periods of flowering and ripening, lasting from 1 to 3 months. Flowering, ripening and seed shattering can all occur simultaneously on one tiller (Lu 1998, 1999). Panicles of both green foxtail and wild rice shatter as soon as they are ripe. On the other hand, both domesticated rice and foxtail millet have a short and synchronised period of flowering and ripening and do not shatter.
2. The dormancy period seems quite long, at least for green foxtail, and the date of germination is irregular. While most green foxtail germinates in the spring, some can sprout as late as early summer (Lu 1999). Domesticated foxtail millet germinates at a relatively fixed date.
3. Domesticated millet and rice produce more tillers/panicles than the wild forms. Consequently, more seeds are produced.

Undoubtedly, the evolution from wild grasses to domesticated cereals was achieved through human cultivation and selection. According to harvesting experiments using green foxtail and wild rice, in order to promote this evolution the first farmers must have used harvesting methods such as cutting or pulling up the whole plant (Lu 1999). Some seeds gathered by these harvesting methods must have been sown in the next year; and cultivation in areas where the wild forms did not occur must have been practised to maintain the cultivated mutants (Hillman and Davies 1992; Lu 1999). Apparently, in order to domesticate millet and rice successfully, it would have been necessary to have substantial understanding of the growth habits of the progenitors.

According to archaeological discoveries in the Middle East, intensive exploitation of wild grasses was a necessary prelude for the emergence of agriculture (Bar-Yosef and Meadow 1995). It is only logical to assume that a similar history of exploitation would have happened in China. Intensive exploitation of wild grasses, including wild millets, would also have reduced forager mobility during the ripening season. As a consequence, populations would have increased, as documented by ethnographic data (Kelly 1995). An increased population demanded more food, thus leading to more intensive exploitation of local resources. Once a depleted local resource failed to meet the demands of the foraging group, the balance between the foragers and their natural resources would have been broken.

This loss of balance would have triggered a strong desire to maintain, or even increase, the availability of food resources. One possible option would have been to move, but if the population was already quite dense and movement was not practicable, then other methods would have to be tried. According to ethnographic data, the planting of seeds was one of the methods used by Great Basin hunter-gatherers to maintain their food supplies (Steward 1938).

If similar practices existed in the Yellow Valley from the terminal Pleistocene to the early Holocene, this would have assisted in the development of millet cultivation.

Archaeological data suggest that by 8000 BP there were numerous agricultural societies spread across the Yellow Valley. The major cultivars for these societies were foxtail and broomcorn millets (*Setaria italica* and *Panicum miliaceum*), as discovered in the Dadiwan and Cishan assemblages (Chen 1994). Polished stone axes, adzes, sickles and grinding slabs occur in these assemblages (The Institute of Archaeology CASS 1984). Remains of houses, storage pits and burials indicate that these were probably sedentary societies. Pottery was made, quite diversified in shape and decoration, representing three or four cultural groups in the Yellow Valley, these being the Dadiwan, Peiligang, Cishan and Houli complexes (although there are differing opinions on whether Peiligang and Cishan represent two cultures or two branches of one culture).

Apparently, there are similarities between the toolkits of the Xiachuan assemblages and those of the early agricultural groups in the Yellow Valley. It has been argued that the prehistoric foragers in the Xiachuan basin were the ancestors of the agricultural societies in the Yellow Valley (Shi 1989). Although more evidence is needed to support this argument, the similarities in stone tools may suggest a strong cultural link between these groups. It is possible that the descendants of the Xiachuan group, with their grinding slabs and other new types of tools, dispersed from the Shanxi basin along the Yellow River after the LGM (Lu 1999). These dispersed groups then developed into agricultural societies. What we do not know at this stage is whether millet cultivation began prior to this dispersal, or after.

One thing, however, is clear. The agricultural societies in the Yellow Valley, dating from 8500 BP onwards, were quite well established. It seems that they were not groups just beginning their cultivation activities. There are good reasons to assume that the transition from foraging to farming in the Yellow Valley occurred prior to 8500 BP, although this assumption awaits further archaeological discovery.

The origin of agriculture was one of the greatest achievements of humankind. Since the late nineteenth century, this topic has become one of the hottest in prehistory and many scholars have made their contribution. Various theories and models have been created. The environmental changes during the terminal Pleistocene, the Younger Dryas, the increased population and the abundance or scarcity of natural resources in given areas are all variables which might have played a role in this great process of human evolution (e.g. Price and Gebauer 1995).

Some of these models may be applicable to China, but others may not. Judging from accumulated data, the environmental changes of the terminal Pleistocene in the Yellow

low and Yangzi Valleys seem certain to have played an important role. The distribution of archaeological assemblages in the Shanxi Basin, where the Xiachuan assemblage is located, also suggests that the population in that area of the Yellow Valley might have been denser than in other areas. This increased population might have further restricted the mobility of foragers and forced them to maintain or increase their food by various methods, including planting seeds. But this hypothesis awaits further study.

In the Yangzi Valley, to date there seems little evidence that the population was dense during the terminal Pleistocene. The cold and dry climate from the terminal Pleistocene into the early Holocene would not have allowed a dense distribution of wild rice there since rice is basically a sub-tropical to tropical plant. It is possible that the demand for an increased supply of wild rice in cooling conditions could have been the impetus for the origin of rice cultivation.

It has been argued that agriculture evolved in conditions of relative affluence. This proposal is only arguably valid for certain areas, depending upon how one defines the term "affluence". In the Chinese context, pollen profiles and animal remains document that prehistoric South China (defined as the area south of the Five Mountains) was a land with more abundant resources than the Yangzi Valley. Yet there is no evidence for an indigenous origin of agriculture here. To date, archaeological and archaeobotanic data from China seem to suggest that agriculture originated in temperate environments with relatively abundant resources, but an abundance restricted by seasonality (Lu 1999).

Once emerged, agricultural societies dispersed rapidly to other areas. In the Yellow Valley, agricultural societies quickly occupied the major part of the area by 6000 BP, represented by the Banpo, Dawenkou and other Neolithic cultures. In the Yangzi Valley, agricultural societies established themselves widely by about the same time. The affluent Hemudu assemblage, dated from 7000 to 6000 BP, is an excellent example of prosperity. The cultivation of millet and rice also spread to other parts of Asia. An eastbound dispersal reached Korea by 5000-4000 BP (Nelson 1993), and a southbound dispersal reached Southeast Asia by 4500 BP (Bellwood 1996).

Unfortunately, there are still many unclear questions on the origins of agriculture in China, particularly in the Yellow Valley. Further research and collaboration among archaeologists and scholars from botany, agronomy and other scientific disciplines is much needed to solve these problems.

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