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What do we know about domestication in eastern Asia?

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ABSTRACT

The body of data based on new work on genetics and DNA, plus a growing number of radiocarbon ages which are independent of dates based on cultural associations has broadened our knowledge of domestication in eastern Asia. Here we review the situation for several plant and animal species that were domesticated locally or imported to east Asia. Major centres of plant domestication in China have been in the Yellow and Yangtze river basins, and in Yunnan. For animals it appears that the Yellow River region, the area around Xi'an and the south-east have been important centres. Many adopted domesticates have entered China through the north-west and later through ports such as Canton (Guangzhou). It appears that while there are outliers to extended ranges of wild plants and animals, sometimes not securely dated, widespread deliberate movement of plants and animals outside their natural ranges coincided with reduced hunting and gathering around 5–4 kyr in the Longshan cultural period. The adoption of agriculture has resulted in large scale landscape transformation; forests and woodlands have been replaced by crop and grazing lands and this is evident in many late Holocene sedimentary records. This transformation continues and the patterns are changing as diets are shifting and much grain is now used to feed chicken and beef, and in addition this has placed increased pressure on water resources.

1. Introduction

The purpose of this paper is to provide a starting point of the current general status of what is known about domestication and landscape transformation by humans across eastern Asia. The following provides analysis of new material which expands on previous reviews and aims to broaden our understanding of the topic. A key element in the development of modern societies was the domestication of plants and animals. This led to a shift of hunter-gatherer groups to settled communities. Hunter-gatherer groups were mobile, necessarily small bands and generally unable to accumulate large quantities of material goods. It can be argued that settled communities had crops and animals to tend which led to predictable and hence reliable food supplies and land ownership. Also shorter breeding cycles meant that population growth was more rapid and a greater diversification of tasks was possible. The latter most likely fostered greater complexity of cultural, religious and political systems, and more rapid technological advancements. Indeed the makings of many modern societies was rooted in the development of domestication and agricultural systems.

The development of domestication apparently began in several distinct places, and the Levant and Eastern Asia were amongst the earliest of these. Diamond (2002) asked why this occurred so late in the history of modern humans. Of course we don't know the answer to this but it may have been related to the onset of milder and more steady climates as the Holocene period opened a little over 10,000 years ago (Richerson et al., 2001). Presumably under more stable climate exploitable species ranges and the living environment for humans became predictable over many generations.

The early phases of domestication were based on local species, and hence differed in detail from place to place. A few widespread species, such as pigs (*Sus* sp.) may have been independently domesticated in several centres. When more extensive trading and technological exchanges were developed useful domesticates and technologies were transported to new areas.

The process of domestication is generally one where selection of species characteristics is made on the basis of their usefulness to humans. This results in a simplification of the gene pool in the domesticated species. A simplified gene pool makes for a more

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vulnerable population, and as agricultural societies often rely on fewer species compared to hunter gatherers it is important that the largest possible gene pool is preserved as insurance against loss of a domesticate. The process of domestication is continuing and indeed has speeded up through application of new gene technology.

There have been several excellent reviews on domestication over the last few decades (e.g. Crawford, 1992; Zohary and Hopf, 2000; Gupta, 2004; Ucko and Dimbelby, 2007; Larson et al., 2014) which have established the broad patterns we continue to recognise today. In the last few year's greater availability of evidence from archaeological excavations and a gradual shift from dating by archaeological context to more objective AMS radiocarbon analyses on seeds, residues and bones has provided new and more refined insights into data. In addition there has been a rapid expansion of genetic data and the application of stable isotopes which has greatly broadened our understanding for several key species; and bringing all this together it is now possible to offer more refined discussions on the impacts of domestication on people, cultures, landscapes and ecosystems.

In this paper focus is on eastern Asia, where the evidence often predates modern states such as China. A summary account of selected early domesticated plants and animals is given here and some of the mid to late Holocene imports of domesticates into and from eastern Asia is presented. The gaps in knowledge remain large; however it is clear that bridging these will help define the challenges of sustainability for the well-being of societies today.

2. Environmental background

The late Pleistocene environment of eastern Asia was like most parts of the temperate world emerging from the Last Glacial Maximum. Temperate areas were several degrees cooler than today, with stronger seasonality, and a punctuation of high magnitude events known variously as Heinrich Events with the youngest of these known as the Younger Dryas. These probably originated from events in the North Atlantic and lasted decades to centuries and their scales were such that major redistributions of biomes and species ranges occurred. In the tropics the scale of change was dampened but lower sea levels greatly increased land area in some places and while temperatures were only a little milder the redistribution of continentality and monsoon driven rainfall was great in some regions (see for example An, 2000 and An et al., 2000). In contrast, globally, Holocene climate variability was subdued compared to the late Pleistocene. With small but sometimes significant differences the distribution of biomes settled into their present configuration by the early Holocene (see for example Zhao et al., 2009). That is, until human impacts of various kinds led to the next major changes in species distributions.

3. Plant domestications in China

3.1. Millets

Two main species of millet are cultivated in China: *Panicum miliaceum* (common or broom corn millet) and *Setaria italic* ssp. *italic* (foxtail millet). These are indigenous to northern China and thus their cultivation is thought to have originated there. The timing of domestication and routes of dispersal are unknown (Lu et al., 2009) but the earliest claimed site, which remains contentious, is at Cishan in northern China (CPAM Hebei Province, 1981, and confirmed by Lu et al., 2009) where husk phytoliths and hydrocarbons and ethers from common millet have been found in material from grain storage pits. The dates from charcoals in these are between ca. 10,300 and ca 8700 cal yr BP, but these do not relate directly to millet. A small amount of foxtail millet appears after this time. Sites further west in Gansu (Gansu, 2006) and in Liaoning (Barton et al., 2009) have dates around 7500–8000 cal yr BP. It is clear that more precise and targeted dates from more locations are needed to lock in the age and place of domestication. Zhao (2011) quotes unpublished dates on millet seed from Xinglonggou (Inner Mongolia) at 7670–7610 cal BP. These are secure ages, the site is regarded as a millet farming site where the society was in transition from hunter-gathering to agriculture. It is the most reliable early millet site for China at present. Common millet can tolerate poorer soils and drought, and the drier climates in the early Holocene (e.g. Feng et al., 2006a,b) may have been crucial in the adoption of common millet before foxtail millet.

Millet may have been introduced into Korea at about 8000 cal BP and is associated with the Middle Jeulmun pottery period (Crawford and Lee, 2003). It is not indigenous to Japan and its spread there was probably as a cultigen (Crawford, 1992). Millets are C4 plants and where they are the main foods of humans and animals the ^{13}C values of animal protein provide evidence of this. The $\partial^{13}C$ values can thus provide a direct link between humans and the use of millets in the food chain.

3.2. Rice

Oryza is a genus of about 24 species in Africa, Asia, Southeast Asia, New Guinea and Australia. Most grow as tall wetland grasses. *Oryza glaberrima* is from Africa and was cultivated from about 2 to 3000 years ago (Linares, 2002). Several rice species are indigenous to China and about five distinct groups occur in *O. sativa* (Garris et al., 2005). The earliest dated rice grains at about 12,000 years ago come from Hunan Province (Zhang and Jiarong, 1998) but there is uncertainty over whether these were in fact domestic rice. Many argue that rice was first domesticated in the mid to lower Yangtze, and the earliest known archaeological evidence tends to support this (see Gross and Zhao, 2014). Rice remains have been found in many early Neolithic sites including Shangshan and Xiaohuangshan with ages of 11,400–9600 cal yr BP and the Pengtoushan site with ages of 9500–8100 cal yr BP (Wang et al., 2010; Zhao, 2010). A key site is at Hemudu near Ningbo where storage pits containing rice dated at around 7000–5000 cal year BP is present. Huang et al. (2012) examined a large set of genome sequences from a large geographical spread of *O. rufipogon* plants and concluded that all domesticated rice came from one wild species found in the Pearl River basin of Guangdong. Clearly this is a key area to look for archaeological evidence that might be associated with that occurrence. Rice has several distinctive phytoliths and these, along with rice seeds, have been identified in many cases. Rice occurs in north China from the early Holocene in places where it would not grow naturally. It is also known from Gansu in the mid to early Holocene (Li et al., 2007a,b). This suggests it was quickly adopted as a major crop. By the mid-Holocene climate in some of those areas led to dryness and the unsuitability of rice for many Neolithic centres and its use was lessened or discontinued. Its cultivation spread to southeast China, southern Asia, Japan and Korea over the next several millennia (Gross and Zhao, 2014). Rice in the Ganges Delta area could have been harvested without domestication in the late Pleistocene (Fuller, 2011) and become domesticated on the Ganges Plains and could thus have been an independent centre of domestication (Saxena et al., 2006).

3.3. Buckwheat

Fagopyrum esculentum ssp. *ancestrale* is regarded as the ancestor of cultivated buckwheat in Asia. Ohnishi (1998) suggested the use as a crop began around 6000 years ago. Since the main ancestors

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