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Rapid agricultural transformation in the prehistoric Hexi corridor, China

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ABSTRACT

The issue of the communication and transfer of agricultural practices between the ancient West and East is being increasingly addressed. The Hexi corridor, which lies on the main path of the ancient Silk Road, is one of the most important relevant study areas. Here we report the results of an archaeobotanical study based on the analysis of flotation samples and AMS ^{14}C dating of eight sites in the Hexi corridor. The results show that rain-fed millet agriculture in eastern China spread westwards to the Hexi Corridor as early as 2300 BC; and that wheat began to be cultivated at approximately 2000 BC, becoming the dominant crop at approximately 1700 BC. This agricultural transformation in the prehistoric Hexi Corridor occurred over some 200 years. In addition, wild soybeans were probably also cultivated at the same time, and the gathering of fruit (*Nitraria*) and nuts (*Corylus*) may have supplemented the food supply.

1. Introduction

The issue of how and why human society changed during the past ca. 10,000 years or so has been a major focus of both archaeological and global change research (Gupta et al., 2006; Kuper and Kropelin, 2006; Mercuri et al., 2011). Over the last few decades, in addition to social factors, rapid climate changes and drought events have been regarded as the most important factor driving the rapid transformation of ancient societies and civilizations during the mid-late Holocene (An et al., 2005; Riehl, 2009; Mercuri et al., 2011; Roberts et al., 2011). The stability of agricultural systems in different ecological environments is critical for understanding ancient cultural development in the context of changing climate (Riehl, 2009). Studies of the structural changes in agricultural systems, combined with precise chronological data, may help us to understand the adaptation strategies and to estimate the impact of climate change on ancient human societies worldwide.

During the mid-late Holocene, between 3000–1000 BC, there was a global climatic transition from the Middle Holocene Megathermal to the relatively cold Late Holocene (Wanner et al., 2008). The monsoon system in Asia weakened, and the vegetation cover was degraded in many parts of the old world. Consequently, local agricultural systems became unstable, causing changes and the reformation of ancient cultures and civilizations which spread from east to west in Eurasia. Early agricultural globalization began at the same time: millet and rice agriculture spread to the west, and wheat and barley spread to the east (Li et al., 2007; Jones et al., 2011; Jia et al., 2012; Dodson et al., 2013; Barton and An, 2014; Liu et al., 2014).

The Hexi corridor lies on the main path of the ancient Silk Road, which was the most important communication route between western and eastern Eurasia. It is located on the margin of the Asian monsoon region and is also influenced by the Westerlies. The ecological environment of the oases scattered along the narrow desert belt is highly sensitive to climatic changes that are driven by the Asian Monsoon and the Westerlies (Wu, 1980; Chen et al., 2010). Neolithic and Bronze Age cultures in the mid-to late-Holocene have been identified in the ancient oases and deserts in this region (Bureau of National Cultural Relics, 2014). Studies of prehistoric agriculture in the Hexi corridor have mainly focused on wheat, naked barley and millet cultivation at the Donghuishan site, and the results document communications between the Western and Eastern civilizations during this period (Li and Mo, 2005; Flad et al., 2010). However, systemic chronological studies of the Neolithic and Bronze Age cultures of this region, combined with archaeobotanical work, are rare.

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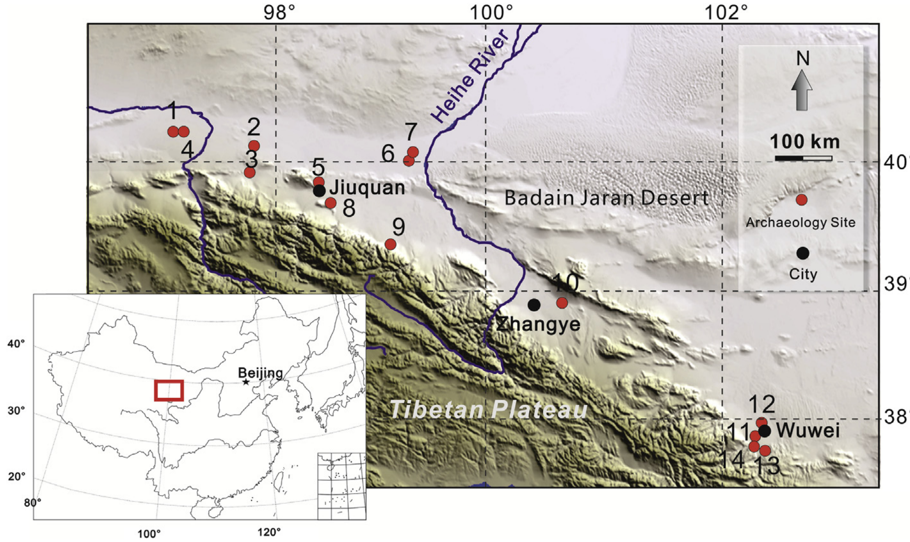

Fig. 1. The inset map shows the location of the study area in China and the main map shows the distribution of the studied archaeological sites. 1. Yingshuwo, 2. Shaguoliang, 3. Huoshaogou, 4. Tuhulu, 5. Zhaojiashuimo, 6. Ganggangwa, 7. Huoshiliang, 8. Xihetan, 9. Ganguya, 10. Donghuishan, 11. Guojiashan, 12. Huangniangniangtai, 13. Mozuizi, 14. Lifuzhai.

In this paper, we present the results of chronological and archaeobotanical studies of sites in the Hexi corridor and the results provide a picture of the emergence, development and decline of agricultural societies during the Late Neolithic and Bronze Age. In addition, by comparing the climatic record of the Asian monsoon and the Westerlies, we also discuss the influence of climate change on these prehistoric agricultural societies.

2. Study area and background

The Hexi corridor The Hexi corridor (E106°20′-108°45′; N35°15′-37°10′) is a narrow belt between the Qilian Mountains and Mongolian highlands. The area has a warm, semi-arid climate which is mainly controlled by the Asian monsoon and westerly circulation. Annual precipitation in the flatland in the Hexi corridor is 100–400 mm and decreases from southeast to northwest. The three main oases in the Hexi corridor are the Wuwei Oasis in the east, the Zhangye Oasis in the centre and the Jiuquan Oasis in the west. The vegetation consists of *Stipa* steppe in the east and desert shrub land dominated by Chenopodiaceae, *Ephedra*, *Tamarix*, *Hippophae* and *Nitraria* in the west. Agriculture in the eastern regions is partly dependent upon irrigation, while in the eastern regions it is entirely dependent upon irrigation.

The earliest agricultural culture in the Hexi corridor was the Majiayao phase of the Majiayao culture in the late Neolithic (Shui, 2001; Li, 2011; Dong et al., 2013; Bureau of National Cultural Relics, 2014). Neolithic settlements have been discovered at Lifuzhai, Xihetan, and Mozuizi. Thereafter, the Qijia and Siba Culture, which practiced copper smelting, became prevalent in the region (Shui, 2001). Remains of the Qijia culture are distributed mainly in the East Hexi corridor, while the Siba sites are distributed in the West (Li, 2011). The number of Siba cultural sites is much greater than that of the other cultural types, which indicates that its agricultural economy was relatively prosperous. Prosperous prehistoric agriculture of the Hexi corridor is likely to have ended after 1500 BC, since the number and size of the archaeological sites of the subsequent Shajing culture is significantly smaller than during the Siba culture (Bureau of National Cultural Relics, 2014).

3. Materials and methods

Fourteen Neolithic or Bronze Age sites in the Hexi corridor were investigated in the present study (Fig. 1). Among these, we chose 8 sites with exposed sections and cultural units for the archaeobotanical analysis of flotation samples (Table 1). The samples were collected from sections containing cultural horizons that were deposited within stratigraphic layers, or from ancient ash pits. Large quantities of soil were needed to collect a statistically significant sample. The volume of each sample was 40 L in the cultural layers and 20 L in the ash pits. The cell number per square inch of flotation sieve was 50 (0.3 mm mesh). The floated samples were air-dried and collected in sample bags and separated in the laboratory.

Table 1
List of the flotation sample sites

Site	Culture type	Site	Samples	Reference
Mozuizi	Machang Phase (Majiayao culture)	Culture Layer	40 L × 4	Bureau of National Cultural Relics, 2014
Xihetan	Machang Phase	Ash Pit	20 L × 3	Bureau of National Cultural Relics, 2014
Huangniang niangtai	Qijia Culture	Culture Layer	40 L × 10	Bureau of National Cultural Relics, 2014
Donghuishan	Siba Culture	Culture Layer	40 L × 8	Bureau of National Cultural Relics, 2014
Huoshaogou	Siba Culture	Ash Pit	20 L × 2	Bureau of National Cultural Relics, 2014
Shaguoliang	Siba Culture	Ash Pit	20 L × 2	Bureau of National Cultural Relics, 2014
Ganggangwa	Machang Phase & Siba Culture	Ash Pit	20 L × 3	
Huoshiliang	Machang Phase & Siba Culture	Culture Layer	40 L × 8	