Journal of Archaeological Science: Reports 20 (2018) 711–721

Contents lists available at ScienceDirect

Journal of Archaeological Science: Reports

journal homepage: www.elsevier.com/locate/jasrep

# Early agriculture at the crossroads of China and Southeast Asia: Archaeobotanical evidence and radiocarbon dates from Baiyangcun, Yunnan

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ARTICLE INFO

*Keywords:*
Neolithic
Archaeobotany
Paleoethnobotany
Rice
Millet
Soybean

ABSTRACT

We report archaeobotanical results from systematic flotation at what is presently the earliest Neolithic site with hard evidence for crop cultivation in the Southwestern Chinese province of Yunnan, at the site of Baiyangcun. Direct AMS dates on rice and millet seeds, included together in a Bayesian model, suggests that sedentary agricultural occupation began ca. 2650 BCE, with cultivation of already domesticated rice (*Oryza sativa*), broomcorn millet (*Panicum miliaceum*), and foxtail millet (*Setaria italica*). Soybean (*Glycine* cf. max) was also present and presumably cultivated, although it still resembles its wild progenitor in terms of seed size. Additional possible cultivars include melon (*Cucumis melo*) and an unknown *Vigna* pulse, while wild gathered resources include fruits and nuts, including hawthorn (*Crateagus*) and aquatic foxnut (*Euryale ferox*). Weed flora suggests at least some rice was cultivated in wet (flooded or irrigated fields), while dryland weeds may derive from millet fields. This subsistence system persisted throughout the site's occupation, up to ca. 2050 BCE. These data provide secure evidence for the spread of Chinese Neolithic crops to Yunnan, and provide new evidence for reconstructing possible sources of cereal agriculture in mainland Southeast Asia.

## 1. Introduction

In many regions the Neolithic transition resulted from the migration of farmers and the spread of key cereal crops from their centres of domestication. In mainland Southeast Asia, evidence has long pointed to the introduction of rice agriculture in the Neolithic via dispersal processes from the Yangtze Valley region of China (e.g. Higham, 1996; Bellwood and Renfrew, 2002; Castillo and Fuller, 2010; Silva et al., 2015; Castillo et al., 2016a, 2016b). In recent years, it has become evident that Neolithic cultivation in Southeast Asia also included foxtail millet (*Setaria italica*), another Chinese domesticate but derived from the more northern loess-based Neolithic traditions (Weber et al., 2010; Castillo and Fuller, 2010; Liu et al., 2009; Qin, 2012; Stevens and Fuller, 2017). The route or routes by which migrating farmers and/or their crops moved from China to Southeast Asia has been open to discussion, with at least three major axes under consideration: (1) a coastal route that started in Taiwan and Fujian (e.g. Bellwood, 1991, 1995; Sagart, 2005; Bellwood and Dizon, 2008); (2) a route from the middle Yangtze to the Lingnan and the Pearl river basin in Guangdong and then onwards through Guangxi into Vietnam (e.g. Fuller et al., 2011); (3) up the Yangtze to Yunnan and then moving down various north-south rivers, such as the Mekong, into Southeast Asia (Higham, 1996, 2002a). Potentially two, or all three, of these routes could have been followed in parallel, and various language phyla in Southeast Asia (e.g. Austronesian, Austro-Thai, Austroasiatic, Tibeto-Burman) do suggest multiple southward and westward dispersals of farmers in prehistory (see, e.g. Higham, 2002b; Blench, 2005; Bellwood, 2005; Van Driem, 2005; Stevens and Fuller, 2017). The degree to which the present archaeobotanical data can support any of these routes is highly variable. Any or all of these scenarios fits with straightforward processes of spatial diffusion of rice from one or two centres of domestication in the Middle and Lower Yangtze (Silva et al., 2015), however the southern routes fit less well with the dispersal of millet. Nevertheless, archaeobotanical sampling from the southern provinces of China has been quite limited, and the present paper reports results from new efforts at systematic flotation for archaeobotanical remains in Yunnan province coupled with direct AMS-radiocarbon dating of crop remains. Given the late date of rice within southern China, e.g. after 2500 BCE (e.g. Zhang and

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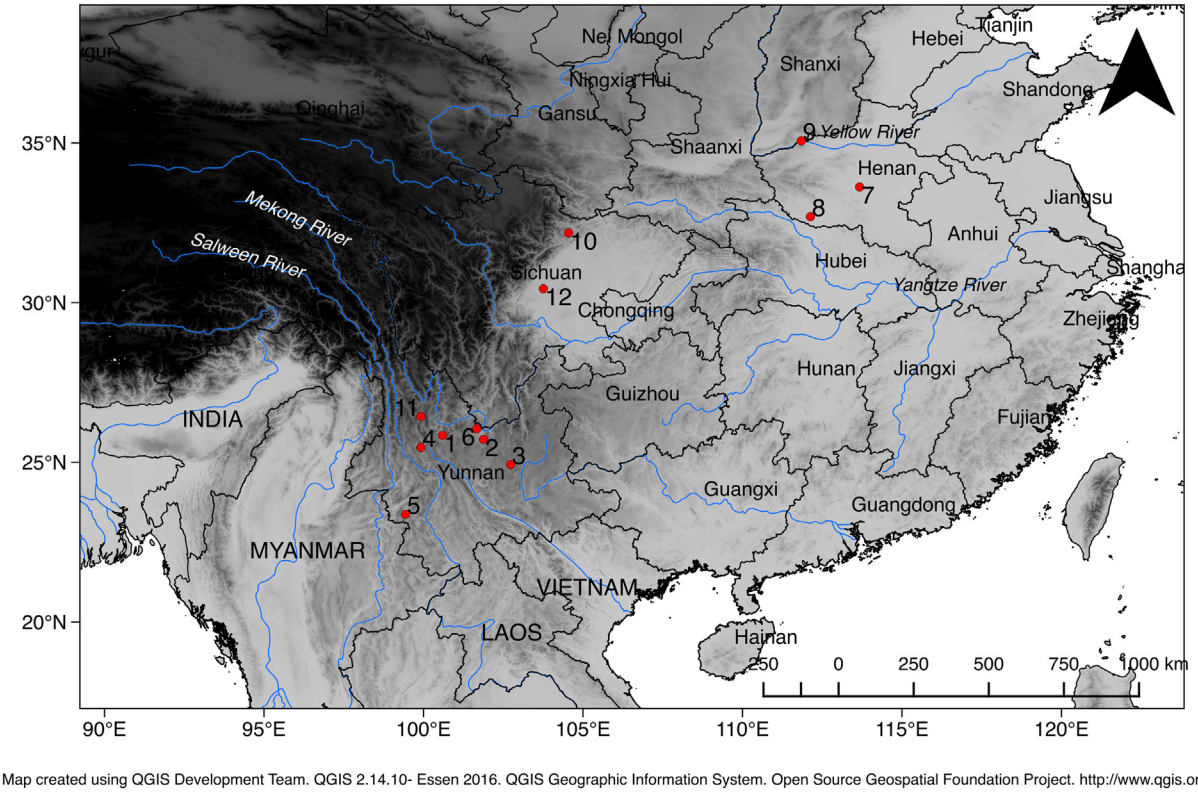
https://doi.org/10.1016/j.jasrep.2018.06.005
Received 30 January 2018; Received in revised form 4 June 2018; Accepted 4 June 2018




Map created using QGIS Development Team. QGIS 2.14.10- Essen 2016. QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://www.qgis.org/

**Fig. 1.** Location of sites mentioned in text: 1. Baiyangcun; 2. Dadunzi; 3. Haidong; 4. Xinguang; 5. Shifodong; 6. Mopandi; 7. Jiahu; 8. Baligang; 9. Bancun; 10. Yingpanshan; 11. Haimenkou; 12. Baodun. Made with QGis.

Hung, 2008; Yao, 2010; Zhang and Hung, 2010; Yang et al., 2017), the dating of early sites in Yunnan and the nature and crop composition are key to understanding this agricultural transition and the migration of farming communities into Southwest China and beyond.

With respect to these possible routes, we report the first flotation results from the Neolithic site of Baiyangcun in north-western Yunnan province China (see Fig. 1). Based on excavation over 35 years ago and the chance recovery of rice (Yunnan Provincial Museum, 1981), this site has played an important role in inferring the presence of rice cultivation by ca. 2300 BCE in this region as a possible precursor to the spread of rice to mainland Southeast Asia (e.g. Higham, 2002a). Some questioned whether or not these finds were intrusive (e.g. D'Alpoim Guedes and Butler, 2014), but new sampling and direct dating reported here suggest otherwise. New excavations were carried out at the site in 2013–2014 by the Yunnan Province Institute of Archaeology, including systematic archaeobotanical sampling through flotation, with subsequent laboratory analyses ongoing through collaboration between Peking University and UCL, with selected grains directly dated by AMS radiocarbon in Oxford, and Glasgow respectively.

### 1.1. Baiyangcun site and excavations

The site of Baiyangcun (白羊村) is located in the Dali Bai Autonomous Prefecture (大理白族自治州) in Binchuan county (宾川县), north-western Yunnan (Fig. 1). Binchuan county is surrounded by high mountains, reaching a maximum altitude of 3700 masl in the north-west, and a lowest elevation of about 1000 masl in the southeast (see Fig. 1). The area is within the influence of the subtropical monsoon, and characterized by distinctive wet and dry seasons, with an annual average temperature of 12–15 °C, and annual average rainfall of about 750 mm (Li and Walker, 1986). The Baiyangcun site is located in the middle Jinsha (金沙江) Valley on the banks of the Bingju tributary River, about 3 km east of Binchuan.

Discovered in 1972, the site underwent one excavation campaign from November 1973 to January 1974. On this occasion, a total area of 290 $m^2$ was excavated and 8 cultural layers were identified that reached a depth of 4.35 m (Yunnan Provincial Museum, 1981). Excavated features included 11 house foundations, 14 fire places, 48 ash and storage pits, and 34 graves. Postholes were found along the perimeter of all house foundations, which were most likely constructed as wattle and daub structures. Storage pits were located around the buildings, and were distinguished by their shape as rounded, oval, rectangular and irregular opening features. Extended inhumation burials in rectangular graves dominated numerically, and a few urn burials were also found. Common burial customs included the placing of the dead in extended supine position, and the removal of the skull (a phenomenon found in about a third of the graves). A few secondary and multiple burials were also found. All deposits were associated with Neolithic cultural remains, which were found in and around the features in the form of ceramic sherds, stone, bone, and shell tools (for a more detailed description of the material culture excavated in this occasion see Rispoli, 2007; Chang, 1964). According to the original excavation report, findings of "white ashes", interpreted as siliceous rice glumes, were discovered in several storage pits, as well as numerous pig, cattle, and sheep/goat bones. Radiocarbon dates were taken on charred wood remains from posthole number 2 of house F3, and from an unnumbered posthole from trench 7, implied occupation of the site to be between 2464 and 1974 cal. B.C. (ZK-0220, 3770 ± 85 BP)/2336–1777 cal. B.C. (ZK-0330, 3675 ± 85 BP) (Yunnan Provincial Museum, 1981; Zhang and Hung, 2010; CASS, 1978; see Table 2). Two main cultural periods were identified within these early excavations: an earlier encompassing layers (8) to (6), and a later period, comprising layers (5) to layer (2). No previous occupation seemed to have taken place, as early house structures cut straight into the bedrock (F7–F11), while later structures (F1–F6) were constructed on top of the early abandoned remains. Rounded storage pits were found to be exclusively associated with the later period.

Although rice remains were found during the first excavation of