

Short communication

# Did alder (*Alnus*) fires trigger rice cultivation in the lower reaches of the Yangtze River, East China?

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Received 20 July 2011; received in revised form 28 October 2011; accepted 8 February 2012

Available online 16 February 2012

## Abstract

It remains debatable as to how the prehistoric human communities managed the environment to enable the initial cultivation of rice during the early Neolithic in the coastal lower reaches of the Yangtze River, East China. Previous studies proposed an environmental context for the first rice cultivation at Kuahuqiao, Hangzhou, based on an archaeological sedimentary microfossil record that had been well-dated using radiocarbon methods. Those studies suggested that early humans began burning the predominantly alder scrub in a local swampy wetland, starting about 7750 cal. yr BP, which permitted the start of dedicated rice (*Oryza*) cultivation. Here we present a new, finer-detailed pollen-phytolith-microscopic charcoal record from the same locality. Our result reveals that local woods dominated by oak (*Quercus*) and pine (*Pinus*) were targeted for burning by early cultivators before the start of rice agriculture.

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**Keywords:** Fires; Rice cultivation; Kuahuqiao culture; Lower Yangtze River

## 1. Introduction

The Yangtze River basin is considered as a key area for exploring the early Neolithic rice cultures in which the earliest cultivation and domestication of rice may have occurred (Normile, 1997; Jiang and Liu, 2006; Fuller and Qin, 2007; Fuller et al., 2009; Zheng et al., 2009a,b; Wang et al., 2010a). Currently, there is a growing interest in understanding the role of the environment in the early rice cultures in East China. However, there is little consensus so far on how early humans managed the environment to begin rice farming (Li et al., 2006a,b; Itzstein-Davey et al., 2007a,b; Shu, 2007; Atahan et al., 2008; Wang et al., 2010b).

Neolithic rice-related cultures originated and prospered in the coastal lower Yangtze area (Fig. 1A). So far excavations have revealed six successive cultures: Shangshan Culture (11 860–9000 cal. yr BP), Kuahuqiao Culture (8000–7000 cal. yr

BP), Majiabang Culture/Hemudu Culture (7500/7000–5900 cal. yr BP), Songze Culture (5900–5200 cal. yr BP), and Liangzhu Culture (5200–4200 cal. yr BP) (Stanley and Chen, 1996; Jiang, 2004; Zong et al., 2007) (Fig. 1B). Previous researches have shown that domesticated forms of rice grains began to be commonly represented in archaeological contexts less than approximately 7000 years ago (Liu et al., 2007; Fuller et al., 2009; Zheng et al., 2009a,b; Wang et al., 2010b). The sedimentary environment was also found to be very localized, with geographic differences resulting from a highly dynamic environmental setting that was constrained primarily by changing sea levels during the Holocene (Stanley and Chen, 1996, 2000; Stanley et al., 1999; Stanley, 2001; Li et al., 2006a,b; Tao et al., 2006; Zhu and Zhang, 2006; Itzstein-Davey et al., 2007a,b; Shu, 2007; Atahan et al., 2008).

Modern climate in the study area is characterized by the East Asian Monsoon. The annual temperature is 16.1 °C and the annual precipitation is 1402.5 mm, most of which falls in the summer. The climatically zonal vegetation is dominated by evergreen broadleaved forests composed mainly of *Cyclobalanopsis*, *Castanopsis*, and *Cinnamomum*, located around the northernmost limit of the middle subtropical area (Editorial Committee

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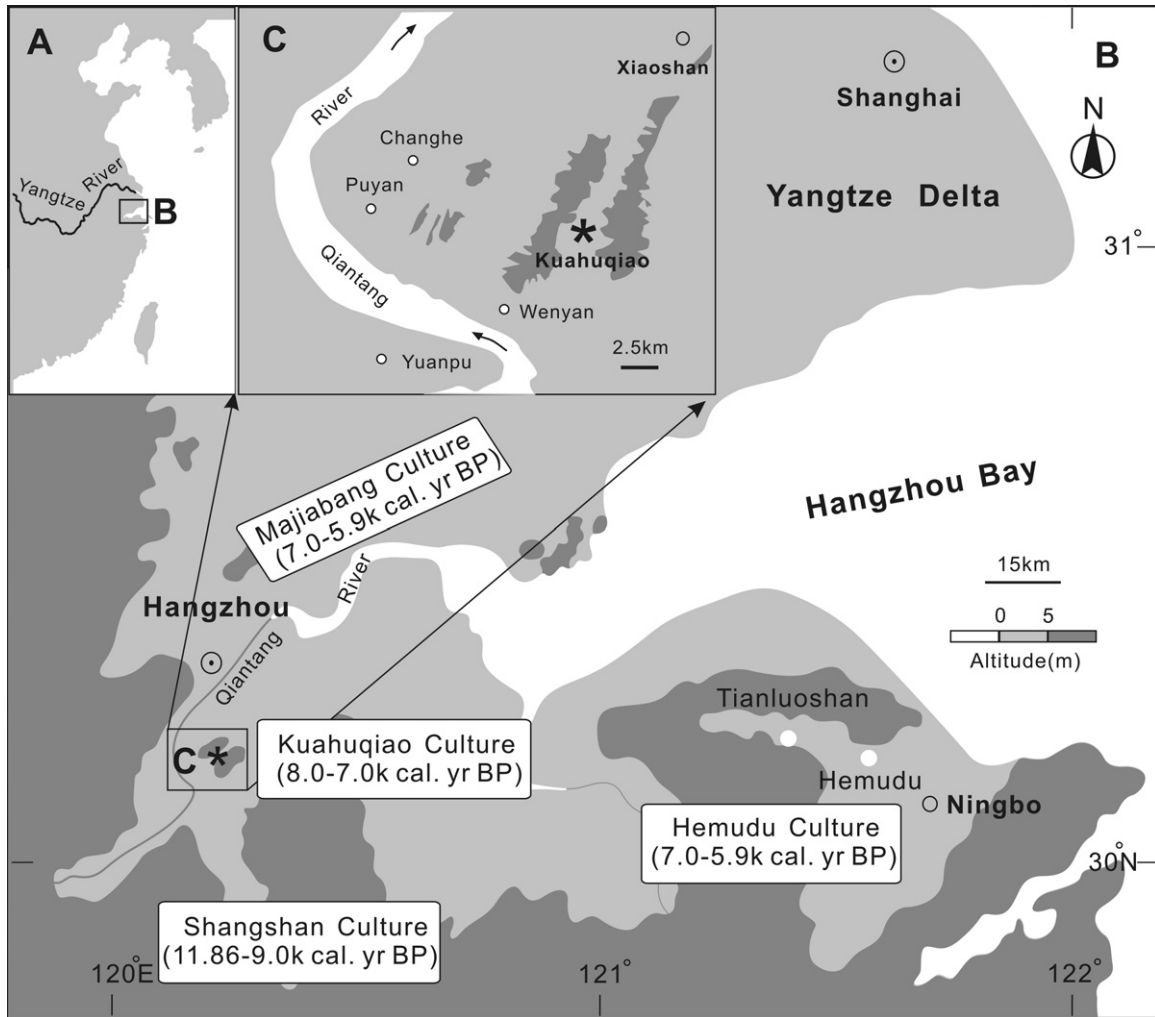


Fig. 1. Map showing the location of the Kuahuqiao site in the lower reaches of Yangtze River in East China (A) and some other Neolithic culture sites in the inner part of the coastal Hangzhou Bay, Zhejiang Province (B and C).

of Vegetation of China, 1980). This forest vegetation has been extensively transformed by humans into the present pine (*Pinus massoniana*)-dominant secondary forests in the highlands and paddy fields in the lowlands, as a result primarily of timber clearance and particularly of the intensive rice (*Oryza sativa*) agriculture.

Geographically, middle to late Neolithic sites that are dated younger than 7000 years ago mostly lie within the wide coastal Yangtze Delta. In contrast, Kuahuqiao is located in the transitional zone between the mountains to the south and west and the flat fluvial plains to the east and north (Fig. 1B). The excavated portion of Kuahuqiao is situated in a small basin occluded between two lines of low parallel hills (Fig. 1C). The organic-rich sediment at this site is expected to provide good sediment archives for ascertaining the environmental context of the incipient rice cultivation due to its secure chronological control, abundant archaeological finds, and sheltered locality (Innes et al., 2009; Shu et al., 2010). Archaeological evidence shows that Kuahuqiao was inhabited by sedentary foragers who initiated rice cultivation in the lower Yangtze during

the early Neolithic (Jiang, 2004; Innes et al., 2009). Culturally, it links the pre-rice cultivating Shangshan Culture to the south, with the rice domesticating Hemudu Culture/Majiabang Culture to the east and north (Fig. 1B), and therefore is critical to understanding the process of transition from sedentary gathering to full domestication in the history of early rice agriculture.

Previous investigations proposed that fire removal of the alder fen carrs by humans opened the way for the immediate start of rice cultivation (Zong et al., 2007; Innes et al., 2009). Their interpretation was based on the coincidence of the sharp drop of the *Alnus* peak in their pollen records with a significant rise in micro-charcoal abundance during the period approximately from 7820 to 7750 years ago (Zong et al., 2007; Innes et al., 2009). The removal of *Alnus* was thought to have facilitated the initiation of rice agriculture, as indicated by what was assumed to be cereal rice pollen (poaceous pollen grains  $\geq 40 \mu\text{m}$  in diameter) in the swampy environment after 7750 cal. yr BP. However, this argument is not supported by our new finer-detailed microfossil work.

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