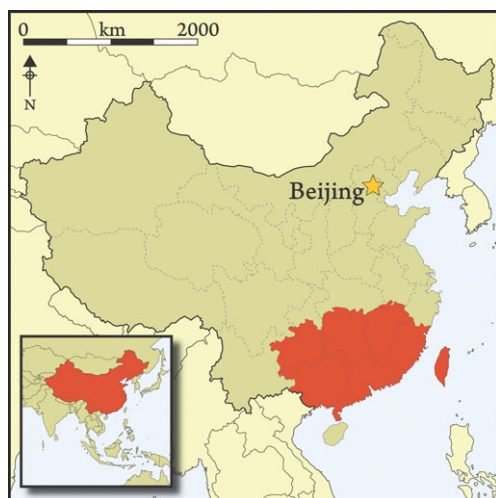


The emergence of agriculture in southern China

Zhang Chi¹ & Hsiao-chun Hung²



The authors give us a newly documented account of the dissemination of agriculture, and rice cultivation in particular, into southern China and beyond. From the central and eastern Yangtze it spread in two prongs – east to Guangdong, Taiwan and island Southeast Asia and south to Guangxi and Vietnam.

Keywords: Southeast Asia, China, southern China, rice, cultivation, origins of agriculture, Austronesian, Austroasiatic

Introduction

The Yangtze Valley in central China is widely regarded by archaeologists, palaeobotanists and plant geneticists as the location of the earliest cultivation of Asian rice (*Oryza sativa* var. *japonica*) (Crawford & Chen 1998; Higham & Lu 1998; Zhao 1998; Bellwood 2005: 111; Jiang & Liu 2006; Londo *et al.* 2006; Fuller *et al.* 2007, 2009). A previous article (Zhang & Hung 2008a) outlined Neolithic cultural developments related to the establishment of food production in the Middle and Lower Yangtze Valley from 10 000 to 2000 BC (¹⁴C-calibrated chronology). The Pengtoushan-Zaoshi and Shangshan-Kuahuqiao phases (8000-5000 BC), in the Middle and Lower Yangtze Valley respectively, have provided evidence for very early pre-domestication rice production, possible pig domestication (Yuan *et al.* 2008), and pottery spindle whorls that imply utilisation of plant fibres. Considerable quantities of rice husk and grains have been recovered from these sites. After 5000 BC, farming settlements

¹ School of Archaeology and Museology, Peking University, Beijing 100871, P. R. China

² School of Archaeology and Anthropology, A.D. Hope Building 14, The Australian National University, Canberra, ACT 0200, Australia

Received: 27 February 2009; Accepted: 5 May 2009; Revised: 28 May 2009

ANTIQUITY 84 (2010): 11–25

<http://antiquity.ac.uk/ant/84/ant840011.htm>

associated with the pivotal Daxi, Shinianshan, Beiyinyangin-Xuejiagang, Hemudu and Majiabang-Songze site complexes (5000-3500 BC) spread gradually throughout the Middle and Lower Yangtze Valley. Enclosed rice fields have been exposed in some Lower Yangtze Majiabang-Songze sites, such as Caoxieshan (Zou *et al.* 2000: 97-113). Later in time, the two Longshan-phase site complexes represented by Qujialing-Shijiahe and Liangzhu (3000-2300 BC), in the Middle and Lower Yangtze Valley respectively, saw the establishment of large-scale wet rice cultivation (Fuller *et al.* 2007).

It has been suggested that the southward dispersal of rice agriculture from the Yangtze Valley was perhaps related to the expansions of Austroasiatic- and Austronesian-speaking populations into Mainland and Island Southeast Asia respectively (e.g. Higham & Lu 1998; Higham 2002; Diamond & Bellwood 2003; Bellwood 2005: 222). If so, then southern China, between the Yangtze Basin and northern Mainland Southeast Asia, must have played a significant role in the spread of rice farming. However, due to the rarity of reported rice remains and reliable ¹⁴C dates, the question of agricultural development in southern China proper, south of the Yangtze Basin, remains poorly understood. We have previously suggested (Zhang & Hung 2008a) that the process of agricultural dispersal in China was not a singular event. To illustrate this, we focus here on recent discoveries from the regions of Lingnan-Fujian-Taiwan (Lingnan includes the provinces of Guangxi and Guangdong) and south-west China (Sichuan, Yunnan and Guizhou provinces).

Coastal south-eastern China and Taiwan

New evidence for ancient rice cultivation has been reported from south-eastern China, with the oldest sites in Fujian, Taiwan and Guangdong (Figure 1). Here, rice remains can be confidently dated to 3000 BC, whereas dates for many other sites are clustered around 2500 BC.

Guangdong (Figure 1, sites 5, 6, 7 and 8)

In the 1970s, a large quantity of rice grains and stalks from the lower and middle layers at Shixia in northern Guangdong (*c.* 2600-2300 BC) were claimed to be of cultivated rice (Yang 1978; Zhang *et al.* 2006). More recently, four new discoveries of older rice remains have occurred in Guangdong. These come from the pre-Shixia phase at Shixia itself (Yang 1998; Xiang 2005), from Shaxia in Hong Kong, from Guye in Gaoming on the Lower Xi River, and from Xinghuahe on the Upper Xi River (Table 1).

There are varied opinions on the date of the oldest rice remains at Shixia. The Guangdong Institute of Archaeology (IA, Guangdong 2000) suggests a date contemporary with the Tangjiagang-Daxi phase in the Middle Yangtze, *c.* 4800 BC, and with the earliest Xiantouling phase, *c.* 5000-3500/3000 BC, in the Zhu (Pearl) Estuary. But the pre-Shixia phase lacks the painted pottery typical of early Xiantouling, and so may be contemporary with Caotangwan phase I in Guangdong and Shenwan (Sham Wan) layer F on Lamma Island in Hong Kong (Meacham 1978; Zhuhai Museum *et al.* 1991; Zhu 2001). Shenwan layer F has been dated by Meacham (1978: 126) to *c.* 3500 to 2200 BC. The site of Shaxia in Hong Kong has produced quantities of rice and Cucurbitaceae phytoliths (Lu *et al.* 2005) from a context

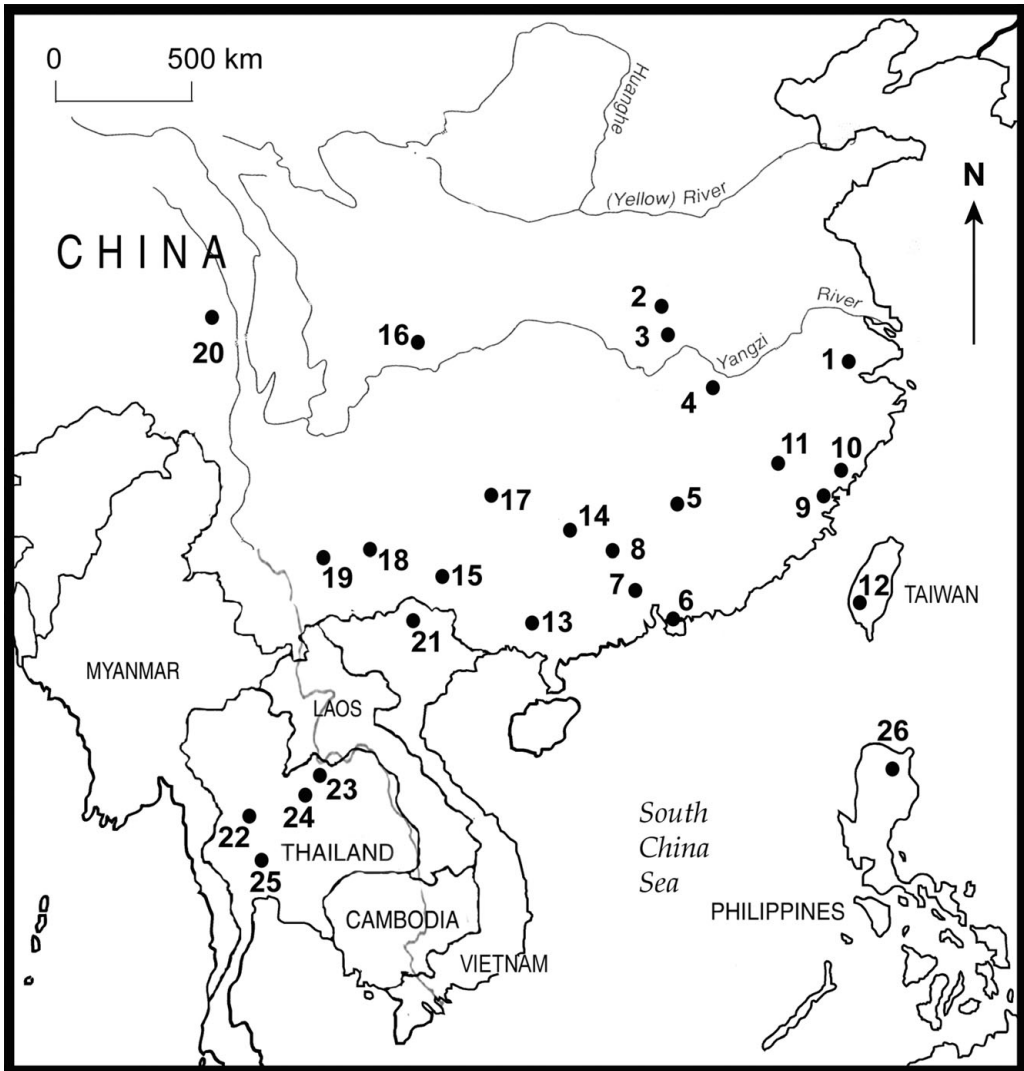


Figure 1. Locations of key sites mentioned in the text: 1) Liangzhu; 2) Qujialing; 3) Shijiahe; 4) Fanchengdui; 5) Shixia; 6) Shaxia; 7) Guye; 8) Xinghuahe; 9) Tanshishan; 10) Huangguashan; 11) Nanshan; 12) Nanganli & Nanganlidong (Taiwan); 13) Dingsishan; 14) Xiaojin; 15) Gantuoyan; 16) Baoduncun; 17) Jigongshan; 18) Haidong; 19) Baiyangcun; 20) Karuo; 21) Phung Nguyen; 22) Non Nok Tha; 23) Ban Chiang; 24) Non Kao Noi; 25) Ban Lum Khao; 26) Andarayan.

related to the Shixia phase, *c.* 2500 BC (AMO & IA 2004). Guye and Xinghuahe are suggested to have similar dates (Xiang & Yao 2006; Relics from the South 2007).

Fujian and Taiwan (Figure 1, sites 9, 10, 11 and 12)

In Fujian, the oldest rice remains have been found at Tanshishan and have been carbon-dated to 2870-2340 cal BC (Yan 1989; Z.S. Chen, *pers. comm.*). Other remains are reported from younger sites such as Huangguashan and Nanshan (Chen, Z.S. 2006). The earliest

carbonised rice grains in Taiwan come from the late Dabengkeng phase sites of Nanguanli and Nanguanlidong, located in the Tainan Science Park in southern Taiwan (Tsang *et al.* 2006). These have been dated to 2700-2200 cal BC and are here found with foxtail millet and beans of an unknown species. These two sites represent a late phase of the Dabengkeng culture in terms of artefact typology (NB: Dabengkeng is the correct Pinyin, but it is better known as Tapedengkeng (TPK), after Chang 1969), and no rice remains are yet reported from the oldest Neolithic assemblages on this island. After 2200 BC, carbonised rice or grain impressions in pottery are reported from many Middle Neolithic settlements in Taiwan, such as Chikan B on Penghu Island (Tsang 1999), Kending at the southern tip of Taiwan (Li 1985), Youxianfang in Tainan (Tsang *et al.* 2006), Zhishanyan in Taipei (Huang 1984), and Changguang in eastern Taiwan (Chao 1994).

South-west China

Guangxi (Figure 1, sites 13, 14 and 15)

The rice phytoliths from Dingsishan phase 4 (the uppermost phase in the site), in southern Guangxi, are currently regarded as the earliest from archaeological contexts in this region (Zhao *et al.* 2005). Despite the claim by Zhao (2006) that Dingsishan phase 4 dates from 4500 BC, the phase 4 pottery is different from that of the preceding phases in the site and resembles that of the Longshan phase in Wuming (ATGZ *et al.* 2006), believed to date to 2500-2000 BC (Li & Yang 2006). No rice has yet been found in the earlier phases 1 to 3 at Dingsishan (8000-4000/3500 BC) (Guangxi Team *et al.* 1998).

Xiaojin, in northern Guangxi, has also produced rice remains. This site has three cultural phases, with no agricultural evidence from the oldest (phase 1), but a large quantity of rice grains from phase 2 (ATGZ & Cultural Relics Committee of Ziyuan 2004). There is a most confusing series of ¹⁴C dates: phase 1, 2900-2000, 2500-1600 and 2900-1950 cal BC; and phase 2, 2750-1900, 2150-1400, 2900-2200, 5300-1400 and 4000-2900 cal BC. These are not consistent with the stratification but, according to our stylistic comparisons of ground stone projectile points, the triangular specimens of Xiaojin phase 2 should postdate the Shijiahe culture in the Middle Yangtze Valley and thus date to *c.* 2500-2000 BC.

Gantuoyan, in western Guangxi, has also produced carbonised rice and millet grains from a late stage of phase 2 in the site sequence (ATGZ & Napo Museum 2003). Two direct AMS ¹⁴C dates on the rice are 1920-1660 and 1220-920 cal BC, and one on millet is 1510-1290 cal BC. Through a comparative study of the pottery, the excavators suggest that Gantuoyan 2 was contemporary with the late Shang dynasty.

Sichuan, Guizhou and Yunnan (Figure 1, sites 16, 17, 18 and 19)

In south-western China, the earliest evidence for agriculture comes from north-western Sichuan, associated with Yangshao expansion during the Miaodigou and Majiayao phases, *c.* 3000 BC (Chen, J. 2007). It is possible that dry land millet cultivation was brought to Sichuan by these Yangshao groups, and carbonised grains of millet *Setaria italica* (L.) P. Beauv. from Karuo in Changdu County, Tibet (Figure 1, site 20), are dated by multiple ¹⁴C determinations to *c.* 3500 to 2500 BC (Committee of Relics in the Tibet Autonomous

Region *et al.* 1985: 168). Rice remains have also been found in Yangshao contexts in eastern Gansu (Zhang & Wang 2000; Liu 2007) and Shanxi (Wang 2003), both north of Sichuan. As far as the Middle Yangtze Valley in Sichuan is concerned, the oldest evidence for rice cultivation comes from the Chengdu Plain during the Baoduncun phase (2500-2000 BC).

In Guizhou, the earliest excavated evidence for a presence of rice comes from Jigongshan in Weining County, contemporary with the late Shang dynasty (IA, Guizhou *et al.* 2006). In Yunnan, the earliest rice remains belong to the Shizhaishan Neolithic phase in the Lake Dian region, dated to 3100-2450 cal BC at Haidong (Xiao 2001). Rice remains from Baiyangcun in Binchuan are dated to *c.* 2500-2000 BC (Yunnan Museum 1981; IA, CASS 1991: 234-6), but the rice from Dadunzi in Yuanmou County is younger (Table 1). Therefore, the appearance of rice cultivation in Guangxi, Yunnan and Guizhou appears to postdate 2500 BC.

Cultural relations between southern China and the Yangtze Valley (Figure 2)

Across such a broad region, the appearance of rice cultivation was probably not a single event. The dates from Fujian and Guangdong in south-eastern China (Figure 2: zone H) extend back to 3000 BC, contemporary with the Qujialing–Early Shijiahe phases in the Middle Yangtze, and the Early–Middle Liangzhu in the Lower Yangtze (zones C and A). But the evidence in Guangxi, Yunnan and Guizhou (zone F) is slightly younger, after 2500 BC, and contemporary with the Middle Shijiahe in the Middle Yangtze and Final Liangzhu in the Lower Yangtze. To examine further this potential time difference we now review relevant cultural sequences and ecological contexts.

From the early Neolithic onwards, Chinese archaeologists divide cultural developments in southern China into two regional traditions – Fujian with Guangdong (including the southern offshore islands) (zone H) and Guangxi with northern Vietnam (Zhang & Hung 2008b) (zone F). In the early and middle Neolithic, Guangxi was occupied by apparent hunter-gatherers (in the absence of any evidence for food production) of the Dingsishan (phases 1 to 3) culture, with pottery and ground lithic technology that would elsewhere be termed ‘Neolithic’. Chinese archaeologists assume that this culture was indigenous to the region, and reliant on gathering, freshwater fishing and hunting. Most Dingsishan culture sites are shell middens with simple cord-marked and paddle impressed pottery vessels and polished stone tools (Guangxi Team *et al.* 1998).

Sites related to Dingsishan phases 1 to 3 occur around Nanning in southern Guangxi, mostly along the Zuo, You and Yong rivers. Excavated sites include Dingsishan itself (Guangxi Team *et al.* 1998), Changtang, Baozitou (Guangxi Team *et al.* 2003), Jiangxian and Ganzao (ATTGZ 1975). During Dingsishan phases 2 and 3 these groups existed throughout central and eastern Guangxi and western Guangdong, especially along the Yu, Xun, Qian and Xi rivers. Excavated sites include Xijin (ATTGZ 1975), Qiujiang (ATGZ & Hengxian Museum 2006), Jiangkou (ATGZ 2000) and Nanshanwan in Guangxi (ATGZ 2004), and Lezhukou in Guangdong (IA & Fengkai Museum 1998). In northern Vietnam, similar forager groups existed in Thanh Hoa province, associated especially with the Da But culture of Vietnamese archaeology (Nguyen 2006). Human burials of these phases, both in

Table 1. Early rice and millet remains from southern China and Taiwan.

Sites	Specimens recovered	Cultural phases & suggested dates	Uncalibrated ¹⁴ C determinations	Oxcal, 2 sigma dates	References
Shixia, northern Guangdong	rice grains and stalks	Shixia phase c. 2600-2300 BC	Phase 1: 4220±110 bp (Bk76024, charcoal) Phase 3: 4330±90 bp (Bk75046, charcoal) Phase 3: 4020±100 bp (Bk75050, charcoal)	3100-2450 BC 3350-2650 BC 2900-2250 BC	Yang 1978; IA, CASS 1991: 208
	rice grains	pre-Shixia phase c. 3000 BC	None		Yang 1998
Shaxia, Hong Kong	rice and Cucurbitaceae phytoliths, one rice grain	earliest Neolithic layer c. 2500 BC	None		Lu <i>et al.</i> 2005; AMO & IA 2004
Guye, Guangdong	rice grains	c. 2500 BC	None		Relics from the South 2007
Xinghuahe, Guangdong	rice grains	Shixia phase c. 2600-2300 BC	4030±120 bp 4030±220 bp (Lab numbers and materials unknown)	2900-2600BC 3100-1900 BC	Xiang & Yao 2006
Tanshishan, Fujian	2 rice grains	Tanshishan phase c. 2870-2340 BC	3090±60 bp (ZK-0098, shell) 3600±70 bp (ZK-0099, animal bone)	1500-1190 BC 2140-1750 BC	Yan 1989; Chen, Z.S. <i>pers. comm.</i> ; Lin 2005
Nanguanli, Taiwan	grains of rice, foxtail millet and beans	Late Dabenkeng phase c. 2700-2200 BC	4470±60 bp (GX-27327, marine shell) 4450±40 bp (NTU-3493, marine shell) 4080±50 bp (NTU-3489, charcoal) 4040±40 bp (GX-27788, charcoal) 3950±40 bp (NTU-3452, charcoal) 4230±40 bp (NTU-3496, marine shell) 3890±110 bp (GX-27329, charcoal) 4190±50 bp (GX-27328, marine shell) 3730±90 bp (GX-27787, charcoal)	2760-2470 BC 2670-2460 BC 2500-2300BC 2700-1950BC 2500-1850BC	Tsang <i>et al.</i> 2006: 316-8
Nanguanlidong, Taiwan	grains of rice, foxtail millet and beans	Late Dabenkeng phase c. 2700-2200 BC	4110±50 bp (NTU-3974, charcoal)	2880-2560 BC	Tsang <i>et al.</i> 2006: 316

Dingsishan, Guangxi	rice phytoliths	Dingsishan phase 4 <i>c. 2500-2000 BC</i>	None		Guangxi Team <i>et al.</i> 1998
Xiaojin, Guangxi	rice grains	Xiaojin phase 2 <i>c. 2500-2000 BC</i>	3850±140 bp 3420±140 bp 4030±110 bp 4700±800 bp 4700±200 bp (Lab numbers & materials unknown)	2750-1900 BC 2150-1400 BC 2900-2200 BC 5300-1400 BC 4000-2900 BC	ATGZ & Ziyuan 2004
Gantuoyan, Guangxi	AMS on rice grains	Gantuoyan phase 2, contemporary with late Shang	3463±50 bp (DY-1014) 2883±50 bp (DY-1013)	1920-1660 BC 1220-920 BC	ATGZ & Napo Museum 2003
	AMS on millet grain		3131±50 bp (DY-D1015)	1510-1290 BC	
Jigongshan, Guizhou	rice grains	contemporary with late Shang	None		IA, Guizhou <i>et al.</i> 2006
Shizhaishan sites, Yunnan	rice grains	Shizhaishan Neolithic phase <i>c. 2500 BC</i>	4235±150 bp from Haidong (Lab numbers & materials unknown)	3100-2450 BC	Xiao 2001
Baiyangcun, Yunnan	rice grains	<i>c. 2500-2000 BC</i>	3770±85 bp (ZK-0220, charcoal) 3675±85 bp (ZK-0330, wood)	2470-1970 BC 2350-1750 BC	Yunnan Museum 1981 IA, CASS 1991: 234-6
Dadunzi, Yunnan	rice grains	contemporary with Shang	3210±90 bp (ZK-0299, charcoal)	1690-1260 BC	IA, CASS 1991: 234-6

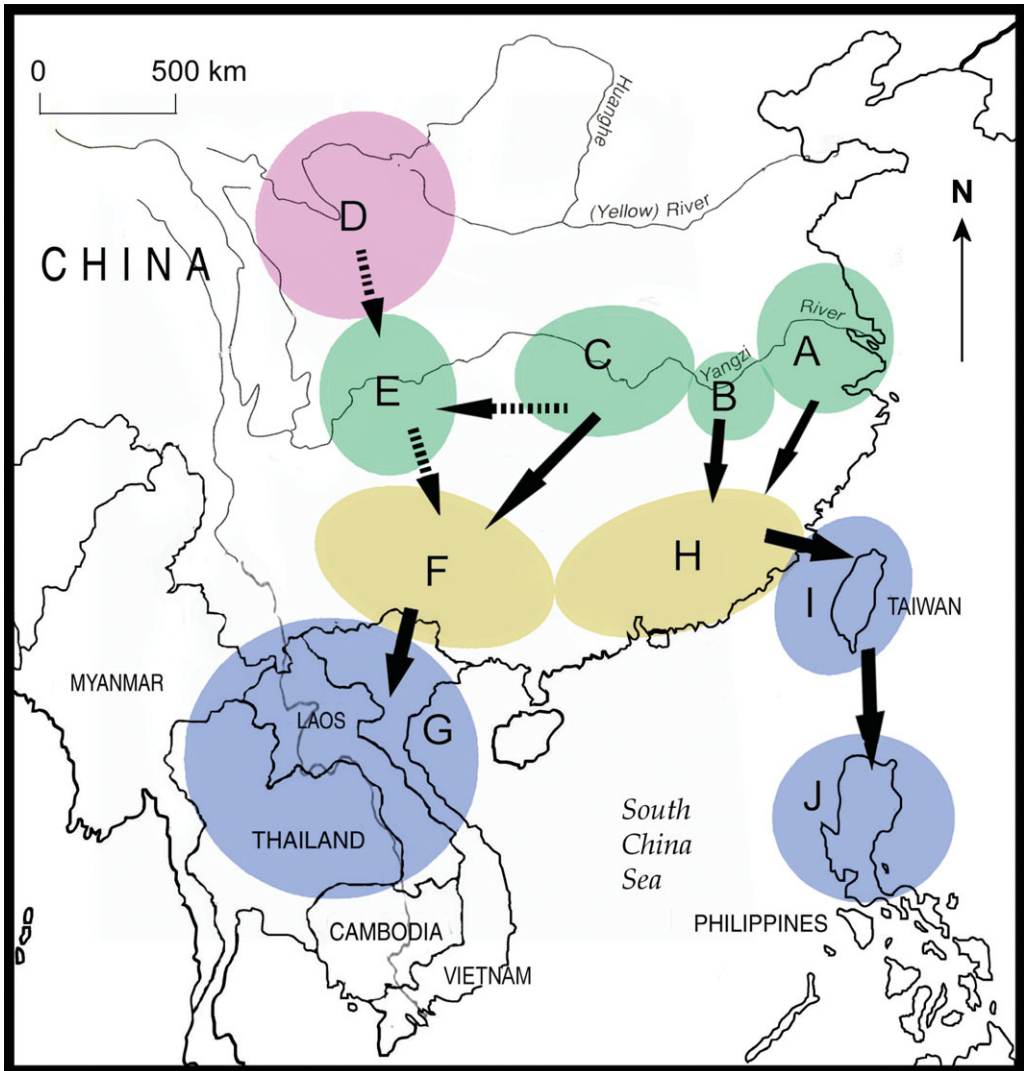


Figure 2. The expansion of rice farming from the Yangtze Valley into southern China and Southeast Asia, c. 3000-2000 BC. A, B and C are major agricultural societies in the Middle-Lower Yangtze Valley that expanded southwards with rice cultivation into Fujian and Guangdong (H), Taiwan (I) and the Philippines (J). E represents the early agricultural society of the Chengdu Plain, perhaps influenced by C as well as by the rice-millet agricultural society of D in northern Sichuan. The appearance of rice cultivation into Guangxi (F) came from C in the Middle Yangtze Valley, and probably from E in the Chengdu Plain, spreading later into Mainland Southeast Asia. A) Liangzhu, 3500-2500 BC; B) Fanchengdui, 2600-2000 BC; C) Qujialing-Shijiahe, 3500-2500 BC; D) Miaodigou & Majiayao, presumably with millet and rice, c. 3000 BC; E) Baoduncun, 2500-2000 BC; F) Dingsishan phase 4 & Xiaojin phase 2, after 2500 BC; G) Phung Nguyen (Vietnam) and agricultural communities in Thailand, after 2300-2000 BC; H) Shixia & Tanshishan, 3000 BC; I) Late Dabengkeng, 2800 BC; J) northern Philippine Early Neolithic, 2000 BC.

Guangxi and northern Vietnam, are in crouched and seated postures. Higham (1996: 78) notes that the Da But sites have no certain traces of agriculture.

Four ¹⁴C dates from Nanshanwan phase 1 are considered to represent the *terminus ante quem* of the Dingsishan (phases 1 to 3) culture. These are 4800-3600, 5350-4650 and

5800-5200 cal BC on animal bone and 8250-7550 cal BC on freshwater shell (ATGZ 2004), suggesting a termination of the Dingsishan culture around 4000-3500 BC. Although many Dingsishan sites are located in zones favourable for rice farming, such as the Xi Valley, no rice macroremains or phytoliths have ever been reported.

In Guangdong and Fujian, unlike Guangxi, there is so far no identifiably *indigenous* pre-farming culture related to Dingsishan phases 1 to 3. The earliest pottery-bearing assemblage in Guangdong is the intrusive Xiantouling culture (zone H), dated to *c.* 5000-3500/3000 BC (Hung 2008: 42), which has more complex lithics and pottery styles than Dingsishan phases 1 to 3. Although the subsistence pattern of Xiantouling is uncertain, most sites are located on sand dunes along the edges of the Zhu Estuary. This suggests a maritime forager group in terms of economic strategy (Higham 1996: 79). Because the Xiantouling assemblage so closely resembles that of Tangjiagang-Daxi in Hunan, many Chinese archaeologists regard Xiantouling as a Lingnan facies of the Daxi culture. However, Xiantouling was not a direct descendant of the rice-growing nuclear Daxi culture located in the Two Lakes region of the Middle Yangtze Basin (Bu 1999; Pei 1999), but rather of the Gaomiao-Songxikou-Daxi facies in the Nanling Mountains of southern Hunan, the latter with no evidence for cultivation of rice. In addition, the Xiantouling culture sites in Guangdong and Hong Kong have a fabric tradition emphasising the use of barkcloth, beaten with distinctive grooved beaters, rather than of textile fibres as spun with spindle whorls by the rice-growing societies of the Middle Yangtze (Bellwood 2005: 126).

Until as recently as 4000 BC, none of the shell middens along the coastlines of Guangdong and Guangxi, such as Fangcheng, Qinzhou and Chaoan, have any remains of potentially cultivated plants. Neither, as yet, have the earliest Neolithic assemblages along the coastlines of Fujian and Taiwan, namely the Keqiutou and early Dabengkeng (pre-Nanguanli) cultures respectively. The Keqiutou and Dabengkeng assemblages have many similarities with Xiantouling in Guangdong (Tsang 2007; Hung 2008), and although both were influenced by the Hemudu culture in Zhejiang (Liu & Guo 2005), neither appear to have been direct descendants of it. To understand the origins of Keqiutou and Dabengkeng we must await future discoveries in southern Zhejiang and northern Fujian.

In short, the earliest Neolithic in Guangdong and Fujian (zone H) can be sourced to the region between the Nanling Mountains and the Yangtze, especially to the Gaomiao-Songxikou-Daxi and the non-agricultural facies of the Daxi (Exi facies) of the Middle Yangtze. The Gaomiao-Songxikou-Daxi and Exi facies developed from the initial agricultural societies in these regions, such as Pengtoushan-Zaoshi and Chengbeixi. Perhaps due to abundant natural resources and shortage of good cultivation land in the Nanling Mountains, hunting-gathering became the major subsistence for the Gaomiao group and farming was temporarily minimised (5000-3500 BC). Rice phytoliths are not identified in Gaomiao (He & Chen 2007) until the Qujialing phase, after 3500 BC.

Therefore, the earliest Neolithic in Guangdong and Fujian (zone H) was *exotic* but by contrast the earliest Neolithic in Guangxi (zone F) was seemingly *indigenous*, developed directly from the local Zengpiyan and Dayan early Holocene pebble and flake tool complexes. Hunting-gathering subsistence continued in Fujian-Guangdong until 3500-3000 BC and in Guangxi until 4000-3500 BC. Also of significance was the subsequent decline in Neolithic southern China of hunting-gathering subsistence, in terms of diminishing frequencies of

wild animal bones and shellfish. In Fujian, this decline followed the Kequtou phase. A similar decline occurred in coastal Guangdong (Nishitani 1997) and also in the Yuan River and Xia-Jiang regions along the Yangtze. One possibility is that this decline reflected a climatic fluctuation (Zheng *et al.* 2004), but we cannot be sure since it could also reflect increasing use of domesticated resources for subsistence.

After 8000 BC, considerable quantities of rice are present in many settlements in the Middle–Lower Yangtze Valley (Zhang & Hung 2008a). Why did rice cultivation not reach the Lingnan-Fujian region until 3000 BC? To answer this question, we must consider the development of agriculture in the Yangtze Basin itself, and review the local cultural background in southern China. In the early stages of agriculture in the Middle–Lower Yangtze, rice did not account for a high proportion of production, and full morphological domestication did not occur until after 5000 BC (Fuller *et al.* 2007). In some instances, such as Gaomiao, there even appears to have been fluctuation between hunting-gathering and agriculture. As we have described previously (Zhang & Hung 2008a), farmers gradually extended their settlements into the uncultivated areas along the tributaries of the Yangtze. By about 3000 BC, cultivation of domesticated rice became a major subsistence activity, and plough cultivation appeared in the Liangzhu sites (zone A). Population densities increased during the Middle–Late Liangzhu and Early–Middle Shijiahe phases. At the same time, the Zhangsidun and Fanchengdui cultures (zone B) between the Middle and Lower Yangtze started to expand southwards. The Tanshishan culture in Fujian and the Shixia in Guangdong (zone H) both contain many Liangzhu and Fanchengdui cultural traits, such as pottery *ding* with feet shaped like fish fins, *hu*, and jade *cong* and *yue*. This was the earliest phase of rice cultivation in Fujian and Guangdong.

The emergence of rice cultivation in Guangxi resulted from a separate and more inland southward dispersal from the Quijialing culture (zone C) in the Middle Yangtze Valley, via the middle Yuan River and Xiajiang regions with their forager groups. Rice cultivation was thus transmitted from Quijialing into Guangxi and Sichuan a little later in time than into Fujian–Guangdong.

From southern China into Southeast Asia

Neolithic agriculture in southern China depended on more than just rice farming. Tubers might also have been significant (Tong 2004: 88–107). Unfortunately, the only available evidence for a presence of unidentified charred tubers (possibly *Dioscorea* sp. and *Colocasia* sp.) comes from Zengpiyan in Guangxi (IA, CASS *et al.* 2003: 343). Recently, Daxi phase millet has been found at Chengtoushan in the Middle Yangtze Valley (Nasu *et al.* 2007a & b), but the domesticated status of this find is uncertain. As mentioned, Yangshao farmers (zone D) introduced millet agriculture into northern Sichuan *c.* 3000 BC (Chen, J. 2007), and millet agriculture in eastern Tibet can be traced back to 2500 BC, but foxtail millet in southern China is so far only reported from Gantuoyan in western Guangxi (ATGZ & Napo Museum 2003), and from Nanguanlidong and Youxianfang in southern Taiwan (Tsang *et al.* 2006). However, these finds are sufficient to indicate that millet cultivation was also part of the expansion of agriculture into southern China.

We believe that agriculture arrived sharply in Lingnan-Fujian and south-west China, already highly developed with fully domesticated species that could be carried successfully into new and varied environments. Once introduced, further cultural developments and population increase took place rapidly. After 2500 BC, the Huangguashan culture developed in Lingnan-Fujian (Lin 2005) and a series of related 'Fine Cord Marked' cultures in Taiwan, the latter perhaps involving some secondary cultural influence or migration from Fujian imposed over the Dabengkeng early Neolithic (Chang 1969). In Guangdong, geometric impressed pottery cultures were associated with a sharp increase in the number of large sites (Zhao 1999). Dalongtan assemblages (the so-called 'Large Shovel' culture) became distributed widely throughout Guangxi, western Guangdong and northern Vietnam (Chen, Y.Z. 2006). Compared with the previous forager assemblages, cultural developments during this stage were unprecedented in scale.

Regarding the rapid growth of population in the Lingnan-Fujian region and south-west China, internal growth alone due to the arrival of rice cultivation need not have been the only cause. Much evidence suggests that contemporaneous southward migration occurred from the Middle and Lower Yangtze into southern China, thus boosting population numbers. During the Late Liangzhu and Middle Shijiahe phases, the cultures of the Middle and Lower Yangtze Valley gradually declined, and groups appear to have moved into the mountainous regions between the Yangtze and Lingnan-Fujian. Thus, the Shixia culture appeared about 2600 BC in the northern mountains of Guangdong, and the Wusaoling in the Xi Valley of western Guangdong and eastern Guangxi. Recent studies indicate that the Shixia culture developed from the Fanchengdui culture in the Middle Yangtze Gan-Bo region, and Wusaoling from the Daiziping assemblage in the Xiang Basin (He 1997). In addition, the Doupengpo culture appeared in the upper Yuan and Zi rivers of northern Guangdong (He 1997). These Neolithic cultures in southern China were thus inter-related in innumerable ways with those of the Yangtze Valley.

With increasing population in Lingnan-Fujian and south-west China, supported by well-developed mixed farming and continuing hunting-gathering, dispersal of rice farming began from southern China into Southeast Asia. The earliest evidence for rice in the Philippines comes from Andarayan in northern Luzon, dated directly by AMS to 2050-1400 cal BC (Snow *et al.* 1986). Research by Hung indicates that the earliest Neolithic settlements in northern Luzon can be traced to the Middle Neolithic of eastern Taiwan, *c.* 2000 BC. Pottery of Taiwan style, Taiwan nephrite, bones of domesticated pigs, and rice remains have been found in the early Neolithic of northern Luzon (Hung 2005, 2008; Bellwood & Dizon 2008; Piper *et al.* 2009). We believe this represents the beginning of the migration of Austronesian-speaking peoples from Taiwan into Island Southeast Asia. In Mainland Southeast Asia, the earliest agriculture is dated to 2500-2000 BC (Higham 2002). In northern Vietnam, *c.* 2000 BC, several Phung Nguyen sites contain rice associated with strong cultural influences from southern China, such as pottery with incised bands infilled with punctate impressions (Rispoli 2007), shouldered adzes, stone arrowheads, jade bracelets and earrings, and pottery spindle whorls (Bellwood 2005: 131-2). The earliest rice in Thailand dates after 2300 BC (Glover & Higham 1996). Most agricultural settlements in Thailand postdate 2000 BC, such as Non Nok Tha, Ban Chiang, Non Kao Noi, Ban Non Wat and Ban Lum Khao (Higham 2004; Higham & Higham 2009).

Conclusion

Rice cultivation was introduced into southern China around 3000-2500 BC from the Middle and Lower Yangtze Valley, possibly earlier in coastal regions. Separate coastal and inland routes of expansion are suggested into Fujian-Guangdong and Guangxi respectively, and it is likely that each area underwent a separate process of introduction. In south-west China, agriculture occurred in Sichuan *c.* 3000 BC and then spread into Guizhou and Yunnan *c.* 2500 BC. The dispersal of rice agriculture was thus not a single event. In the early stage, before 3000 BC, dispersal was slow, even involving periodic returns to non-agricultural subsistence with a heavy emphasis on fishing and hunting in areas marginal to the main Yangtze Basin, such as the Middle Yuan and Xia-Jiang regions. But once the Yangtze agricultural systems became highly developed with domesticated and transportable crops and animals, rice cultivation spread very quickly. The process of southward dispersal carried not only the knowledge and technology of rice cultivation, but also considerable human population. Because of the consequent growth of farming populations in southern China after 2500 BC, the Neolithic cultures of Lingnan-Fujian and south-west China spread rapidly into Southeast Asia.

Acknowledgements

We thank Professors Peter Bellwood and Martin Carver and two anonymous reviewers for giving us invaluable comments on this manuscript. We also thank Dr Qin Ling for providing a reference. Zhang Chi would like to thank the Humanities and Social Sciences Research project (2009-2018) of Peking University for supporting this research. Hsiao-chun Hung thanks the Australian National University for funding her research in East and Southeast Asia.

Abbreviations

- IA: Institute of Archaeology
ATGZ: Archaeological Team of the Guangxi Zhuang Autonomous Region
ATTGZ: Archaeological Training Team of the Guangxi Zhuang Municipality
CASS: Chinese Academy of Social Science
Kaogu: Kaogu (Archaeology)
Wenwu: Wenwu (Culture Relic)
Nanfang Wenwu: Nanfang Wenwu (Relics from South)
AMO, Hong Kong: Antiquities and Monuments Office, Leisure and Cultural Services Department of Hong Kong

References

- AMO, Hong Kong & IA, Henan 2004. Excavations at zone C02 and DII02 in Shaxia, Hong Kong. *Huaxia Kaogu [Ancient Chinese Archaeology]* 4: 3-47 (in Chinese).
- ATGZ. 2000. Excavations at Jiangkou in Hengxian, Guangxi. *Kaogu* 1: 12-21 (in Chinese).
- 2004. Excavations at Nanshawan in Xiangzhou, 1999-2000, in ATGZ (ed.) *Guangxi Kaogu Wenji [Essays on Guangxi archaeology]* 1: 176-91. Beijing: Wenwu (in Chinese).
- ATGZ & Cultural Relics Committee of Ziyuan. 2004. Excavations at Xiaojin in Ziyuan, Gangxi. *Kaogu* 3: 7-30 (in Chinese).
- ATGZ & Hengxian Museum. 2006. Excavations at Qiujiang in Hengxian, Guangxi, in ATGZ (ed.) *Guangxi Kaogu Wenji [Essays on Guangxi archaeology]* 2: 144-87. Beijing: Science (in Chinese).
- ATGZ & Napo Musuem. 2003. Excavations at Gantuoyan in Napo, Guangxi. *Kaogu* 10: 35-56 (in Chinese).

- ATGZ, Nanning Museum & Wuming Institute of Culture and Relics. 2006. Cave burials at Bawang & Nongshan in Wuming, Guangxi, in ATGZ (ed.) *Guangxi Kaogu Wenji [Essays on Guangxi archaeology]* 2: 206-37. Beijing: Science (in Chinese).
- ATTGZ. 1975. Neolithic shell middens in Nanning, Guangxi. *Kaogu* 5: 295-301 (in Chinese).
- BELLWOOD, P. 2005. *First farmers*. Oxford: Blackwell.
- BELLWOOD, P. & E. DIZON. 2008 Austronesian cultural origins, in A. Sanchez-Mazas, R. Blench, M.D. Ross, I. Peiros & M. Lin (ed.) *Past human migrations in East Asia*: 23-39. London: Routledge.
- BU, G. 1999. Chronologies and genealogies of the Late Neolithic at the mouth of the Pearl River. *Wenwu* 11: 48-56 (in Chinese).
- CHANG, K.C. 1969. *Fengpitou, Tapenkeng and the prehistory of Taiwan*. New Haven (CT): Yale University Press.
- CHAO, C.Y. 1994. Excavations at Changguang in Taidon. Unpublished MA dissertation, National Taiwan University (in Chinese).
- CHEN, J. 2007. Boxi, Yingpanshan and Shawudu – the cultural development of Neolithic cultures in the Upper Min River. *Kaogu Yu Wenwu [Archaeology and Cultural Relics]* 5: 65-70 (in Chinese).
- CHEN, Y.Z. 2006. Dalongtan assemblages in southern Guangxi, in IA, CASS (ed.) *Prehistoric archaeology of South China and Southeast Asia*: 409-20. Beijing: Wenwu (in Chinese).
- CHEN, Z.S. 2006. Ten years of discoveries from prehistoric Fujian, 1996-2005. *Journal of the Zhejiang Institute of Archaeology* 8: 275-83 (in Chinese).
- Committee of Relics in the Tibet Autonomous Region & Department of History, Sichuan University. 1985. *Karuo in Changdu*. Beijing: Wenwu (in Chinese).
- CRAWFORD, G.W. & S. CHEN. 1998. The origins of rice agriculture: recent progress in East Asia. *Antiquity* 73: 858-66.
- DIAMOND, J. & P. BELLWOOD. 2003. Farmers and their languages: the first expansions. *Science* 300: 597-603.
- FULLER, D., E. HARVEY & L. QIN. 2007. Presumed domestication? Evidence for wild rice cultivation and domestication in the fifth millennium BC of the lower Yangtze region. *Antiquity* 81: 316-31.
- FULLER, D., L. QIN, Y. ZHENG, Z. ZHAO, X. CHEN, L.A. HOSOYA & G.P. SUN. 2009. The domestication process and domestication rate in rice: spikelet bases from the Lower Yangtze. *Science* 323: 1607-10.
- GLOVER, I. & C. HIGHAM. 1996. New evidence for early rice cultivation, in D. Harris (ed.) *The origins and spread of agriculture and pastoralism in Eurasia*: 412-41. London: UCL Press.
- Guangxi Team, IA, CASS, ATGZ & Nanning Museum. 1998. Excavations at Dingsishan in Yongning, Guangxi. *Kaogu* 11: 11-33 (in Chinese).
- Guangxi Team, IA, CASS & ATGZ. 2003. Excavations at Baozitou in Nanning, Guangxi. *Kaogu* 10: 22-34 (in Chinese).
- HE, G. 1997. Cultural relations of the middle-late Neolithic between the northern and southern Nanling Mountains, in the Association of Chinese Archaeology (ed.) *The Ninth Annual Conference of Chinese Archaeology Association*: 175-94. Beijing: Wenwu (in Chinese).
- HE, G. & L.W. CHEN. 2007. Gaomiao and its influence and dispersal to other regions. *Nanfeng Wenwu* 2: 51-60 (in Chinese).
- HIGHAM, C. 1996. *The Bronze Age of Southeast Asia*. Cambridge: Cambridge University Press.
- 2002. Language and farming dispersals: Austroasiatic language and rice cultivation, in P. Bellwood & C. Renfrew (ed.) *Examining the farming/language dispersal hypothesis*: 223-232. Cambridge: Cambridge University Press.
- 2004. Mainland Southeast Asia from the Neolithic to the Iron Age, in I. Glover & P. Bellwood (ed.) *Southeast Asia: from prehistory to history*: 41-67. London: Routledge.
- HIGHAM, C. & T. HIGHAM. 2009. A new chronological framework for prehistoric Southeast Asia, based on a Bayesian model from Ban Non Wat. *Antiquity* 83: 125-44.
- HIGHAM, C. & T.L.D. LU. 1998. The origin and dispersal of rice cultivation. *Antiquity* 72: 867-77.
- HUANG, S.C. 1984. *Excavations at Zhishanyan*. Taipei: Taipei Committee of Documents (in Chinese).
- HUNG, H.C. 2005. Neolithic interaction between Taiwan and northern Luzon. *Journal of Austronesian Studies* 1(1): 109-33.
- 2008. Migration and cultural interaction in southern coastal China, Taiwan and the northern Philippines, 3000 BC to AD 100: the early history of the Austronesian-speaking populations. Unpublished PhD dissertation, Australian National University.
- IA of CASS (ed.). 1991. ¹⁴C dates from Chinese archaeology, 1965-1991. Beijing: Wenwu (in Chinese).
- IA of CASS, ATGZ, Zengpiyan Museum in Guilin, Archaeological Team of Guilin. 2003. *Zengpiyan*. Beijing: Wenwu (in Chinese).
- IA, Guangdong. 2000. A century of Gangdong archaeology. *Kaogu* 6: 1-10 (in Chinese).

- IA, Guangdong & Fengkai Museum. 1998. Excavations at Leizhukao, Fengkai in Guangdong. *Wenwu* 7: 38-41 (in Chinese).
- IA, Guizhou, Department of History, Sichuan University & Institute of Relic Preservation and Management, Weining. 2006. Excavations at Jigongshan, Weining, Guizhou in 2004. *Kaogu* 8: 11-27 (in Chinese).
- JIANG, L. & L. LIU. 2006. New evidence for the origins of sedentism and rice domestication in the Lower Yangtzi River, China. *Antiquity* 80: 355-61.
- LI, K.C. 1985. *Archaeological investigations in Kenting National Park at the southern tip of Taiwan*. Taipei: National Taiwan University (in Chinese).
- LI, X.Q., X.Y. ZHOU, H.B. ZHANG, J. ZHOU, X. SHANG & J. DODSON. 2007. 5000 BP rice remains in northwest China. *Chinese Science Bulletin* 52(6): 673-8 (in Chinese).
- LI, Z. & K. YANG. 2006. Cave burials at Longshan and Bawang in Wuming, Guangxi and related problems, in IA of CASS (ed.) *Prehistoric archaeology of south China and Southeast Asia*: 421-34. Beijing: Wenwu (in Chinese).
- LIN, G.W. 2005. The Neolithic in coastal Fujian. *Fujian Wenbo* 4: 41-50 (in Chinese).
- LIU, Y.C. & S.Q. GUO. 2005. The significance of Fukuodun in Jinmen, in J.C.Y. Chen & J.G. Pan (ed.) *The archaeology of the southeast coastal islands of China conference*: 135-95. Mazu: County Government (in Chinese).
- LONDO, J.P., Y.C. CHIANG, K.H. HUNG, T.Y. CHIANG & B.A. SCHAAL. 2006. Phylogeography of Asian wild rice, *Oryza rufipogon*, reveals multiple independent domestications of cultivated rice, *Oryza sativa*. *Proceedings of the National Academy of Sciences (USA)* 103: 9578-83.
- LU, L.D., Z.J. ZHAO & Z. ZHENG. 2005. The prehistoric and historic environments, vegetations and subsistence strategies at Sha Ha, Sai Kung, in AMO, Hong Kong (ed.) *The ancient culture of Hong Kong: archaeological discoveries in Sha Ha, Sai Kung*: 57-64. Hong Kong: AMO of Hong Kong.
- MEACHAM, W. 1978. Shenwan, Lamma Island. *Journal of the Hong Kong Archaeological Society* 3: 1-293.
- NASU, H., A. MOMOHARA & Y. YASUDA. 2007a. Habitats of rice cultivation from plant macrofossil assemblages at Chengtoushan, in J.J. He & Y. Yasuda (ed.) *Chengtoushan in Lixian*: 90-97. Beijing: Wenwu (in Chinese).
- NASU, H., A. MOMOHARA, Y. YASUDA & J. HE. 2007b. The occurrence and identification of *Setaria italica* (L.) P. Beauv. (foxtail millet) grains from the Chengtoushan site (ca. 5800 cal BP) in central China, with reference to the domestication centre in Asia. *Vegetation History and Archaeobotany* 16(6): 481-94.
- NISHITANI, M. 1997. The Neolithic in coastal southern China. *Bulletin of the National Museum of Japanese History* 70: 1-56 (in Japanese).
- NGUYEN, V.T. 2006. Da But in Vietnam, in IA of CASS (ed.) *Prehistoric archaeology of South China and Southeast Asia*: 341-6. Beijing: Wenwu (in Chinese).
- PEI, A.P. 1999. Xiantouling assemblage in the Zhu estuary. *Dongnan Kaogu Yanjiu [Study of Southeast Archaeology]* 2: 117-28 (in Chinese).
- PIPER, P., H.C. HUNG, F.Z. CAMPOS, P. BELLWOOD & R. SANTIAGO. 2009. A 4000 year-old introduction of domestic pigs into the Philippine archipelago: implications for understanding routes of human migration through Island Southeast Asia and Wallacea. *Antiquity* 83: 687-95.
- Relics from the South. 2007. New discoveries from the south in 2006. *Nanfeng Wenwu* 4: 29 (in Chinese).
- RISPOLI, F. 2007. The incised and impressed pottery style of Mainland Southeast Asia: following the paths of Neolithization. *East and West* 57(1-4): 235-304.
- SNOW, B.E., R. SHUTLER, D.E. NELSON, J.S. VOGEL & J.R. SOUTHON 1986. Evidence of early rice cultivation in the Philippines. *Philippine Quarterly of Culture and Society* 14: 3-11.
- TONG, E.Z. 2004. *Nanfeng Wenming [Southern civilization]*. Chongqing: Chongqing (in Chinese).
- TSANG, C.H. 1999. *Archaeology of Taiwan*. Taipei: Council for Cultural Affairs (in Chinese).
- 2007. Recent archaeological discoveries in Taiwan and northern Luzon, in S. Chiu & C. Sand (ed.) *From Southeast Asia to the Pacific*: 75-103. Taipei: Academia Sinica.
- TSANG, C.H., K.T. LI & C.Y. CHU. 2006. *Xian Min Lu Ji [Footprints of our ancestors]*. Tainan: County Government (in Chinese).
- WANG, W.L. 2003. Banpo and the related problems, in Province Administration of Cultural Heritage in Shanxi, IA in Shanxi & Banpo Museum (ed.) *Zhongguo Shiqian Kaoguxu Yanjiu [Archaeological Studies of Chinese Prehistory: Papers in Honour of Professor Shi Xing-bang]*: 203. Xian: Sanqin (in Chinese).
- XIANG, A.Q. 2005. Archaeological research on prehistoric rice farming in Guangdong. *Agricultural Archaeology* 2005(1): 149-55 (in Chinese).
- XIANG, A.Q. & J.H. YAO. 2006. Cultivated rice in Xinghuahe. *Nongye Kaogu [Agricultural Archaeology]* 1: 33-45 (in Chinese).
- XIAO, M.H. 2001. A brief report on Yunnan archaeology. *Kaogu* 12: 3-15 (in Chinese).
- YAN, W.M. 1989. Rethinking the origins of rice agriculture. *Nongye Kaogu [Agricultural Archaeology]* 2: 72-83 (in Chinese).

- YANG, S.T. 1978. Cultivated rice in Shixia. *Wenwu* 7: 23-8 (in Chinese).
- 1998. The Neolithic cultural relation between Guangdong and its surrounding regions, in S.T. Yang (ed.) *Lingnan Wenwu Kaogu Lunji [Lingnan Relic Archaeology Papers]*: 271-81. Guangzhou: Guangdong Ditu (in Chinese).
- YUAN, J., R. FLAD & Y.B. LUO. 2008. Meat-acquisition patterns in the Neolithic Yangzi river valley, China. *Antiquity* 82: 351-66.
- Yunnan Museum. 1981. Baiyangcun in Binchuan, Yunnan. *Kaogu Xuebao (Acta Archaeologica Sinica)* 3: 365-6 (in Chinese).
- ZHANG, C. & H.-C. HUNG. 2008a. The Neolithic of southern China – origin, development and dispersal. *Asian Perspectives* 47(2): 299-329.
- 2008b. The hunter-gatherer groups in southern China and its adjacent regions during the Neolithic. *Kaoguxue Yanjiu [Archaeology Studies]* 7: 415-34 (in Chinese).
- ZHANG, W.X. & H. WANG. 2000. Ancient rice in Qingyang, Gansu. *Nongye Kaogu [Agricultural Archaeology]* 3: 80-85 (in Chinese).
- ZHANG, W.X., A.Q. XIANG, L.C. QIU & S.T. YANG. 2006. Ancient rice from Shixia ruins at Maba of Qujiang in Guangdong Province. *Acta Agronomica Sinica* 32(11): 1695-8 (in Chinese).
- ZHAO, H. 1999. Geometric impressed pottery in the Pearl River delta, in Z.Y. Xu & Z.P. Zhang (ed.) *Rethinking cross-century archaeology in China* 1: 221-50. Hong Kong: The Commercial Press (in Chinese).
- ZHAO, Z.J. 1998. The Middle Yangtze region in China is one place where rice was domesticated: phytolith evidence from the Diaotonghuan Cave, Northern Jiangxi. *Antiquity* 72: 885-97.
- 2006. Rethinking the primary agriculture in southern China, in IA, CASS (ed.) *Prehistoric archaeology of South China and Southeast Asia*: 145-56. Beijing: Wenwu (in Chinese).
- ZHAO, Z.J., T.L.D. LU & X.G. FU. 2005. Phytoliths from Dingshishan, Yungning, Guangxi. *Kaogu* 11: 76-84 (in Chinese).
- ZHENG, Z., Y. DENG, H. ZHANG, R. YU & Z. CHEN. 2004. Holocene environmental changes in the tropical and subtropical areas of the southern China and the relation to human activities. *Quaternary Sciences* 24(4): 387-93 (in Chinese).
- ZHU, F.S. 2001. The cultural relation between Shixia and the Zhu River delta, in IA, Guangdong (ed.) *Essays of the Tenth Anniversary of the Institute of Archaeology, Guangdong*: 24-63. Guangzhou: Lingnan Meishu (in Chinese).
- Zhuhai Museum, IA in Guangdong & Guangdong Museum. 1991. Excavation at Caotangwan in Sanzaodao, in Zhuhai Museum (ed.) *Archaeological discovery and research in Zhuhai*: 22-33. Guangzhou: Guangdong Renmin (in Chinese).
- ZOU, H.B., J.X. GU, M.C. LI, L.H. TANG, J.L. DING & Q.D. YAO. 2000. Findings in the paddies of Majiabang Culture at Caoxieshan, Jiangsu, in W.M. Yan & Y. Yasuda (ed.) *The origins of rice agriculture, pottery and cities*: 97-114. Beijing: Wenwu Press (in Chinese).