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Research Article

Early Holocene exploitation of taro and yam among southern East Asian hunter-gatherers

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Increases in population size are associated with the adoption of Neolithic agricultural practices in many areas of the world, but rapid population growth within the Dingsishan cultural group of southern China pre-dated the arrival of rice and millet farming in this area. In this article, the authors identify starch grains from taros (*Colocasia*) and yams (*Dioscorea*) in dental calculus and on food-processing tools from the Dingsishan sites of Huiyaotian and Liyupo (*c*. 9030–6741 BP). They conclude that the harvesting and processing of these dietary staples supported an Early Holocene population increase in southern East Asia, before the spread of rice and millet farming.

Keywords: Southern China, Early Holocene, Dingsishan, microfossil analysis, dental calculus, starch grains, taro

Introduction

Around 10 000 BP, the first open settlements emerged on terraces along the Yongjiang River in southern Guangxi in southern China (Fu 2002; Zhang & Hung 2010, 2012; Hung 2019; Hung *et al.* 2017; Li *et al.* 2017a & b; Zhang *et al.* 2021; Guangxi Provincial Institute of Cultural Relics and Archaeology & Fusui Institute of Cultural Relics 2023). These

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settlements were inhabited by communities of the Dingsishan cultural group and experienced rapid population growth in contexts that pre-date direct evidence for food production, resulting in the accumulation of numerous large shell midden sites. Although this cultural group did not farm rice or millet, it was characterised by large settlements and cemeteries. For instance, more than 300 human burials have been excavated from cultural contexts dating to 9000–7000 BP from the Dingsishan site alone (Zhu *et al.* 2020). Similar shell middens and cultural remains, including pottery vessels, lithic tools, and large cemeteries have been excavated in nearby western Guangdong and northern Vietnam; in the latter, such assemblages belong to the Đa Bút culture and date to approximately 6700–4500 BP (Nguyen 2005; Zhang & Hung 2012; Higham 2014; Bellwood 2017; Oxenham *et al.* 2018).

Our research aims to understand how the subsistence techniques of Dingsishan populations and their successors were able to support such dense populations and settlements in apparently pre-agricultural contexts. The enhanced exploitation of freshwater faunal resources has been confirmed through archaeological and isotopic analyses at Dingsishan (Zhu *et al.* 2020); and archaeobotanical findings from Guangxi and northern Vietnam suggest the exploitation of palms and tree nut resources in these areas at least since the Early Holocene (Nguyen 2008; Deng *et al.* 2019; Zhang *et al.* 2020) (Table 1). Seeds, tubers and cycads (palm-like evergreen cone-bearing plants, including some with edible starch inside the trunk) may have contributed to local diets (Li 2016; Zhang *et al.* 2021, 2022). For instance, the prevalence of carious lesions among the dentition of human skeletons from Dingsishan and Liyudun suggests an increased consumption of tubers and other high-carbohydrate plants during the Early Holocene, but associated archaeobotanical evidence is lacking (Chen & Li 2013; Zhang *et al.* 2018; Zhu *et al.* 2020). In the broader Asia-Pacific context, southern China has long been proposed as a potential region of early plant cultivation, particularly for vegetatively propagated plants such as taro and yam but also for palms. Yet archaeobotanical evidence to support this hypothesis remains scarce (Zhao 2011; Denham *et al.* 2018).

Taro (*Colocasia esculenta*) is one of the oldest cultivated crops in the Asia-Pacific region, currently distributed throughout the northern and southern temperate through to tropical zones (Matthews 2006; Matthews & Ghanem 2021). Previous archaeobotanical studies have proposed Papua New Guinea as a primary domestication centre for aroids—plants from the family Araceae that grow from tubers, including taro (Denham *et al.* 2003; Fullagar *et al.* 2006). However, recent analysis of chloroplast DNA diversity from cultivated and wild *Colocasia* indicates that domestication of this aroid first took place in Southeast Asia during the Early to Middle Holocene, with a later introduction into Papua New Guinea (Ahmed *et al.* 2020). This recent study emphasises an Asian origin for *Colocasia*, but a precise geographical origin for cultivated taro remains elusive (Grimaldi *et al.* 2018). Indeed, the great diversity of taro cultivars may suggest multiple episodes of domestication (Matthews & Nguyen 2018). Geographically, the highest diversity in wild *Colocasia* species occurs in mountainous regions stretching from the eastern Himalayas to Vietnam and southern China, with the diversity gradually declining to two species in Island Southeast Asia and a single species in Australia and Melanesia (Matthews *et al.* 2022).

Archaeological sites of the Dingsishan and Đa Bút cultures in southern China and northern Vietnam have produced a range of stone grinding tools, reflecting an emphasis on the processing of plant foods. In this article, we discuss the extraction and analysis of

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Table 1. The representative archaeobotanical findings from pre-farming sites in Guangxi (southern China) and northern Vietnam.

Region	Site name	Dates (cal BP)	Method	Species	Reference
Guangxi	Zengpiyan	12 500–7600	flotation, starch, phytolith	Geophytes (*C. esculenta*), *Carya* (1), Poaceae, Arecaceae*, others	Institute of Archaeology, CASS *et al.* 2003
	Baozitou Shichuantou Nabeizui	9459–9284 # 11 253–10 500 10 132–9700 #	flotation, starch, phytolith	Fagaceae (22), Poaceae (35), geophytes (5), *Canarium* (48), Arecaceae*, *Oryza**, *Nelumbo nucifera***, others	Zhang *et al.* 2020, 2021
	Baozitou	8000–7000	starch	Panicoideae (65), geophytes or *Cycas* (56), Triticeae (23), Alismataceae (9), Zingiberaceae (7), Fabaceae (1)	Li 2016
	Dingsishan	10 000–4500	phytolith, starch	Geophytes, Poaceae (Panicoideae, *Oryza**, Triticeae), Fabaceae, Fagaceae, Arecaceae*, others	Zhao *et al.* 2005; Zhang et al. 2022
	Ganzao	10 500-7500 #	hand-picked?	Nutshell (probably *Canarium*) from cultural layer	Guangxi Provincial Institute of Cultural Relics and Archaeology & Fusui Institute of Cultural Relics 2023
	Huiyaotian	9030–8315 #	flotation	*Canarium*	Li *et al.* 2017a & b;
	Liyupo	7667–6741 #	flotation	*Canarium*	Deng *et al.* 2019
	Tangdichong	7966–7701 #	flotation	*Canarium*	Deng *et al.* 2019
Northern Vietnam	Dong Cang	11 000–10 000 #	dry-sieving	*Quercus*/*Castanopsis*, *Canarium*, *Juglans*-like	Nguyen 2008
	Con Moong	12 000–8000 #	dry-sieving	*Quercus*/*Castanopsis*, *Canarium*, *Aleurites*	Nguyen 2008
	Mai Da Dieu	9000–4500 #	dry-sieving	*Canarium*	Nguyen 2008
	Hang Doi	11 000–10 000 #	dry-sieving	*Canarium*	Nguyen 2008
	Con Co Ngua	6700–6200 #	flotation?	*Canarium*	Oxenham *et al.* 2018
	Cai Beo	7000–4000	starch, phytolith	*Colocasia*/*Alocasia* (1203), *Dioscorea* (701), *Quercus* (145), *Cyclobalanopsis* (86), *Castanopsis* (12), *Lithocarpus* (11), *Arenga*/*Caryota* (15), Zingiberaceae (8), Arecaceae*, *Musa**, *Oryza**	Wang *et al.* 2022

Direct dating of the analysed plants or human remains; * phytoliths; ** parenchyma; (n) number of starch grains or macro-remains.

micro-remains (starch grains) from human dental calculus, as well as from excavated shell and stone tools, from the sites of Huiyaotian and Liyupo in southern China. We compare our results with those from surrounding regions.

Archaeological sites and chronology

The analysed samples from the Dingsishan culture sites of Huiyaotian and Liyupo were excavated by Zhen Li, Hirofumi Matsumura, Hsiao-chun Hung, Chi Zhang and colleagues through an international collaboration project (Hung *et al.* 2017; Matsumura *et al.* 2017, 2019) (Figure 1). Huiyaotian (22°47′24″N, 108°25′48″E) is a well-preserved shell midden located on the first terrace of the Yongjiang River in Nanning (Li *et al.* 2017a) (Figure 2). The site covers 1800m^2, of which 280m^2 were excavated in 2006. Radiocarbon (^{14}C) dating of two charred *Canarium* sp. seed fragments and one human tooth indicates occupation at Huiyaotian between 9030 and 8315 cal BP (Hung *et al.* 2017; Li *et al.* 2017a) (Figure 3, Table 1).

More than 60 human burials were excavated at Huiyaotian, associated with pits, post moulds, ground-stone tools, earthenware pottery, animal bones and riverine shells. Bodies consistently were placed in flexed or squatting postures (found in both upright and side-laying positions) in burials that contained no grave goods. The Huiyaotian pottery shows sand tempers and cord-marked surfaces. Among the stone implements are polished adzes, axes and grinding stones; most adzes or axes are partially polished and many show use-wear on their blades. The site is rich in both aquatic and terrestrial animal remains, including knives made from large bivalve shells—called 'fish-headed knives' by Chinese archaeologists—that are a unique characteristic of the Dingsishan cultural assemblage.

The Liyupo site (23°10′48″N, 107°58′12″E) is a small soil mound surrounded by limestone hills in Longan County, located 53km north-west of Nanning (Li *et al.* 2017b). A total of 26m^2 was excavated in 2008, and five ^{14}C dates on a charred *Canarium* sp. nutshell, charcoal, human bones and a human tooth range from 7667 to 6741 cal BP, thus corresponding with the Dingsishan cultural phase (Li *et al.* 2017b) (Figure 3 & Table 1). As at Huiyaotian, the 43 human burials reported from Liyupo were without grave goods, and all contained flexed inhumations. Almost all burials were covered with large stones (Figure 4). Other artefacts from the site include grinding stones, stone pestles, bone awls, bone needles, small perforated shell 'shovels' and three cord-marked sherds.

Extraction and identification of micro-remains

The assemblages of human bone and artefacts excavated from Huiyaotian are stored in the Nanning Museum; those from Liyupo are in the Guangxi Provincial Institute of Cultural Protection and Archaeology. The current study focuses on five stone tools, one shell knife and six human dental calculus samples from Huiyaotian, and on six stone tools and five human dental calculus samples from Liyupo (Figure 5 & Table S1).

Sediments adhering to the artefacts, and storeroom dust, were collected as control samples to exclude the possibility of modern contamination. Micro-remains analysis of artefacts and dental calculus followed previously reported procedures (Piperno & Dillehay 2008;

Figure 1. The locations of Huiyaotian and Liyupo (red triangles) and other sites mentioned in the text (black dots) (figure by Weiwei Wang).

Figure 2. The Huiyaotian site on the Yongjiang River (photograph by Zhen Li).

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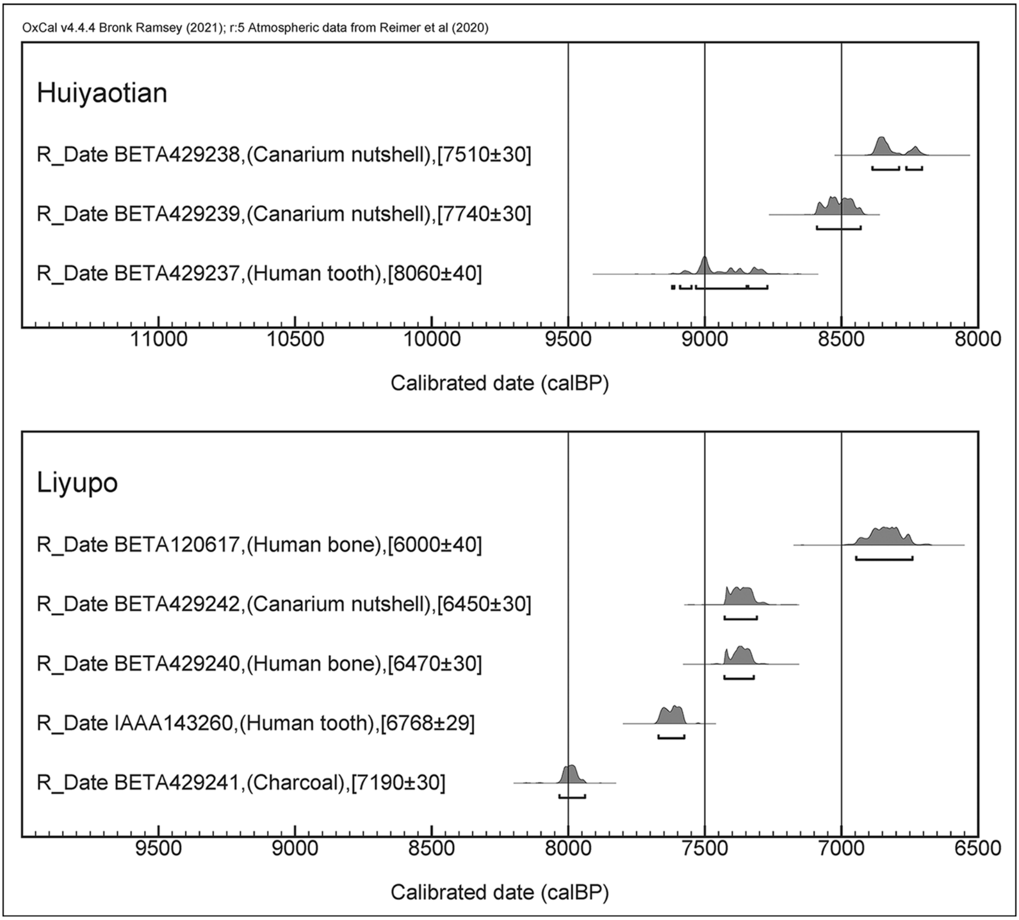

Figure 3. Radiocarbon dates from Huiyaotian and Liyupo. All dates were calibrated with OxCal v4.4.4 and presented at 95.4% probability (figure by Weiwei Wang).

Mickleburgh & Pagán-Jiménez 2012; Yang *et al.* 2013; Wang *et al.* 2022) with minor modifications, focusing on the recovery of starch grains (see details in the online supplementary material (OSM)).

Recovered starch grains were counted and measured under an optical microscope (Machine model: Olympus BX-51) at 400× magnification. No starch grains were recovered from any of the control samples. Species identifications are based on modern reference collections from Guangxi, a Chinese starch database containing more than 200 Asian species (Yang *et al.* 2018), and published datasets from tropical and subtropical areas of Asia and the Pacific (Fullagar *et al.* 2006; Lentfer 2009; Yang *et al.* 2013; Wang 2017; Li 2021; Wang *et al.* 2022).

In total, 503 starch grains were recovered from all samples (Table S1). Among them, 69 could not be identified due to damage or a lack of diagnostic characteristics. The remaining 434 starch grains are classified into six types and 10 subtypes based on their morphological features and visible attributes, after comparison with the modern reference samples (Figures 6 & 7; see identification details in OSM and Tables S1 & S2).

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Figure 4. Human burials under excavation at Liyupo. Some are covered by large stones (photograph by Zhen Li).

Starch grains from aroids and yams accounted for around 34 per cent of the total findings (Type I & II, n > 170) (Figure 8). Numerous small grains (Type Ia) on a stone pounder from Liyupo resemble both wild and domesticate taro starch grains (Figure 6A–C). Furthermore, eight clusters (compound grains) comparable with taro were also identified from all examined samples (Figure 6A'–C').

Eighty-five starch grains exhibit a large size and a multifaceted morphology (Type Ib, Figure 7A–A') consistent with other aroid plants outside the *Colocasia* genus, including konjac (*Amorphophallus konjac*) (Figure 7J–J'). Raphides—needle-shaped calcium oxalate crystals—are commonly produced in aroid plants, but none were observed in our samples. This lack of observation can be attributed to the complexities of preservation at archaeological sites, varied raphide content in aroid species and probable raphide destruction during food processing. Fifteen per cent of the grains are from *Dioscorea* (Type II, n = 77, Figure 8), including 65 small polygonal granules (Type IIa) that compare well with lesser yam (*Dioscorea esculenta*) (Figure 7B–J', K–K'). Twelve starch grains of Type IIb have triangular ovoid shapes and larger sizes that relate them to the greater, or purple, yam (*Dioscorea alata*) (Figure 7C–C', L–L').

Thirty-seven per cent of the starch grains exhibit the typical features of panicoid grasses (Type III, n = 187, Figure 8). Forty-eight (Type IIIa) probably come from wild grasses such as green foxtail (*Setaria viridis*) (Figure 7D-D', M–M'; Table S2). The other 139 specimens (Type IIIb) resemble Job's tears (*Coix lacryma-jobi*) (Figure 7E–E', F–F', N–N', O–O').

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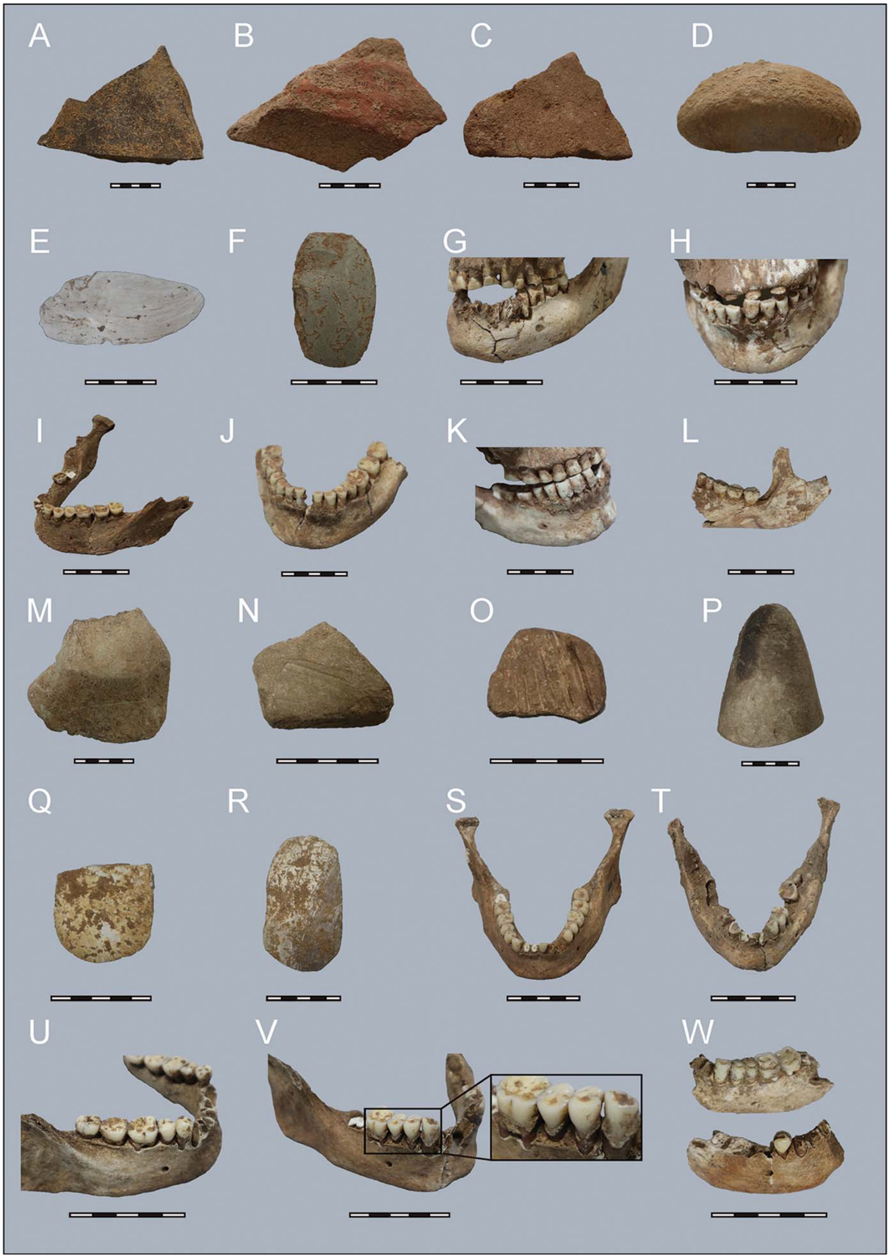

Figure 5. Analysed stone and shell tools and human remains with dental calculus from Huiyaotian (A–L) and Liyupo (M–W). A–C & M–O) grinding stones; D & P) mullers/pounders; E) a shell knife; F & R) adzes; Q) a single-bevelled axe. All scale bars represent 50mm (figure by Weiwei Wang).

Fourteen per cent of the starch grains (Type IV, n = 52) can be identified as from *Castanopsis* (Figure 7G–G', P–P') and *Quercus* tree nuts (Figure 7H–H', Q–Q') from the family Fagaceae. One per cent are from piths of the Arenga palm (*Arenga* sp.) (Type V, n = 6, Figure 7I–I', R–R').

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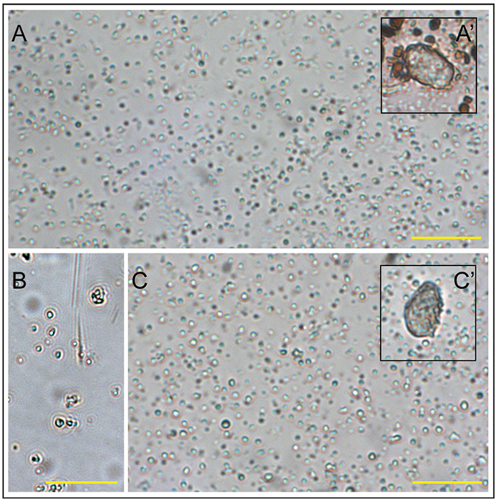

*Figure 6. Type Ia starch grains from archaeological samples (A–A') and modern reference samples (B–C'). A) Type Ia starch grains from a Liyupo stone pounder; A') compound starch grains of Type Ia; B) wild taro starch grains (*Colocasia esculenta *var.* aquatilis*); C) domesticated taro starch grains (*Colocasia esculenta*); C') compound starch grains of domesticated taro. Scale bar 20µm (figure by Weiwei Wang).*

Discussion

*Taro (*Colocasia esculenta*)*

The oldest written records of taro in China are more than 2000 years old; the plant is mentioned in *Guanzi* (*Writings of Master Guan*) of the Warring States period (476–221 BC) and in *Shiji* (*Records of the Grand Historian*) of the Western Han Dynasty (202 BC–AD 8) (Li *et al*. 2005). Remains of taro only rarely are identified at archaeological sites as they generally produce no phytoliths and their carbonised corm fragments are difficult to identify through macro-botanical identification (Piperno 2006; Tromp & Dudgeon 2015). Starch grains from taro have not yet received much attention from archaeobotanists in China, likely due to their extremely small size which makes recognition difficult. Prior to the current study, the only ancient taro reported in China came from the identification of starch grains at Zengpiyan Cave in Guangxi (*c*. 12 500–7600 BP), together with the charred remains of unidentified roots and tubers (Institute of Archaeology, Chinese Academy of Social Sciences *et al*. 2003). Our study is the first to capture abundant and clear evidence of taro starch grains from China, although the morphological differences between the starch grains of modern cultivars and wild types of taro still lack comprehensive study.

In the wider Asia-Pacific region, the utilisation of aroids (*Alocasia*, *Colocasia, Cyrtosperma*) and yams can be traced back to at least the late Pleistocene at sites such as the Niah Caves in Sarawak and Kilu Cave on Bougainville Island, and into the Early Holocene at Ille Cave on Palawan Island in the Philippines, Kuk Swamp in Papua New Guinea and Cai Beo in north-eastern Vietnam (Loy *et al*. 1992; Barton 2005; Fullagar *et al*. 2006; Barton & Paz 2007; Barker *et al*. 2007, 2011; Wang *et al*. 2022) (Figure 9). *Colocasia* taro was probably transported from Southeast Asia to the Remote Oceanic Islands

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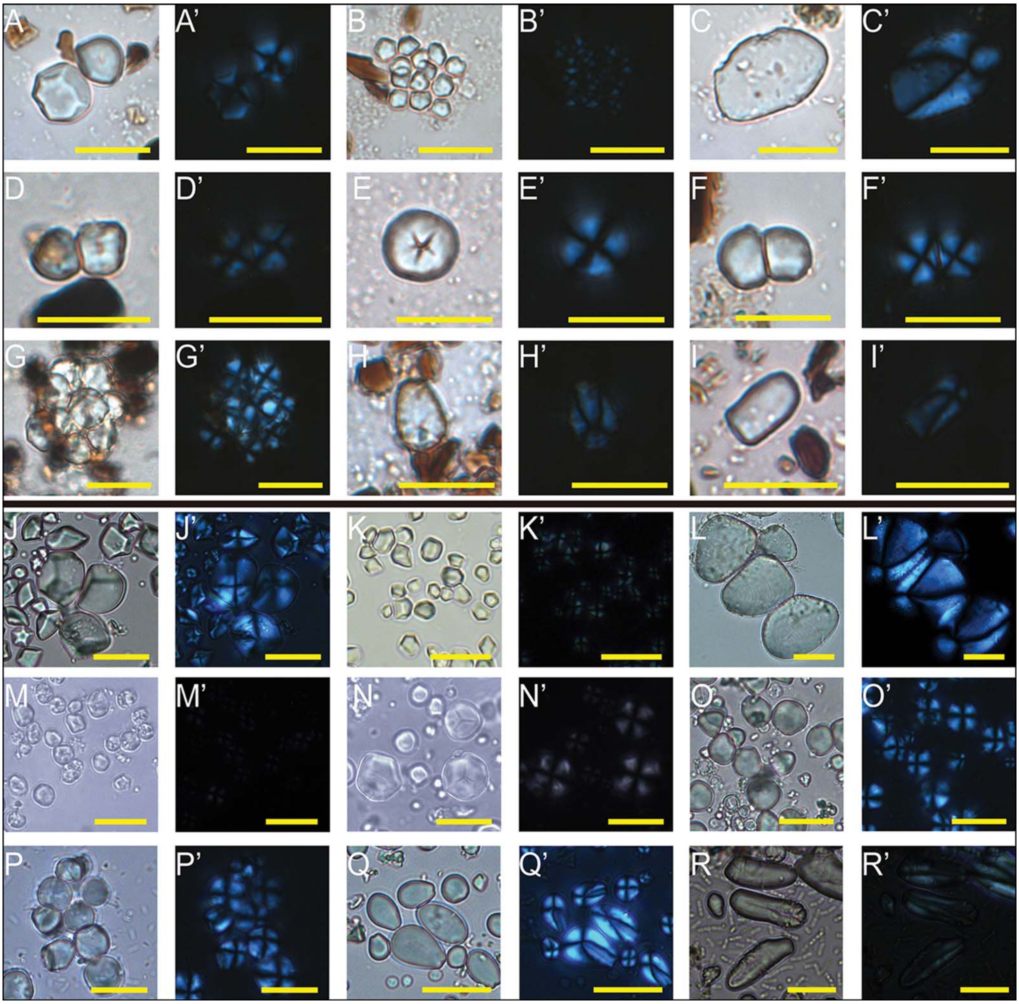

Figure 7. Ancient starches of Types Ib–V (A–I') and comparable modern reference samples (J–R') under polarised and brightfield light. A/A') Type Ib; B/B') - Type IIa; C/C') Type IIb; D/D') Type IIIa; E/E' & F/F) Type IIIb; G/G') Type IVa; H/H') Type IVb; I/I') Type V; J/J') Amorphophallus konjac*; K/K')* Dioscorea esculenta*; L/L')* Dioscorea alata*; M/M')* Setaria viridis*; N/N' & O/O')* Coix lacryma-jobi*; P/P')* Castanopsis fargesii*; Q/Q')* Quercus franchetii*; R/R')* Arenga pinnata*. Scale bar 20μm (figure by Weiwei Wang).*

by Austronesian speakers around 3000 BP (Matthews 1995; Horrocks & Nunn 2007), where it became a staple food crop and remained so until modern times, with plentiful linguistic and ethnographic documentation (Pollock 2017). Without claiming any direct relationship, we note that the morphologies of stone pounders at Dingsishan cultural sites (Figure 10A) are similar to those used for pounding and mashing cooked plant foods, such as breadfruit, into preservable pastes in Pacific Oceania (Carson 2018: 334–8). Dingsishan-type pounders and shell knives occur in dense concentrations in western Guangxi and the adjacent areas of Guizhou and northern Vietnam (Li & Wu 2017), within the natural distribution of wild *Colocasia* species.

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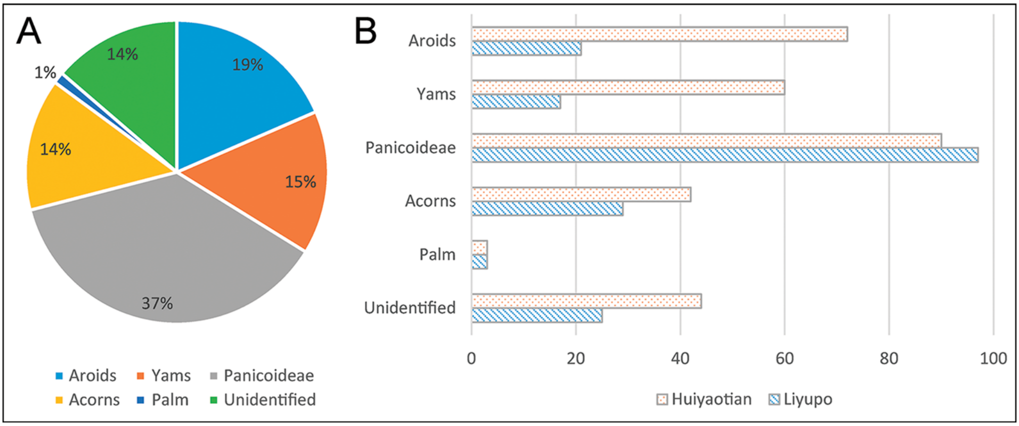

Figure 8. The plant species identified at Huiyaotian and Liyupo, displayed as relative proportions (A) and total numbers (B) of starch grains recovered (figure by Weiwei Wang).

*Figure 9. Archaeological sites with aroids (*Alocasia; Colocasia*) and yams mentioned in this article (figure by Weiwei Wang).*

Ethnographic accounts surrounding the preparation of a paste of breadfruit or taro, known as *poi* in many parts of Polynesia, are particularly detailed in the Hawaiian Islands (McElroy 2003) (Figure 10D–E). Preparing Hawaiian taro *poi* involves first steaming taro roots in an earth oven, followed by peeling the cooked roots with a scraper, sometimes made of shell (McElroy 2003). The peeling is necessary for removing the raphides (needle-shaped crystals) from the taro exterior or to remove the inedible outer skin of breadfruit. Similarly, shell

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Figure 10. A) a stone pounder from Liyupo; B & C) two shell knives from Huiyaotian, Guangxi, China (image A, B & C from Zhen Li); D) Hawaiian men pounding taro (image from Bishop Museum Archives, Honolulu, Hawaii, reproduced with permission); E) a food-pounding stone from the Hawaiian Islands (©Pitt Rivers Museum, University of Oxford. Accession number: 1901.43.12, reproduced with permission) (figure by Weiwei Wang & Hsiao-chun Hung).

'breadfruit scrapers' have been found with traces of breadfruit, taro and other remains in the Marquesas Islands of East Polynesia (Allen & Ussher 2013). The peeled items next are placed onto a wooden pounding board to be mashed with a stone pounder before being set aside to ferment (McElroy 2003). Such processing extended the storage life of the *poi*, whether made of breadfruit or of taro.

These ethnographic accounts from Pacific Oceania offer valuable insights for understanding food preparation at the Dingsishan sites and the possible function of shell knives featuring

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a single perforation that were unearthed in large quantities at Guangxi (Figures 10B–C). While these shell tools may have been used in various ways—for example, in the scraping and cleaning of plant fibres or serving as finger sickles for harvesting grasses—identification of starch grains from taro and yam on the knife from Huiyaotian indicates that one of its functions was the scraping of tuber skins.

*Yams (*Dioscorea*)*

Compared with taro, yams (*Dioscorea* sp.) are more commonly identified at archaeological sites as they produce more prominent and distinctive starch grains (Wang 2017). China is a significant yam domestication centre, where various *Dioscorea* species, including the greater, lesser and Chinese (*D. polystachya*) yams are cultivated for food and medical preparations (Wu *et al*. 2014).

Yams have been exploited in Island Southeast Asia and China since the late Pleistocene (Liu *et al*. 2011, 2013; Wan 2012), although preserved remains are infrequent in southern China and potential evidence from pre-farming contexts was previously reported only at the Haogang site in Guangdong (*c*. 6000–4000 BP) (Li 2021). Large quantities of starch grains from at least five species of *Dioscorea* have, however, been recovered from stone tools excavated at Cai Beo in north-eastern Vietnam (Wang *et al*. 2022) (Table 1), a site with a potentially Early Holocene chronology.

Other plants

Our results show that early populations in southern China exploited panicoid grasses, as also observed at Niulandong (*c*. 12 000 BP), Zengpiyan (*c*. 12 500–7600 BP) and Baozitou (*c*. 8000–7000 BP). Starch grains from grasses account for a large proportion of the micro-remains so far identified at these sites (Institute of Archaeology, Chinese Academy of Social Sciences *et al*. 2003; Wan 2012; Li 2016).

We recovered 139 starch grains (Type IIIb) that resemble those from the Job's tears plant (Figure 7E–E', F–F', N–N', O–O'). Despite widespread documentation of starch grains from this plant at archaeological sites in both southern and northern China (Yang 2017; Liu *et al*. 2019), their starch identification is controversial due to the scarcity of associated macro-remains of the plant. The lack of macro-remains of Job's tears at Huiyaotian (Deng *et al*. 2019) means that we cannot confidently claim that the 139 micro-remains of starch grains reported here are from it. This plant is, however, a widespread and potentially early crop in Mainland Southeast Asia that grows easily in ditches and watercourses (Fuller & Castillo 2021). Overall, the role of Job's tears in ancient economies needs further investigation.

Acorns (*Castanopsis* sp. and *Quercus* sp.) and palms (*Arenga* sp.) were important supplementary food resources for Dingsishan groups. Both *Castanopsis* and *Quercus* seeds contain large amounts of starch. As elements of the native forest flora, they were widely distributed in the Pearl River Delta and adjacent areas during the Early to Middle Holocene (Cao *et al*. 2007; Hao *et al*. 2021). Archaeobotanical evidence already indicates that acorns provided essential starch resources in southern China and northern Vietnam prior to the arrival of rice and millet farming (Yang *et al*. 2017; Li 2021; Wang *et al*. 2022).

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The trunk pith of the sugar palm (*Arenga westerhoutii*) may be processed to produce sago flour, which remains a traditional nutritional specialty in the Chongzuo region of Guangxi today (Ge 2015; Lan *et al.* 2022). Additionally, the sap yields palm sugar, the consumption of which (possibly in the form of alcoholic beverages) could account partially for the high rate of dental decay in Dingsishan populations.

Our findings add to the wider regional evidence about the presumed interface between the indigenous Dingsishan-associated populations of southern China and Southeast Asia and the incoming rice farmers who were present across the region by at least the fourth millennium BP. The Neolithic cemetery of Man Bac (*c.* 3900 BP) in northern Vietnam contained both an indigenous Hoabinhian-derived population of Australo-Papuan genetic and craniofacial affinity and a majority population of East Asian Neolithic affinity (Oxenham *et al.* 2011; Lipson *et al.* 2018; Matsumura *et al.* 2019). Indigenous pre-rice populations were able to integrate, to some degree, with the incoming rice farmers, and their aroid and yam food staples likely contributed to the emergence of the Neolithic economies of Southeast Asia and Oceania. The absorption of indigenous horticultural practices may have played an important role in the incremental expansion of rice farming communities in these tropical regions.

Conclusions

Previous archaeological, linguistic and genetic studies indicate that farming groups with rice and/or millet production originated in central China and expanded southwards into southern China and Mainland Southeast Asia, admixing with indigenous Dingsishan and Đa Bút populations around 4500–4000 BP (e.g. Zhang & Hung 2010, 2012; Higham *et al.* 2011; Hung *et al.* 2017; Lipson *et al.* 2018; McColl *et al.* 2018; Matsumura *et al.* 2019; Bellwood 2023). The recovery of taro, yam, palm, acorn and panicoid grass starch grains from Huiyaotian and Liyupo indicates the processing of these plant materials in pre-rice contexts but does not clarify whether these resources were gathered from fully wild plants or cultivated and domesticated by humans. Nevertheless, the plant assemblages from Huiyaotian and Liyupo, together with those from Vietnam (Wang *et al.* 2022), portray an Early Holocene economy that depended upon a range of indigenous tuber, nut and palm foods (Table 1), with no evidence for domesticated cereals such as rice or millet (common or foxtail).

The research presented here provides strong evidence that edible aroids (Araceae) and yams (Dioscorea) have been major food plants in Southern China for at least 10 000 years. Congruent with the recent genetic study of taro (Ahmed *et al.* 2020), this discovery from Guangxi shell middens, and the previous findings from Zengpiyan Cave (northern Guangxi) and Cai Beo (northern Vietnam), provides further support for the view that southern East Asia was among the earliest centres of taro exploitation.

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Supplementary material

To view supplementary material for this article, please visit https://doi.org/10.15184/aqy.2024.67.

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