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## Transitions to farming in Island Southeast Asia: archaeological, biomolecular and palaeoecological perspectives

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## Chapter 5

# Transitions to Farming in Island Southeast Asia: Archaeological, Biomolecular and Palaeoecological Perspectives

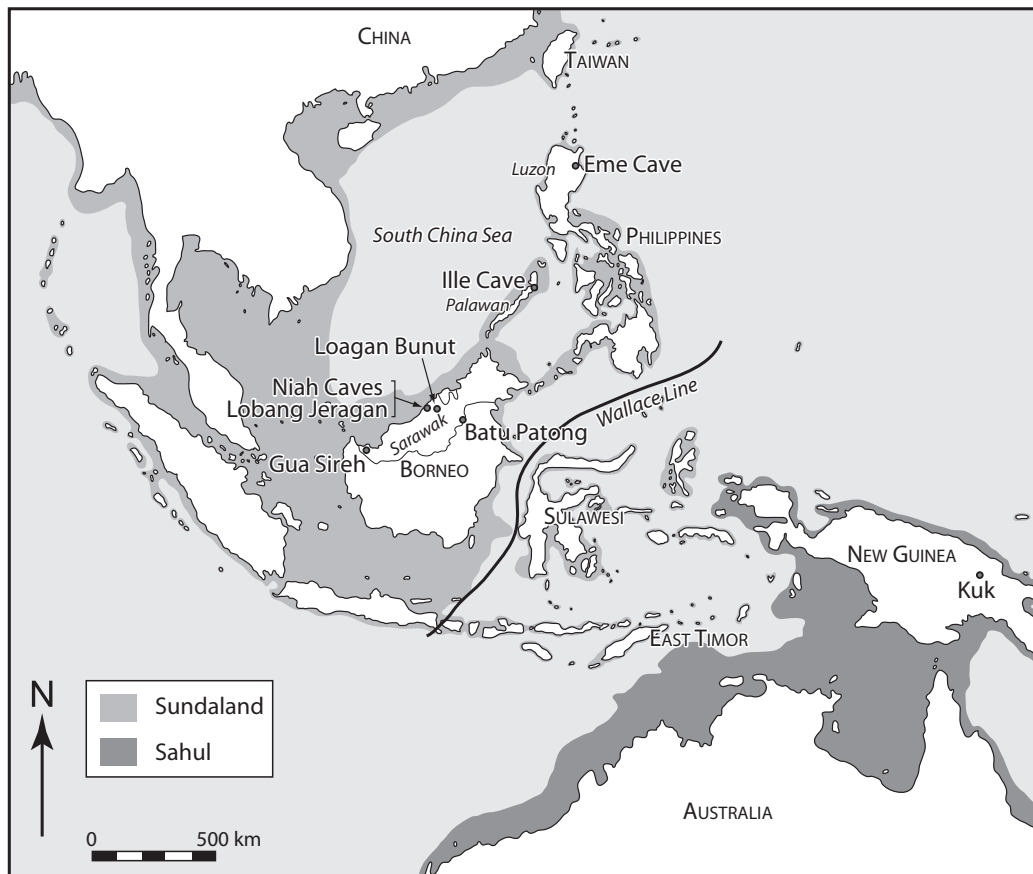
Graeme Barker, Chris Hunt & Jane Carlos

The theory that the development of agriculture in Southeast Asia has links with the development of the Austronesian languages has a long history of scholarship, though interpretations have varied considerably. Some 600 Austronesian languages are spoken today in Vietnam, Taiwan, the Philippines, peninsular Malaysia, Sumatra, Java, Timor, Sulawesi, coastal New Guinea, island Melanesia, much of Remote Oceania, and Madagascar. In 1889, Hendrik Kern used lexical evidence to argue that early speakers of these languages were acquainted with plants such as banana, pandanus, taro and yam, and went on to suggest that a pioneer community of proto-Austronesian speakers, which he located in the coastal zone of Mainland Southeast Asia, must also have been responsible for domesticating the dog, pig and chicken, and must have had knowledge of rice and iron. In 1964 George Murdock used the evidence of the highest lexical diversity within the Austronesian family occurring in New Guinea to argue instead that the spread of proto-Austronesian speakers in Mainland and Island Southeast Asia was from east to west rather than west to east, and would 'almost certainly antedate the spread of Southeast Asian agriculture and its major crops (banana, breadfruit, taro and yams)' (Murdock 1964, 124). He concluded that Austronesian speakers in Island Southeast Asia must have obtained these plants, together with pig and fowl, and later rice, water buffalo and iron, from 'peoples of a different language and superior culture' on Mainland Southeast Asia.

A contrasting argument then gained currency, that the Austronesian language group was likeliest to have developed where today there is least linguistic diversity, the island of Taiwan; satellite populations of speakers would then have spread south and east, their languages growing ever more diverse with time and distance from the homeland (Pawley & Green

1975; Shutler & Marck 1975). Robert Blust (1976) used the many linguistic correspondences across the language family to reconstruct the culture of proto-Austronesian speakers, at least west of the Wallace Line, as follows: people lived in settled villages; they made pottery and textiles; they kept domestic dogs, pigs and chickens, but also hunted; they cultivated a variety of root and tree crops and rice, and made alcoholic beverages; they possessed a well-developed maritime technology; they were probably socially stratified; 'and headhunting with its associated complex religious ideas must certainly have existed as early as 2000 BC' (Blust 1976, 36–7).

In the ensuing decade archaeologists noted that the chronology proposed by the linguists for the spread of Austronesian languages (or rather of 'proto-Austronesian') in Island Southeast Asia appeared to chime remarkably closely with the radiocarbon chronology emerging for the beginnings of Neolithic material culture in the region (Fig. 5.1): sites with Neolithic pottery in Taiwan dated to c. 4000 BC, in the Philippines and Sulawesi to c. 3000/2500 BC, and in East Timor to c. 2000 BC (Bellwood 1985; Spriggs 1989). Charred rice remains and rice inclusions in pottery in Gua Sireh cave in Sarawak, northern Borneo, were dated to c. 2300 BC (Bellwood *et al.* 1992), and rice in the northern Philippines was dated to c. 1700 BC (Snow *et al.* 1986). Peter Bellwood in particular concluded that, in combination, the linguistic and archaeological evidence suggested a 'demic diffusion' model for the beginnings of farming in the Pacific region: Austronesian-speaking Neolithic colonists from mainland China and Taiwan spread throughout the Pacific region between about 3000 and 1000 BC, taking pottery, rice cultivation and domestic livestock (dogs, pigs, chickens) with them. They established agricultural settlements in the Philippines, Borneo, and Melanesia, displacing or absorbing



**Figure 5.1.** Island Southeast Asia, showing the principal sites and regions mentioned in the text. The map also shows the likely coastline of 'Sundaland' at the time of maximum sea level regression at the Last Glacial Maximum, when world sea levels were some 130 m below present levels.

the existing populations of non-Austronesian hunter-gatherers (Bellwood 1988; 1990; 1996; 1997; 2004; Diamond & Bellwood 2003). This so-called 'Express Train' model (Diamond 1988) for the beginnings of farming in Island Southeast Asia remains highly influential, but a wide range of evidence — archaeological, biomolecular and palaeoecological — increasingly suggests a far more complicated — and interesting — picture.

### Pleistocene foraging at the Niah Caves

Recent work in the Niah Caves in northern Borneo has been very informative about the subsistence practices of our species, *Homo sapiens*, after it arrived in Southeast Asia as part of its Out of Africa migrations, perhaps 60,000–70,000 years ago (Barker *et al.* 2007). The caves are a system of enormous inter-linked caverns on the coastal plain of Sarawak, about fifteen kilometres from the South China Sea. Several of their entrances, the West Mouth in particular, were the focus of major excavations by Tom and Barbara Harisson in the 1950s and 1960s. The find that brought the

original excavations to international attention was the discovery in 1958 of an anatomically modern human skull of a teenage girl, the so-called 'Deep Skull'. Charcoal collected near its location yielded a radiocarbon date of *c.* 40,000 years ago, at that time the earliest date for anatomically modern human remains anywhere in the world. New uranium-series dates on the skull itself date it to 37,000–35,000 years ago and a series of new charcoal samples from its estimated location, mostly obtained by the Oxford laboratory, indicates that modern humans were probably using the caves by about 50,000 years ago (Higham *et al.* 2008).

Borneo 50,000 years ago was part of 'Sundaland', an enormous land mass created by the lowered sea levels of the late Pleistocene that connected the major islands of present-day Island Southeast Asia to the mainland (Fig. 5.1). The climate was cooler, drier and more seasonal than today, and analyses by Chris Hunt of fossil pollen extracted from the cave sediments indicate that vegetation around the cave was a constantly changing mosaic landscape containing at times elements of savannah, regenerating wood-



**Figure 5.2.** View of Ille Cave, showing west (left) and east (right) mouths and platform. (Photograph: Victor Paz.).

land, dry rainforest and mangrove swamp (Bird *et al.* 2005; Hunt *et al.* 2007). The ecologies of the animals hunted by the Pleistocene foragers likewise indicate a mosaic landscape around the caves that included lowland dipterocarp and/or swamp forests, open woodland, scrub, lakes or large rivers and mangrove swamp (Rabett *et al.* 2006). The main animal hunted was the bearded pig; the degree of selectivity in their age structure, compared with the lack of selectivity in the range of other taxa killed, is consistent with some form of neck or leg snare-trapping (Piper & Rabett forthcoming). The presence of arboreal species like orang-utan and smaller primates, and of some larger terrestrial animals, implies the use of other technologies, such as spears. The presence of large freshwater and estuarine species of fish and turtles is another indicator of sophisticated procurement technologies such as spears and traps.

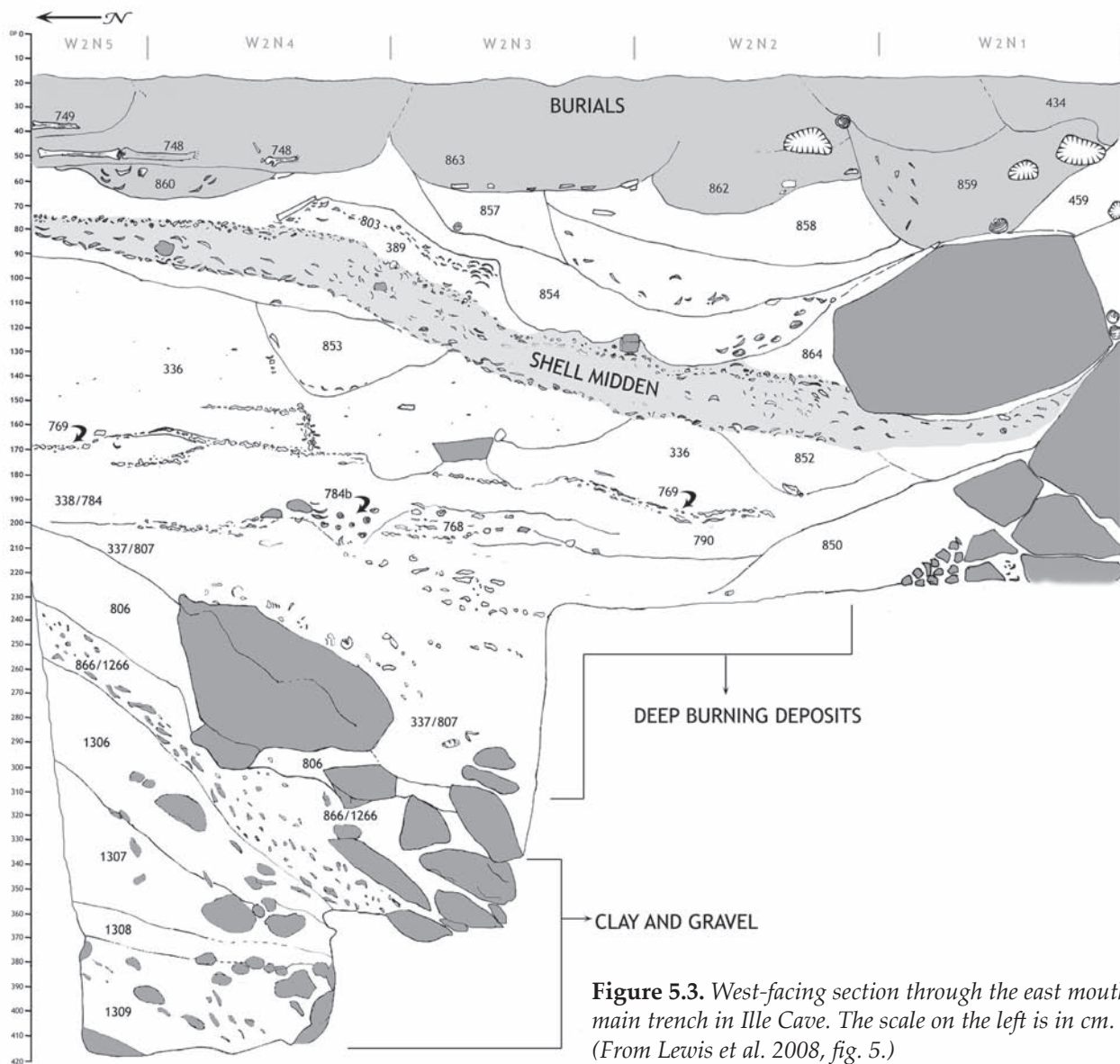
Botanical remains (parenchyma or plant tissues) and starch granules in the sediments and on the surfaces of stone tools demonstrate the exploitation of rainforest for a variety of roots and tubers, fruits, and nuts (Barton 2005; Paz 2005). The evidence includes the true taro (*Colocasia elim. esculenta*), swamp taro (*Cyrtosperma merkusii*), a forest aroid (*Alocasia longiloba*), the greater yam (cf. *Dioscorea alata*), the highly toxic but still widely eaten 'gadong' yam (*Dioscorea hispida*), and starch grains of sago, possibly *Eugeissona utilis*,

the latter being the staple plant food today of Penan foragers in Borneo (Brosius 1991). The charred endocarps of a wide variety of nuts include the poisonous *Pangium edule*. In Australia, traditional Aboriginal methods for leaching out toxins in nuts, fruits and seeds included burying them in pits full of ash for a month or so. A series of intercutting pits in the West Mouth sediments full of ash and plant remains, dated to c. 34,000–28,000 BP, is likely to be evidence of this method of plant detoxification. Also, episodically high incidences of *Justicia* pollen, an initial colonizer of fired clearings today, suggest that the Niah foragers were deliberately burning the forest (Hunt *et al.* 2007), presumably to enhance open or disturbed areas that would have provided good habitats for tubers and other food plants and for hunting and trapping animals attracted to these clearings.

#### Early Holocene plant use at Ille Cave

Important evidence for late Pleistocene/early Holocene plant gathering is being recovered from ongoing excavations in Ille Cave in Palawan in the southern Philippines (Lewis *et al.* 2008; Szabó *et al.* 2004; Fig. 5.1). The site consists of two rockshelter mouths opening onto a platform (Fig. 5.2). Excavations inside and in front of the eastern mouth have discovered a series of late prehistoric burials overlying a thick





**Figure 5.3.** West-facing section through the east mouth main trench in Ille Cave. The scale on the left is in cm. (From Lewis et al. 2008, fig. 5.)

shell midden that accumulated between 7000 and 5000 years ago (Fig. 5.3). Below was 60–100 cm of burnt deposits rich in cultural debris including intact hearths, stone artefacts, fragments of butchered animal bone and a cremated burial, the latter yielding two radiocarbon dates of c. 9500–9000 cal. (calibrated) BP. A basal deposit, some 1 m thick, consisted of clays and gravels with fewer traces of human occupation. Twenty radiocarbon dates from charcoal and bone suggest that the occupation deposits below the shell midden accumulated between 9000 and 11,000 years ago, though one sample returned a date of 14,000 cal. BP. Use-wear studies of the stone artefacts indicate that the people visiting the cave produced and maintained a range of stone tools in order to manufacture

tools of organic materials such as bamboo and rattan, presumably hunting equipment such as spears, traps, and so on. The animal bones include pig, deer, macaque and various small carnivores.

In addition, a rich array of plant remains has been retrieved (Tables 5.1 & 5.2) by a combination of hand collection during excavation, dry and wet sieving the excavated sediments through a 2 mm sieve and, in particular, water flotation of bagged sediment samples. At least seventeen species of plants were determined from the flotation samples analysed, but only four of these — *Canarium hirsutum*, *Boehmeria cf. platanifolia*, *Celtis* sp. type and unidentified small nuts — are consistently transformed (i.e. unlikely to be later natural intrusions) in all contexts, whereas

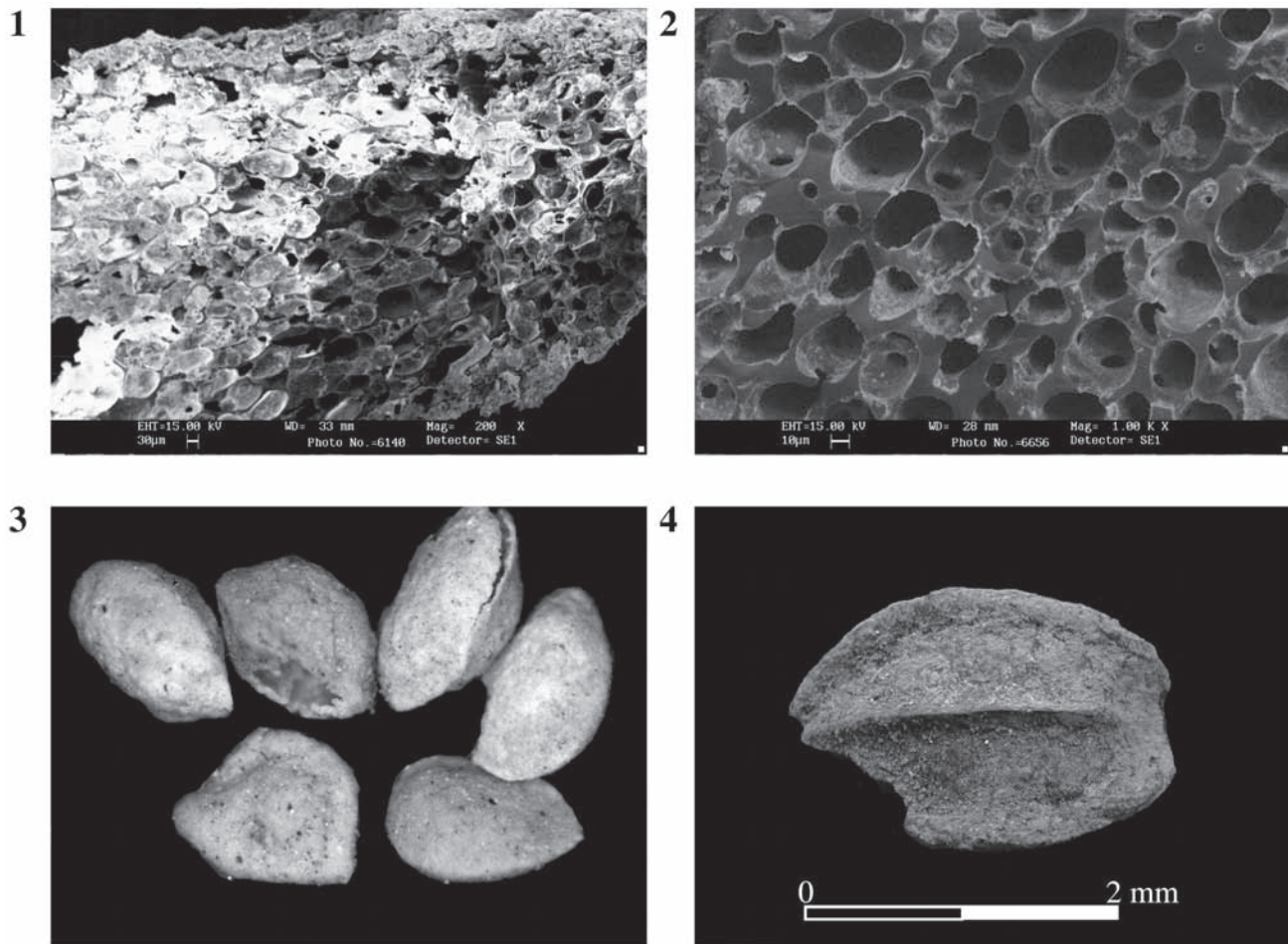
Transitions to Farming in Island Southeast Asia

**Table 5.1.** Identification of seeds and nuts from Ille Cave, with numbers adjusted as per 1000 unit volume to allow comparisons of samples of very different sizes. (Identifications by Jane Carlos.)

Context no.	Approx. age cal. BP	Original volume (liters)	Charred <i>Canarium hirsutum</i>	<i>Canarium</i> cf. <i>odontophyllum</i>	<i>Boehmeria</i> cf. <i>platanifolia</i>	<i>Boehmeria</i> cf. <i>longispica</i>	<i>Macaranga</i> sp.	Charred <i>Buchanania</i> sp.	Untrans. <i>Buchanania</i> sp.	<i>Pinanga</i> sp.	prob. <i>Pericampylos</i> sp.	<i>Eupatorium</i> sp.	prob. Cucurbitaceae	prob. <i>Celtis</i> sp.	<i>Hypericum japonicum</i>	Charred thin shelled small nuts	Parenchymatous tissues
297		5	no plant remains														
308		22	no plant remains														
313		7.5	no plant remains														
327		67	no plant remains														
332	7000–5000	68	24.56		14,411.76	14.7			29.4		44.1		44.1			present	present
335	9500	12															present
336	10,000–9500	146	2.74	6.85		27.4	21				27.4	21	6.85	41.1		present	present
340		121	0.31											8.26		present	present
378		3															present
379		103	<0.388		9.71		9.7							9.71		present	present
422		5	no plant remains														
487		129														present	present
745		24	3.09		41.67										166.67	present	
758	9500–9000	0.5															present
763		2															present
768		138.5	0.53	21.7	9068.59	86.6	58				180.5	549	7.22	152		present	present
769	10,000	272.5	<0.27	3.67	1908.26	161		3.67			44	106		56.9		present	present
771		29	1.28		34.48							138				present	present
778		8			125												present
784	10,000	553	0.8	30.7	27.12	284	29	3.62	18.1	13	397.8	3.6	3.62	157		present	present
790		58	1.6		103.5												present
806		131		11.5							15.3			15.3			
807	10,250	510.5	0.29	2.94	3.92	3.92	20				21.6	3.9		17.6		present	present
866	14,000	2330.50	<0.017	0.43	12.01	10.7	0.4		0.43	0.4	3	23	4.29	12		present	present

**Table 5.2.** Identification of parenchyma from Ille Cave. (Identifications by Jane Carlos.)

Context no.	Approx. age cal. BP	elim. <i>Dioscorea hispida</i>	prob. <i>Dioscorea alata</i>	cf. <i>Dioscorea alata</i>	elim. <i>Colocasia esculenta</i>
332	7000–5000			1	
335	9500				1
336	10,000–9500		1	2	
769	10,000			1	
771	10,000		1	1	
784	10,000	1		1	



**Figure 5.4.** Examples of late Pleistocene/early Holocene plant remains from Ille Cave: 1. *elim.* *Dioscorea* sp.; 2. *elim.* *Colocasia* sp.; 3. *Boehmeria* cf. *platanifolia*; 4. *Canarium* prob. *hirsutum*. (Photographs: Jane Carlos.)

untransformed seeds of the genera *Buchanania*, *Eupatorium*, *Macaranga* and *Pericampylus*, all genera found around Ille Cave today (Bandong 2005), are likely to be modern intrusions carried from the surface to lower levels by bioturbation.

The genus *Canarium* is of the family Burseraceae, which are 'balsamic or resinous trees with edible, oily seeds' (Burkill 1966, 249). The *Canarium* samples from Ille Cave (Fig. 5.4:4) are very similar in morphology to, but much smaller than, a specimen of *Canarium hirsutum* in the herbarium of the University of the Philippines. Charring causes a decrease in size due to moisture loss, but even the reference materials are devoid of moisture: the herbarium specimens, collected in the early 1990s, are very dry. A study of the sizes and morphology of selected nuts from archaeological sites in Melanesia, comparing them with modern reference material to assess the effect of time and selection pressure, showed that the size of *Canarium* nuts increased through time (Lepovsky

*et al.* 1998). On this basis the Ille material is identified as *Canarium hirsutum*. Burkill (1966, 433) states that *C. commune* produces one large kernel whereas wild species of *Canarium* usually have three small ones. On this evidence the nuts recovered from Ille Cave are identified as wild. Similar nuts have been recovered from Eme Cave in the northern Philippines in contexts dated to 3990–1690 BP (Paz & Carlos 2007) and from Leang Burung 1 in Indonesia (Paz 2004). In the Philippines today *Canarium* is an important source of oil and protein (Marcone *et al.* 2002). Mineralized seeds of *Boehmeria* cf. *platanifolia* (Fig. 5.4:3), a genus of small fibrous trees and shrubs (Burkill 1966), found in substantial quantities in eleven contexts, and of another species, *B. racemosa* ('ramie'), may denote the use of these plants for string, as today in the Philippines.

Of the 42 parenchyma samples from twelve contexts that underwent SEM imaging and analysis, nineteen samples from eight contexts exhibited



distinct cells, making quantitative analysis possible. On cell shape the Pleistocene material includes both *Dioscorea hispida*, the wild 'na-me' yam (Fig. 5.4:1), and *Dioscorea alata*, a domesticated species of yam previously thought not to occur as early as the Pleistocene/Holocene transition. *D. alata* also dominates the Holocene parenchyma. One sample (Fig. 5.4:2) was determined as taro, elim. *Colocasia esculenta*, from a context probably dating to c. 9500 BP. The paucity of taro at Ille Cave compared with yam is somewhat surprising, given that taro has been recovered more frequently than yam in archaeological samples from the region (Paz 2001).

The reasons for taro's frequency may be as much taphonomic and/or geographical as cultural: Burkill (1966) notes the robustness of taro compared with yam, for example, and also that its range extends more than ten degrees north and south of the range of yam. As noted by Barton and Denham (Chapter 2 this volume), the genetic patterning in modern taro suggests multiple domestication events, including in Southeast Asia (Lebot *et al.* 2004; Matthews 2003). Archaeological remains of taro have been found in Fiji dating to c. 3000–2000 BP (Horrocks & Nunn 2007) and in New Caledonia dating to c. 2700–1500 BP. In both islands it was certainly an introduced species, coinciding with the appearance of the Lapita pottery that is commonly taken as a signature of Austronesian voyager-farmers. In Island Southeast Asia, however, its history of use is clearly of far greater antiquity: taro starch on stone tools at Kuk in Papua New Guinea is of about the same antiquity as the Ille Cave parenchyma specimen (Denham *et al.* 2003).

It is clear from the prevalence of charred fragments of *Canarium* prob. *hirsutum* in the shell midden and the layers below it dating to c. 11,000–9000 BP that this forest resource was sufficiently accessible and common enough for the rainforest hunter-gatherers using Ille Cave in the terminal Pleistocene and early Holocene to be able to make regular use of it. Though morphologically wild, it was clearly collected intensively, the large size of the modern herbarium specimen compared with the Ille Cave examples suggesting that there has been a consistent process of selecting for larger size through the millennia. The appearance of the domesticated yam in Island Southeast Asia has traditionally been ascribed to the supposed expansion of Austronesian-speaking Neolithic farmers c. 4000–3000 years ago, but the parenchyma resembling morphologically domesticated yam at Ille Cave in secure stratigraphic contexts provide extremely strong evidence that it was being intensively exploited by people in Palawan thousands of years before.

### Pleistocene and early Holocene 'vegeculture'?

Barton and Denham (Chapter 2 this volume) propose the term 'vegeculture' to encompass the variety of plant-management strategies practised by late Pleistocene and early Holocene foragers in Island Southeast Asia, including asexual propagation and the deliberate translocation of plants to increase the productivity and reliability of key foraging patches. The long sequence of subsistence development revealed at Kuk in the highlands of New Guinea suggests that vegecultural strategies were further developed and intensified through the Holocene, emerging recognizably as formalized agriculture long before the putative Austronesian expansion (Bayliss-Smith & Golson 1992; Denham *et al.* 2003; 2004a,b; Golson 1989). Pits, stake-holes, post-holes and runnels on the levees of palaeochannels dated to c. 8000 BC are interpreted as evidence for the planting, digging and 'tethering' of plants and localized drainage in cultivated plots (Denham *et al.* 2004a), probably of taro given the presence of grains of taro starch on the edges of stone tools, though possibly also of yam, sago, and pandanus. By 5000 BC people were using well-drained mounds to grow these crops and also banana.

The archaeological evidence for the sophistication of Pleistocene and early Holocene subsistence practices chimes with the indications from modern molecular studies for multiple domestication events in different parts of Island Southeast Asia in the case of banana, sugarcane, yam and taro, probably by the early Holocene (Carreel *et al.* 2002; Grivet *et al.* 2004; Lebot *et al.* 2004; Malapa *et al.* 2005). Phytoliths (microscopic silica bodies) of banana in secure mid-Holocene archaeological contexts in West Africa (Mbida *et al.* 2000) are remarkable evidence for the subsequent long-distance dispersals of Island Southeast Asian domesticates, the exchange mechanisms for which we can only begin to imagine. Animals may also have been involved in such translocations, on the evidence that Pleistocene foragers were responsible for transporting the wild cuscus, a kind of wallaby, to the island of Matenbek on New Ireland off New Guinea c. 20,000 years ago (Allen *et al.* 1989).

The evidence that animals and plants were being exploited, and moved around, in complicated ways from the time that modern humans arrived in Sundaland chimes with the complex human demographic history that is emerging from genetic studies of the modern populations of the region. This has demonstrated that less than 20 per cent of modern mtDNA in Island Southeast Asia is likely to have been introduced at the time of the Neolithic (Hill *et*



al. 2007). Haplogroup M9, which is largely restricted to East Asia, Japan, and Island Southeast Asia, is thought to have evolved from the descendants of the first settlers of Sundaland. The patterning in the diversity within haplogroup E, a member of the M9 haplogroup which accounts for about 15 per cent of mtDNA lineages in Taiwan and Island Southeast Asia today, suggests strongly that it evolved within Island Southeast Asia from the founder population about 35,000 years ago and that it expanded dramatically throughout Island Southeast Asia around the beginning of the Holocene 12,000 years ago (Soares *et al.* 2008). People of haplogroup E reached Taiwan and Near Oceania within the past 8000 years. It looks inherently likely that it was the episodes of massive flooding in Sundaland in the train of the massive global warming following the Last Glacial Maximum 20,000 years ago that triggered these major displacements of the human groups living on the Sunda coastline, and that they played a critical role in shaping subsequent life in the region, including the deliberate movement of plants and animals to cope with enforced migrations, and the development of the sailing technologies that underpinned these strategies.

### Pre-Austronesian rice exploitation

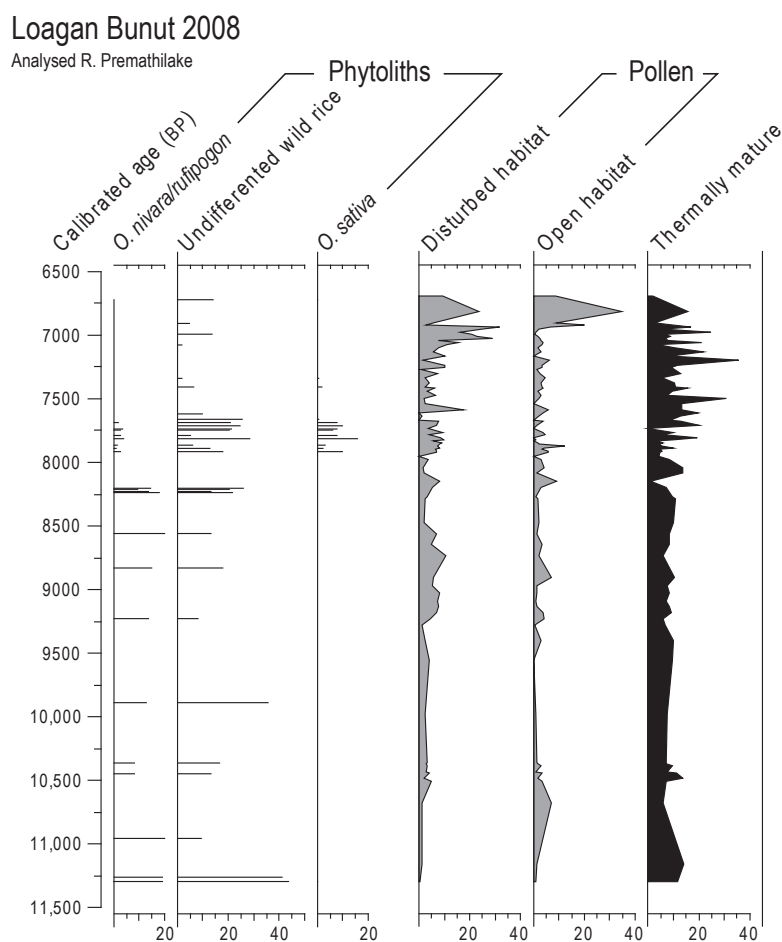
Until recently, the best evidence for the appearance of domestic rice (*Oryza sativa*) in Island Southeast Asia consisted of charred rice remains in sediments, and inclusions in pottery in the same sediments, at the cave of Gua Sireh in western Sarawak dated to c. 2300 BC (Bellwood *et al.* 1992). A single rice grain was also identified in a potsherd from Niah dated by association with a burial to c. 2000 BC (Doherty *et al.* 2000). Other evidence in Island Southeast Asia was generally later, such as rice husks in pottery from Andarayan in northern Luzon in the Philippines dated to 1500 BC (Snow *et al.* 1986). These findings were broadly in line with the assumed introduction of rice farming to Island Southeast Asia by Austronesian farmers from Taiwan around 4000 years ago. Current palaeoecological studies in Sarawak, however, are suggesting very different scenarios that may relate to the emerging picture of how humans coped with the landscape transformations of late Pleistocene and Holocene Sundaland.

A very deep (40 m) sediment core taken by Chris Hunt from the Loagan Bunut lake in Sarawak has yielded a detailed vegetation sequence for the period 11,200–7000 BP (Hunt *et al.* 2006; forthcoming) (Fig. 5.5). There is a consistent pattern of heavy burning and forest disturbance throughout the pollen record,

to such an extent that the normal successional pattern of forest vegetation seen in the Late Pleistocene (Hunt *et al.* 2007) could not occur. Rice pollen occurs in tiny quantities, but it is impossible to tell whether such pollen belongs to wild or domestic rice. However, the core also contains large quantities of phytoliths that, in the case of rice, can be separated into morphologically wild and morphologically domestic categories by size and shape (Lu *et al.* 2002). The analysis of the Loagan Bunut phytoliths by Rasnathiri Premithilake indicates that two-thirds of them, throughout the core, are of rice, the remainder consisting of open ground, bamboo and forest species. The phytolith evidence is consistent with the pollen story of a repeated pattern of forest disturbance throughout the sequence, but with the appearance of morphologically domestic rice after c. 8000 BP or c. 6000 BC. About 60 per cent of the rice phytoliths with diagnostic features that can be identified as either wild or domestic are of domestic type. Intriguingly, the appearance of the domestic rice phytoliths coincides with the appearance of a few pollen grains of Indian mango (*Mangifera indica*), which is exotic to Borneo. We are faced with the remarkable possibility, therefore, that domestic rice actually reached Borneo as part of the plant dispersals in Southeast Asia associated with major early Holocene population movements across the flooding Sundaland archipelago 8000 years ago, rather than with putative Austronesian farmer-voyagers 4000 years later.

The other possibility, equally remarkable, would be that indigenous wild rice species had been domesticated separately in Island Southeast Asia by this time. The natural habitat of the wild rice of Borneo today is on the inland limits of saline water, alongside tidal watercourses behind coastal mangrove swamps and in lowland freshwater pools and swamps. Loagan Bunut, at the edge of the coastal mangrove swamps, was the ideal habitat. In her doctoral research supervised by Chris Hunt, Samantha Jones has recently found phytoliths of wild rice in a core taken at Batu Patong in the Kelabit Highlands of Borneo, dated to c. 6500 BP (Samantha Jones pers. comm. 2009). If, as currently supposed, wild rice did not grow naturally in the highlands of interior Borneo, the discovery would be further evidence for the translocation of plants by prehistoric people in Island Southeast Asia as part of their forest-management strategies. Whatever its previous history in terms of introductions or local domestications, on the evidence of Loagan Bunut by the sixth millennium BC rice cultivation was being practised in lowland Borneo where appropriate environmental conditions prevailed, incorporated into strategies of

**Figure 5.5.** Selected phytoliths, pollen and thermally mature material (organic matter that has been 'matured' or darkened by fire action) from the sediment core at Loagan Bunut, Sarawak. The phytoliths (calculated as % total phytoliths) show the substantial presence of wild rice from near the beginning of the Holocene, and their replacement c. 8000 BP by phytoliths attributed to cultivated rice, *Oryza sativa*. The pollen (calculated as total % pollen) and the thermally mature material (calculated as % total palynomorphs) show that there is no appreciable change in the level of disturbance of vegetation or the intensity of fire with the appearance of the cultivated rice. This suggests that the mode of exploitation of the rice did not change appreciably with the introduction of the cultivated rice species, but was already in place 3000 years earlier.



forest management and vegiculture that had been practised there, on the Niah evidence, from 50,000 BP.

Two pollen cores taken within the environs of Niah Cave overlap with and follow on chronologically from the Loagan Bunut core (Hunt & Rushworth 2005). They indicate an early Holocene landscape dominated by mangrove swamps prior to 7500 BP, an environment that would have been too saline for rice to grow. Around 6400 BP there is considerable evidence for burning accompanied by a sharp rise in pollen of plants typical of open ground, presumably forest clearances, and the appearance of rice-type pollen. The latter is in all aspects similar to modern rice pollen, but unfortunately it is impossible to distinguish between morphologically wild and morphologically domestic rice from pollen grains. Also, wild species of rice grow in Sarawak today, so the wild or domestic status of the Niah grains is unclear. Nevertheless, the combination of burning, forest clearance, and rice pollen all appearing at c. 6400 BP is clearly suggestive of the development of crop cultivation around Niah 2000 years before the occurrence of the grains of domestic rice at Gua Sireh and in the Niah Neolithic pottery. The phytoliths have yet to be studied.

### Neolithic societies at Niah

Almost 200 Neolithic burials in the West Mouth of Niah Great Cave were excavated by Barbara Harrison in the 1950s and 1960s (Harrison 1967), comprising the largest prehistoric cemetery in the region. The Austronesian model predicts a clear dichotomy between indigenous pre-Neolithic foragers and incoming Neolithic farmers, but the Niah cemetery evidence does not support this: the pre-Neolithic and Neolithic people buried in the cave are of exactly the same physical type (Krigbaum & Manser forthcoming NOT IN REFS Krigbaum forthcoming??), and pre-Neolithic mortuary practices such as flexed burial continued to be used in the Neolithic. These mortuary practices also indicate that the people who buried their dead in the Niah Caves were far more complex in their make-up than the kind of pan-Pacific 'proto-Austronesian society' reconstructed by Blust (1976) from the present-day linguistic convergences across the language family (Lloyd-Smith 2009). Burial practices in the West Mouth included flexed inhumations, extended inhumations in coffins or shrouds and the secondary burial of body parts, sometimes cremated,

sometimes in multiple groups of individuals in jars. Subtle differences in the arm positions of the extended burials appear to reflect a combination of the kin group in which a body was buried and the gender of the person. Strontium-isotope analyses indicate that some individuals buried in the West Mouth, especially women, were not from the immediate locality of the caves, unlike most males (Valentine *et al.* 2008), suggesting that different lineages with distinct ancestral traditions used different parts of the cemetery over time, and that marriage exchange was a feature of these societies. Further family-like clusters can also be identified in the secondary burials. Interestingly, the relationships between arm positions, gender and local or exotic strontium signatures at a nearby burial cave, Lobang Jeragan, are very different from those of the West Mouth, suggesting intra-community variability even at the local scale.

Isotopic analyses of bone chemistry indicate that the 'pre-Neolithic' people buried in the West Mouth in the early Holocene consumed a diet extracted from a predominantly closed-canopy forested landscape, whereas Neolithic people consumed a diet from more open environments, taken to indicate cultivated land (Krigbaum 2005). The isotope signatures of the burials that can now be ascribed to the final phase of the cemetery, around 400–200 BC, which include flexed burials of pre-Neolithic type, are closed canopy, perhaps suggesting an abandonment of cultivation and a reversal to forest foraging and vegiculture, evidence of the kind of non-linear relationship between foraging and farming that is well evidenced in the ethnographic record yet rarely discussed in archaeological accounts of foraging–farming transitions (Diamond 1997).

### The social contexts of rice cultivation

On the evidence of pottery tempers from a suite of excavated Neolithic, Metal Age and Historic sites in Sarawak, rice may not have been a staple crop here until the period of European colonialism (Doherty *et al.* 2000). Palynological studies in interior Borneo also indicate that rice cultivation only became dominant there in the last few hundred years (Yulianto *et al.* 2005). So on current evidence rice was probably being cultivated intermittently from 6000 BC in coastal Borneo; was possibly being grown around Niah around 4000 BC; was certainly being used by people at Gua Sireh in western Sarawak around 2000 BC, and perhaps around Niah in the second and first millennia BC; but that it only became a staple food a few centuries ago. What was its role beforehand?

Today in Island Southeast Asia the plants of both field and forest have complex meanings for people, as

well as providing sustenance, but rice is regarded as particularly closely linked to humans and the human body. Its cultivation dominates the economic, cultural, and social lives of almost every inhabitant of Southeast Asia, urban and rural. In Borneo, rice has sacred or quasi-sacred status, its growing is highly ritualized, and growing it and eating it are associated with status and prestige. As described by Janowski and Langub (Chapter 9 this volume), Penan 'foragers' and Kelabit 'rice farmers' living side by side in the interior mountains of Borneo both rely heavily on forest foods, but both regard the act of rice-growing as expressing a profoundly different relationship between humans and the forest. The Penan believe they are 'of the forest', leaving only tracks in it, whereas the Kelabit believe that they not only belong in the landscape but somehow 'own' it. They express this relationship by making a variety of marks (*tuu*) in the forest: constructing wet and dry rice fields, maintaining pathways through the forest, erecting stones, carving prominent boulders, maintaining elaborate and long-lived cemeteries, carving ceremonial ditches across ridges and constructing stone mounds.

Given the antiquity and efficacy of vegiculture in Southeast Asia, it is easy to imagine how rice may have been actively resisted by the prehistoric population of the region as they began to encounter it through the Holocene (Barton and Denham, Chapter 2 this volume). Nevertheless, however small scale its cultivation and dietary contribution, rice probably had an important social role from the time of its first introduction, the small quantities of rice being found in the archaeological and palaeoecological record of Island Southeast Asia, as Barton and Denham have commented, likely to be 'more about cultivating social relationships than cultivating plants'. It may be that the palatability of rice led to its gathering and eventual domestication in the context of feasting occasions amongst forager communities, as a way of projecting status (Hayden 2001; 2003).

### Conclusion

Archaeological, biomolecular and palaeoecological evidence suggests that a complicated and ambiguous but fascinating story is emerging in Island Southeast Asia about foraging–farming transitions and interactions. The new data are raising entirely new questions about how, over many millennia, neighbouring and far-distant communities engaged with each other; how and why particular forager communities reacted to new technologies, new food resources, new ideas and new cosmologies; in what particular circumstances they regarded them as threats or opportuni-

ties; and why they took the decisions they did about them. So what of 'the Austronesians'? Clearly the voyager-farmer model as currently presented looks increasingly unfit for purpose. Yet it remains true that there were significant changes in aspects of material culture across much of Island Southeast Asia in the second millennium BC, the time when Neolithic burial practices began in the Niah Cave. A detailed regional assessment of Neolithic (Red-Slipped) pottery assemblages dating to c. 1500 BC, assumed in the Bellwood model to be the primary indicator of Austronesian farmers-voyagers, indicates that, whilst the assemblages of sites within different regions of Island Southeast Asia commonly share similarities, at the inter-regional level such links fall away, and there is no evidence of directionality (Swete Kelly 2009). A related view is that there are many long-established axes of communication across Island Southeast Asia which predate the Austronesians, with items of material culture widely shared within a 'maritime interaction sphere' from the Early Holocene onward (Bulbeck 2008). The same is true of the jar-burial tradition: different components of a widespread material culture were selected, and used, in very different ways in different parts of Island Southeast Asia (Lloyd-Smith 2005). Bringing the focus down still more, current research by Franca Cole for her Cambridge PhD, on unpublished ceramic assemblages from a series of Niah burial caves, is demonstrating widely-divergent ceramic-related mortuary practices at contemporary burial sites only a few hundred metres apart.

Ceremonial valuables in New Guinea and the Bismark Archipelago provide strong evidence that the social differentiation assumed to be one of the defining characteristics of Austronesian societies had in fact developed much earlier in the Holocene (Torrance and Swadling 2008). Style zones of mortars and pestles and distributions of particular classes of obsidian tools indicate the existence of long-lived social networks through the Holocene, networks through which 'new ideas, rituals, and technologies, whether developed locally or introduced from outside, could have travelled quickly [...] across an enormous region' (Torrance & Swadling 2008, 614). Swete Kelly (2009) suggests that the loosely shared aspects of material culture represented by Neolithic pottery and other artefacts may be an outward indicator not only of such expanding communication networks but perhaps also of elite social groups 'buying into' components of Neolithic material culture as part of a process of signification and display. We can imagine rice-eating as an important component of such processes; and did new behaviours, networks, and worldviews link with new forms of language? Certainly the archaeological and

genetic complexities described in this paper suggest that new scenarios about the kind of historical processes that have resulted in present-day distributions of the Austronesian languages, very different from the voyager-farmer model, need to be explored.

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