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## Chapter 2

# Prehistoric Vegeticulture and Social Life in Island Southeast Asia and Melanesia

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There is a current view that agriculture began in Island Southeast Asia with the near wholesale replacement of an indigenous population of foragers by Austronesian farmer-voyagers in the mid-Holocene (Bellwood 1997; 2005), whereas in Melanesia (especially New Guinea) an indigenous agriculture emerged from pre-existing foraging practices in the early Holocene (Denham & Barton 2006; Golson 1991), followed up by limited incursions of Austronesian-language speakers in enclaves along the coast (Spriggs 1995). Though the evidence is variable in the two regions (primarily archaeological in New Guinea, primarily historical and genetic in Island Southeast Asia) we argue instead that there were clear continuities in plant-exploitation practices in both Island Southeast Asia and Melanesia across space and through time, with broad similarities in the ways in which people engaged with their world, specifically in terms of how they managed plant-food staples. Over the long term, we see that relatively simple plant-management techniques may have resulted in complex outcomes influencing forest structure, plant domestication, and the entanglement of human behaviour and plant reproduction. The practices of environmental manipulation and plant management seen in New Guinea from the Pleistocene onwards provide an important model for how we might reappraise the nature of people-plant interactions throughout the forests of Island Southeast Asia at similar periods in the past. In the case of the latter we take Borneo as our primary case study.

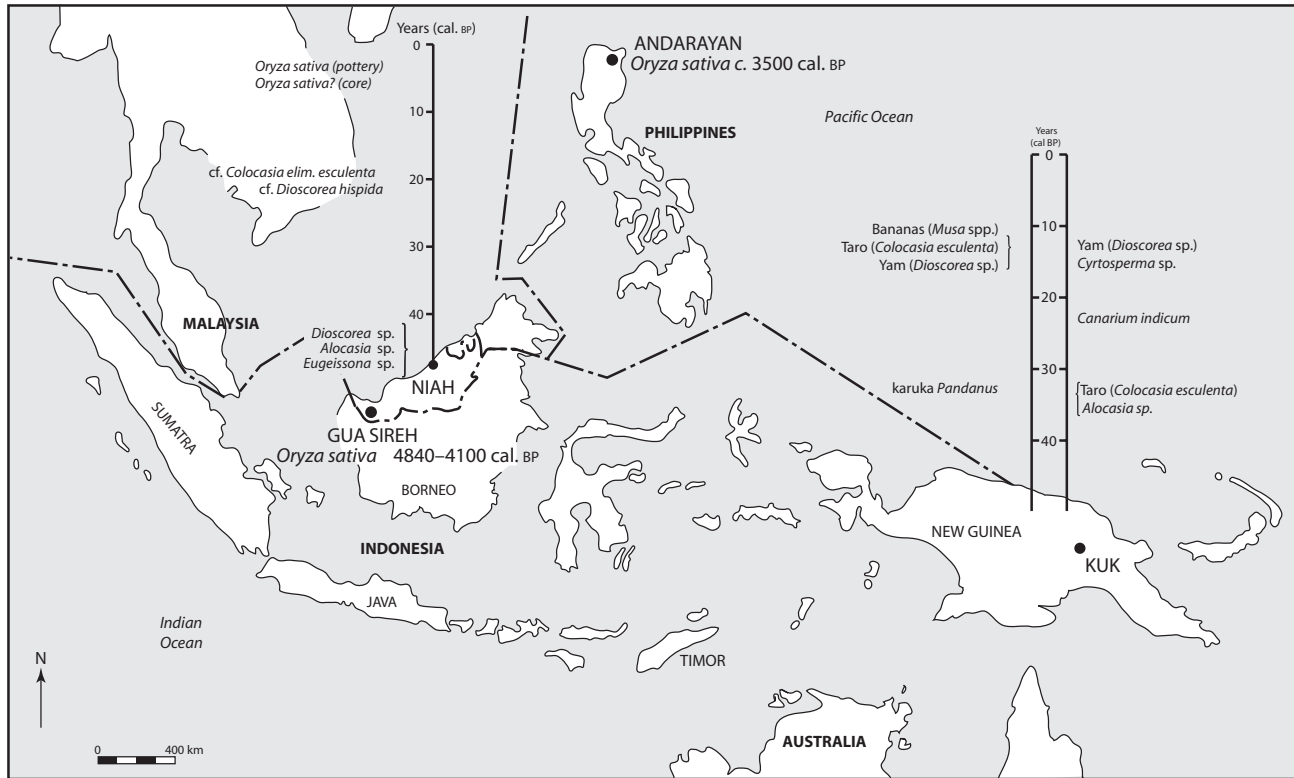
We also challenge the notion that the inhabitants of the Island Southeast Asia rapidly abandoned long-held plant exploitation and social practices, indeed ways of life, with the advent of rice cultivation, which is often presumed to have accompanied the dispersal of Austronesian-language speakers (Bellwood 2005). We argue instead that the adoption of rice and other animal and plant domesticates, together with their associated technologies and the social practices within

which they were embedded, were gradually grafted onto pre-existing, predominantly vegetative, forms of plant exploitation in the context of social interactions and transformations that spanned millennia.

### Prehistoric vegeticulture in Borneo and New Guinea

Excavations at the Niah Caves on Borneo have provided much needed new data on the antiquity and nature of plant use and animal exploitation for interior rainforests during the Pleistocene (Barton 2005; Barton & Paz 2007; Barker *et al.* 2007; Chapter 5, this volume; Fig. 2.1). Starch granule and macrobotanical analyses provide evidence for the exploitation of true taro (*Colocasia elim. esculenta*), swamp taro (*Cyrtosperma merkusii*) and a forest aroid (*Alocasia longiloba*) in the Pleistocene. People were also exploiting yam including the highly toxic and still widely eaten 'gadong' (*Dioscorea hispida*). Additionally, Pleistocene sediments contain: starch possibly from greater yam (cf. *Dioscorea alata*); charred macro-remains of unidentified yam species (*Dioscorea* spp.); charred exocarps of a wide variety of nuts, including the poisonous *Pangium edule*; and starch granules from sago, probably *Eugeissona utilis*. The recovery of several poisonous varieties of tubers and nuts from sediments demonstrates that people were detoxifying poisonous plants and rendering acrid tubers and rhizomes digestible from at least 40,000 BP (years before the present). Although the Niah evidence does not provide definitive evidence for the active management or cultivation of plants, it certainly demonstrates a long history of people-plant interactions, including with several important starch species cultivated today — taro, swamp taro, sago and yams.

Multi-disciplinary investigations at Kuk Swamp on New Guinea have yielded archaeological, archaeological and palaeoecological evidence for early agriculture and its transformation through time (Denham



**Figure 2.1.** Geographical and historical representation of key trends in plant exploitation for Indo-Malaysia and New Guinea. References are provided in the text for the data displayed.

2007; Denham & Haberle 2008). The earliest form of cultivation, using mounds, occurred c. 7000–6500 BP (Denham *et al.* 2003; 2004a,b), with earlier equivocal evidence of plant exploitation at c. 10,000 BP. Ditches for draining wetlands for cultivation appeared c. 4000 BP, becoming more widespread across the highlands after c. 2500 years ago (Denham 2007; Powell 1982).

There is relatively scant evidence for tuber and tree exploitation in Melanesia in the Pleistocene (Barton & White 1993; Fairbairn *et al.* 2006; Loy *et al.* 1992), but people–plant interactions are then well attested for the Holocene (Hope & Golson 1995; Terrell 2002). In the terminal Pleistocene and early Holocene the hunter-gatherers of the region employed two key strategies to increase the productivity and reliability of key foraging patches: burning and the deliberate translocation of plants (Denham & Barton 2006). Environmental manipulation through the clearance and burning of vegetation begins in the highlands from at least 20,000 BP, with evidence for such activities being practised on a sustained and systematic scale in some highland valleys from the early Holocene (Haberle 2007). They were widespread in New Guinea by c. 4000 BP (Powell 1982), although there is considerable regional variability in the directionality, nature,

and timing of disturbance (Denham & Haberle 2008). People were moving plant and animal species around Melanesia during the terminal Pleistocene and early Holocene (Yen 1998), including taking plants eastward and westward to and from New Guinea (Denham forthcoming; Kennedy & Clarke 2004).

In this situation we can envisage how agriculture ultimately arose from pre-existing foraging strategies through increased environmental manipulation and a greater reliance on the vegetational propagation of perennially-yielding starch sources such as banana, taro, sago and yam. Across Island Southeast Asia and Melanesia all of these traditional staples are usually reproduced by vegetative propagation: transplanting a reproductively viable portion of the plant to a new location. For yams and taro, a portion of the tuber will produce new growth; for some species of nut trees, bananas and sago, replanting is usually undertaken via suckers. In New Guinea, traditional cultivation was predominantly vegetative, with a vast range of plant types including root crops, herbs, grasses and trees being propagated in this way (Powell 1976).

Though asexual propagation only allows for somatic mutation in the genome of the new plants, changes to the physical environment can cause favour-

able and lasting (although often elastic) changes to clonal phenotypes. For example, experimental programmes significantly altered the physical form of wild yam tubers within a score of years without any sexual reproduction in the plants (Chikwendu & Okezie 1989). Changes in the growth environment such as exposure to sunshine, tending, weeding, tillage and mound heaping were major factors inducing favourable changes to tuber morphology. Simple strategies of vegetation clearance to promote secondary forest regrowth, clearance around individual plants to reduce competitive growth, periodic burning and repetitive digging to harvest tubers, would have similar effects.

### Domesticatory relationships

Phylogeographic, morphological, molecular and archaeobotanical evidence indicates variable histories of domestication across Island Southeast Asia and Melanesia for four major starch staples: sago, banana, taro and the greater yam. These processes point towards long-term patterns of exploitation and domestication, as well as complex and multi-directional flows of plant resources across these regions long before the assumed arrival of Austronesian language-speakers. Vegetative propagation was the dominant mode of cultivation, with the increasing (albeit variable) importance of sterile cultivars in some species.

Of the wide variety of palms that produce 'sago' (Ruddle *et al.* 1978), two species are important food resources, *Eugeissona utilis* (Borneo hill sago) and *Metroxylon sagu* (New Guinea swamp sago). Both species have comparable growth habits, reproduce asexually via suckers, produce multiple stems and have similar methods of starch extraction. *Eugeissona utilis* has a restricted distribution confined to the Malay peninsula and the highlands of Borneo. Starch granules in deposits dated to at least 40,000 BP at Niah indicate a very long chronology for its use in Island Southeast Asia (Barton 2005). *Metroxylon sagu* is the most widespread sago palm geographically. Its original wild distribution included New Guinea, the centre of its greatest diversity, and did not extend west of the Moluccas (Flach 1997, 24). The palm is now widely dispersed throughout New Guinea and Southeast Asia, probably via human agency, although over what time period dispersal occurred is unknown. While there are many described variants in the phenotype, or landraces, of the palm, genetic studies of *M. sagu* in Papua New Guinea confirm that there is only one species (Kjær *et al.* 2004). Genetic variation is believed to result from its wide geographic distribution and

continuous vegetative propagation (Ellen 2006, 284; Kjær *et al.* 2004, 115). There is limited archaeobotanical information for *M. sagu* (Gillieson *et al.* 1985), although its exploitation is considered to be ancient.

The domestication of bananas (*Musa* spp.) was complex and variable. It appears to have involved hybridization among species and subspecies originally dispersed throughout Southeast Asia and New Guinea. Phylogeography and DNA analyses indicate the initial domestication of two subspecies, *Musa acuminata* ssp. *errans* and ssp. *banksii*, respectively in the Philippine and New Guinea regions (Carreel *et al.* 2002; de Langhe & de Maret 1999). This underpinned the domestication process for the vast majority of the bananas cultivated across the world today, a process that occurred at different times, in different places, and with different genetic stock, involving both inter-specific and inter-subspecific hybridization (Kennedy 2008). A similar scenario of net genetic transmission westward and interspecific hybridization has been proposed for the domestication of sugarcane, *Saccharum officinarum* (Grivet *et al.* 2004).

The existing genetic evidence for taro (*Colocasia esculenta*) indicates distinctive gene pools for diploid cultivars in Southeast Asia and New Guinea, suggesting separate domestication events (Lebot *et al.* 2004). In contrast to the degrees of regional interaction suggested by the complexities of banana domestication, the molecular data for taro and some other plants such as *Dioscorea bulbifera* (Lebot 1999, 625) support a scenario of geographical isolation between people living in Southeast Asia and New Guinea. Although the time depths for these domesticatory relationships are currently unknown, they are likely to be of Pleistocene antiquity given that *C. esculenta* was being exploited in Borneo by at least 20,000 BP (Barton & Paz 2007), the Solomon Islands at 28,000 BP (Loy *et al.* 1992), in highland New Guinea at 10,000 BP (Fullagar *et al.* 2006), and soon after that at Ille Cave in Palawan (Chapter 5, this volume).

The limited genetic diversity of greater yam (*Dioscorea alata*) populations indicates that the domesticated form originated in one region, probably New Guinea, and dispersed vegetatively across the globe (Lebot *et al.* 1998; Malapa *et al.* 2005). The Pleistocene occurrences of starch granules that match those of *D. alata* at Niah Cave (Barton & Paz 2007) suggest that the plant was available in Sundaland during the Pleistocene. Until the archaeobotanical record is resolved, however, its domestication history will remain enigmatic.

The archaeological evidence for east–west exchanges includes trajectories westward from Melanesia as well as eastwards from Southeast Asia.

Obsidian from Talaesea in New Britain appears at the site of Bukit Tengkorak in Sabah around 3000-2000 BP, a journey of some 3000 kilometres (Bellwood 2005). Evidence for the Asian trade in bird plumes from the New Guinea Birds of Paradise dates from around 2000 years ago until c. AD 300 (Swadling 1996, 272). Chinese records indicate that colourful bird feathers, cinnamon and scented woods, ivory, pearls and turtle shell were important luxury imports before 2000 years ago (Swadling 1996, 53). Decoration on the exterior of bronze Dong Son drums from Vietnam made before AD 250 shows people wearing plumed headdresses. Bronze alloy recovered from Lou Island, New Guinea, dated to c. 2300–2100 BP from Lou Island has the same properties as the Dong Son drum alloys (Swadling 1996, 57), demonstrating the westward and eastward flow of goods and ideas.

In summary, multiple lines of evidence indicate a long antiquity for the exploitation of sago, taro, yam and bananas across both Island Southeast Asia and New Guinea. The botanical remains from well-investigated sites are too limited and spatially restricted to allow us to fully understand the domesticatory relationships in which these plants were enmeshed. Nevertheless, the evidence suggests that Pleistocene and early Holocene foragers were moving a series of starch-rich cultivars westward and eastward beyond their natural range well before the putative introduction of agriculture by Austronesian farmers-voyagers.

### Vegetative propagation and people

Asexual propagation allows for a particular plant with particular physical characteristics to be redistributed around a landscape. One plant is spread to many places through networks and connections maintained by people. The potential longevity of particular plants within a vegetocultural system is conceptually as well as technically different from other models of plant manipulation because these vegetatively-propagated species of plants have a 'life span' that far exceeds that of human beings, facilitating the trans-generational management of plant resources (Ingold 2000; Terrell 2002): For example, 'the importance of *Metroxylon sagu* as a long-term resource is inextricably linked to an ecology of human modification. Once a palm is planted it will continue to grow on a site for generations' (Ellen 2006, 289).

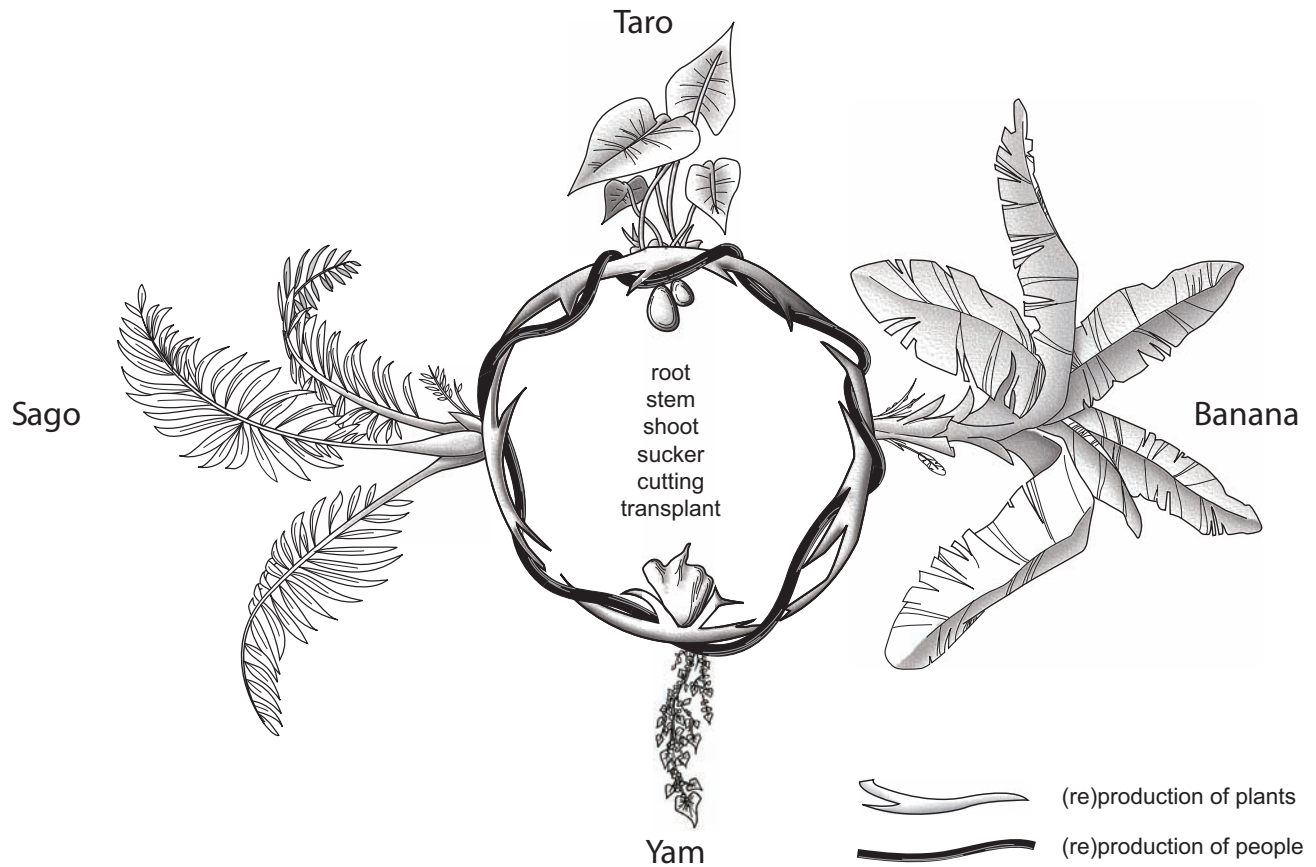
Vegetative propagation involves plants that have temporal and cultural, as well as practical, inertia. The distribution of plants through the forest produces and reproduces the social connections that people have between places and each other. The lives of cultivated plants — visible in specific plots, stands and cultivars —

have a temporal duration and social inheritance that people do not simply cast aside. Cultivated plants and tended stands, such as sago palm, are often 'owned' by individuals or groups and passed down through successive generations (Ellen 2006, 290; and see Chapter 4, this volume). Given the method of propagation, a particular genetic heritage is inherited, as expressed through the phenotype or variety with the characteristics preferred by the owner.

The resilience of vegetative-based cultivation and staple crops is almost certainly a product of cultural 'entanglement' in both Island Southeast Asia and New Guinea (Fig. 2.2). In Borneo, monospecific stands of sago are anthropic artefacts created by Penan foragers (Brosius 1991). Practices of harvesting, exploitation and transplanting are socially embedded, with specific rules of management and ownership. The Penan use the term '*molong*' to refer to 'in part a resource management technique, and in part a tree tenure system' (Puri 1997, 209). Ownership is derived from marking a tree, clearing surrounding vegetation or planting a sucker or seedling. The Kawelka of Kuk in New Guinea articulate their kinship relationships with reference to vegetative propagation: the original people, or principal landowners, are 'ground-rootmen' (*mae pukl wua* in Melpa) (Ketan & Muke 2001; Strathern 1971) and people who 'hold onto the ground bone' (*mae ombil amborom*) (Strathern and Stewart 1998, 87–8). The root binds the people to the ground, like plants. New generations, lineages and sub-clans emerge from the original clan through time, as stems, shoots, and cuttings emerge from the root, and like transplants, people are adopted by or married into other groups (Muke & Mangi 2006, 42–62; John Muke pers. comm. 2007).

There is an important conceptual difference between plants such as taro and yams, and short-lived annuals such as rice, because in the case of the former it is the root or shoot — the body of the plant — that is the target for human consumption and this portion that, when discarded or planted, will produce a new plant (an asexual clone of the original plant). Fruit trees are similar to other vegetocultural staples in that they are long-lived, lasting many generations of people, and may be transferred from one generation to the next. In the case of both tubers and fruit trees, there is no need for human intervention to ensure their survival, although people can affect the yield or size of tubers with minimal labour investment; these are plants of the forest, used by people, and essentially renewed by the forest.

While vegetative propagation involves the clonal reproduction of specific plants, this does not prevent the formation of novel hybrids and/or of domesticates.



**Figure 2.2.** Conceptual image of the entwining of food (re)production (vegecultural) and social (re)production in New Guinea. (After Muke 1992; Muke & Mangi 2006; John Muke pers. comm. 2007). The plant food and social realms are mutually entangled, thereby providing resilience to new innovations that are not readily accommodated within this milieu.

While some domesticated staples such as taro and the giant yam do not always flower and thus cannot reproduce sexually, this would not have been the case for wild populations. The selection by people of favourable species from the wild and the movement of those varieties within human spaces would have led naturally to the creation of new varieties, followed by further selections of favourable phenotypes, further translocations, and so forth.

Recent genetic studies on three South American domesticates have shown that the process of ‘backyard hybridization’, brought about through deliberate or unintentional movement of new genetic stock, was a significant process influencing rates of hybrid formation in prehistory (Hughes *et al.* 2007). Similar processes must have been equally important in the forests of Island Southeast Asia and Melanesia. A two-tier model of hybridization events can be envisaged. At the local level, vegecultural practices of moving plants from forest to campsites would have led over time to increased rates of hybridization, with new varieties

emerging gradually simply because of people’s interference with the forest. At larger scales, movements of people would have dispersed these plants over much wider geographic areas, such as through a few corms of taro or a sucker of sago tucked into a string bag. The rate and intensity of these events would have been important factors in rates of hybrid formation. Such processes have been invoked for the generation of AA diploid cultivars of banana in New Guinea, with subsequent westward dispersal and hybridization with other subspecies and species generating AAA and AAB triploid cultivars that ultimately spread to Africa (Carreel *et al.* 2002).

The social and physical practices associated with asexual reproduction and translocation, with some management of the immediate environment, would have established the necessary conditions for the formation of new genetic hybrids. Hunter-gatherer groups that moved plants, whether in systems of high or low residential mobility, would have increased local levels of patch productivity and local rates of

hybrid formation. Over time the species composition of utilized forests and the genetic stock of plants would have significantly changed. Such processes are a necessary precursor for plant domestication, which may or may not occur depending on the biological nature of the plant, the genetic isolation from wild stock and the social nature of the domesticatory relationship. Over time people would have created a genetic mosaic of exploited species that gradually transformed as a direct and indirect result of human actions and interactions (see Chapter 1, this volume). Specific domestication processes would have occurred within the context of these more general people–plant relationships. Domestication of individual species may have been relatively haphazard, occurring in different places at different times. Such processes may account for the separate domestications of species or varieties of banana, taro and some yams in Melanesia and Island Southeast Asia.

Particular practices with plants co-evolved specific ways of doing things and specific world views that would have found expression in the ways that people saw and made themselves. Supplanting one staple with another, or one way of doing things with another, therefore, was not just about energetics and ecology. Given the socio-cultural embeddedness and inertia of vegeticultural practices, people are unlikely to have simply abandoned one way of doing things when another came along.

### Domesticated rice in a vegetative world

Growing rice today in Borneo demands a totally different set of people–plant relationships from those associated with vegeticulture. The Kelabit of upland Sarawak, for example, distinguish between rice, as a plant that can only grow if humans care for it, from all other plants, both wild and domestic, that can ‘grow on their own’ (*mulun sebulang*); its cultivation signifies a particular way of living in the landscape and in the cosmos (Janowski 2003; Chapter 9, this volume). For them, the distinction between a rice-growing way of life and a way of life which does not involve rice-growing is very meaningful. The choice of rice-growing in the tropical forest is not an economically sensible one (Barton 2010), and they are quite clear about this: the point of growing rice is to show exceptional ability. If they only wanted to survive, they could make sago or grow root crops (Janowski *et al.* forthcoming).

Even as late as the early twentieth century in locations in Borneo where rice was culturally regarded as the preeminent crop, this did not necessarily reflect its role in daily subsistence. Amongst many groups in interior Borneo, rice remained a minor crop sup-

plementing other starchy staples such as root crops that could be grown in greater quantity and were considered more reliable to harvest (Harrisson 1949, 142). Amongst the Dusun of north Borneo, though rice was planted by all tribes, it was considered supplementary to a diet of taro and imported South American cultivars such as cassava, sugar cane and maize (Rutter 1929, 75). Wild fruits and sago were also considered important, the latter especially in swampy lowlands (Rutter 1929, 96), suggesting that the sago in question may have been the introduced swamp sago, *Metroxylon sagu* Rott. Root crops and sago (indigenous *Eugeissona utilis*, *Caryota* spp., and *Arenga* spp.) were important foodstuffs in the interior uplands of Borneo (Harrisson 1959, 66). Although groups such as the Kelabit state emphatically today that their staple food has always been rice, in fact taro, cassava, sweet potato and maize all contribute significantly to caloric intake (Janowski 2003). In his review of subsistence and agricultural practices in the Kelabit Highlands, Harrisson (1964) considered it highly likely that root crops and sago palms were major staples until the early twentieth century. They were certainly part of the diet of hunting and trading parties away from the villages (Harrisson 1959, 66). Harrisson (1964, 333) regarded the pre-1960s irrigated rice fields as overly elaborate and uncharacteristic of wet rice farming elsewhere, possibly a relic of an earlier agricultural system based on root crops and sago (Harrisson 1964, 333). Eghenter and Sellato (2003, 23) suggest that the earliest groups occupying the Kerayan region of interior Indonesia may have been horticulturalists with a subsistence system based on tubers.

The most reliable early date for domesticated rice (*Oryza sativa*) in Borneo is for charred rice remains and inclusions in pottery at Gua Sireh cave in western Sarawak dated by  $^{14}\text{C}$  to 4840–4100 cal. BP (ANU 7049) (Datan 1993, 116), together with a grain of rice (of unknown species) in pottery fabric at Niah Cave dated to 2925–2469 cal. BP (Doherty *et al.* 2000). After that the archaeobotanical evidence for rice in Island Southeast Asia consists mainly of rice impressions or temper within pottery, rather than food refuse (Paz 2002). Adding further complexity to the history of domesticated rice in Borneo is the presence of four species of wild rice (*O. meyeriana*, *O. officinalis*, *O. ridleyi*, *O. rufipogon*) in the forests and swamps (Vaughan *et al.* 2005). The last of these, *O. rufipogon*, is an aquatic perennial that has been identified as an early Holocene target of Mesolithic hunter-gatherers in southeastern China (Zong *et al.* 2007).

Although direct archaeobotanical evidence for rice cultivation is both scant and late (see Chapter 5, this volume), rice cultivation is still presumed to

have spread rapidly through Island Southeast Asia with Austronesian-language speakers after 4500 cal. BP (Bellwood 2004; 2005; Glover & Higham 1996, 426). As people moved through these island landscapes with their rice, its disappearance eastwards towards Melanesia is usually linked to problems of cultivation and concomitant shifts by innovative farmers to new cultivated staples (Bellwood 1997). A more literal reading of the archaeobotanical record, combined with the evidence of sustained anthropogenic burning (Anshari *et al.* 2001), suggests that rice cultivation may only have become dominant in inland Borneo, and possibly other parts of Island Southeast Asia, in the last 1500 years or even later in some places.

We think it is possible that the small quantities of rice associated with pottery at Gua Sireh (Datan 1993), Niah (Barker 2006, 223), Andarayan (Bellwood 2004, 31) and elsewhere (Fig. 2.1) are likely to have been as much about cultivating social relationships as about cultivating a new introduced plant. As discussed earlier, the cultivation of rice is likely to have been on a different technological and conceptual plane to vegeticultural practices and world-views. The success of rice lies outside the forest, not within it (see Chapter 1, this volume). Spaces for rice have to be cut out of the forest and maintained by a constant pushing at the edges. Within a forest that has become over a long period of time an artefact of human behaviour, a distinctive socio-biological milieu, where was the first cut? Perhaps rice represented more than just the idea of food, but an exotic way of cultivating plants and living. From this perspective, the incorporation of small quantities of rice into pottery may not have been accidental or serendipitous but the result of a deliberate strategy of recycling or transferring values associated with rice and the world it represented onto other objects. In addition to the potential value of rice as a commodity for exchange, we can also hypothesize resistance, or much greater resilience, to rice within systems of cultivation based on vegeticulture. What social conditions might have regulated the adoption of planting seeds in a cultural milieu suffused with vegeticultural meanings?

The farmer-voyager model of Austronesian dispersal is primarily a one-way system: these Neolithic farmers are considered to have moved new goods and practices along with themselves between islands, eventually replacing the hunter-gatherers who were already living there. However, the movement of materials, including the westward and eastward movement of plants by people to and from New Guinea discussed earlier in this chapter, suggests a dynamic picture of social interaction throughout Island Southeast Asia and Melanesia in the millennia before the hypoth-

esized Austronesian expansion. The long history of rainforest occupation documented at Niah Cave and emerging at Ille Cave (Barker *et al.* 2007; Chapter 5, this volume) offers an alternative historical perspective to the Austronesian orthodoxy. The domesticatory relationships established during the Pleistocene entailed vegetative propagation and transplantation, and culminated in the intra- and inter-regional dispersal of plants. They did not just belong to separate 'economic', 'energetic' or 'production' realms but were socially and spatially entangled. Rice cultivation did not likely sweep all before it, following its introduction into the region. Rice may have been primarily an exotic trade item, or a status food (see Chapter 6, this volume), or a minor sexually-reproduced seed crop in a vegetatively-dominated world. Either way, it appears increasingly likely that rice cultivation was grafted onto, or incorporated into, pre-existing practices, and that this was a slow rather than a rapid process.

The history of plant cultivation in Island Southeast Asia and Melanesia is likely to be far more complex than is currently allowed by the Austronesian farmer-voyager hypothesis. As discussed in this chapter, recent archaeobotanical analyses and studies of plant genetics suggest a far more nuanced and deeper history of people-plant relationships in both regions. Long histories of plant manipulation, incipient cultivation, and cultivation with domesticates are likely to constitute an entanglement of processes that over time gave rise to a variety of systems of cultivation based on genetically wild and domesticated plants, or combinations of both. Certainly such mosaics are characteristic of plant exploitation across the region today.

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