**In the Society of Vegecultural Cultivators**

Huw Barton, School of Archaeology and Ancient History, University of Leicester. LE1 7RH, UK. hjb15@leicester.ac.uk

Tim Denham, School of Geography and Environmental Science, Building 11, Monash University, Clayton Campus, VIC 3800, Australia. Tim.Denham@arts.monash.edu.au

**Introduction**

This paper considers the implication of vegecultural systems of food production within a prehistoric context within Southeast Asia and contrasts this with the better described systems of plant cultivation known from the prehistory of Papua New Guinea. In doing this we also consider the social significance of vegecultural traditions as a more than simply a method of providing food in tropical contexts but as an embedded ‘practice’ that, over millennia, had become tightly woven into indigenous cosmologies. We consider long histories of vegeculture across Melanesia and Island Southeast Asia, primarily involving asexual propagation, transplanting, and low intensity plant management within forested environments We argue that mosaics, or a patchwork, of human-plant interactions existed across Island Southeast Asia and into Melanesia from the Pleistocene until the late Holocene and that this had important implications for the histories of people-plant interactions and instances of phenotypic change in some plants, but its absence in others. Finally we consider what this implies for the apparent late adoption of rice as a major staple across island Southeast Asia south of Taiwan; a transformation that was structured by behavioural predispositions (*habitus*), domesticatory relationships (*domus*), including exploitation practices, and plants (after Bourdieu 1990; Hodder 1990; Denham 2004). Rather than solely being inherited from Austronesian-speaking colonisers (Bellwood 2005), the deep antiquity of vegecultural forms of people-plant interaction did not pave the way for a new farming system and new farming technologies, and is more likely to have discouraged its adoption for many thousands of years.

Accepting a long chronology for human occupation of rainforest allows a very different perspective on concepts such as ‘cultivation’ and ‘agriculture’ than was previously the case; a short chronology tended to support the ‘devolution’ rather than ‘evolution’ of foragers in rainforest (e.g. Bailey et al. 1989; Bellwood 2005: 38; Diamond and Bellwood 2003). Practices of environmental manipulation and resource exploitation, which are becoming increasingly well-documented for Borneo and New Guinea, were likely to have been more widespread throughout tropical Melanesia and Island Southeast Asia during the Terminal Pleistocene and early Holocene; a continuum of people-plant interactions as envisaged by Hather (1996). Long-term practices of vegetative plant propagation were eventually responsible for domestication across Island Southeast Asia and New Guinea, as discussed here with reference to three major starch staples: banana, taro and the greater yam.

**Vegeculture**

Vegeculture refers to a system of cultivation in which the dominant mode of plant reproduction used by people is vegetative propagation. All of the traditional staples across Island Southeast Asia and New Guinea discussed thus far, including yam, taro, banana and sago, are usually reproduced by transplanting a portion of the plant to a new location. For yams and taros, a portion of the tuber will produce new growth; for some species of nut trees, bananas and *Metroxylon* sago replanting is usually undertaken via suckers. In New Guinea, traditional cultivation was predominantly vegetative and a vast range of plant types were propagated this way, including root crops, herbs, grasses and trees (Powell 1976; Denham 2005b).

Though asexual propagation only allows for somatic mutation in the genome of the new plants, changes to the physical environment can cause favourable and lasting (although often elastic) changes to clonal phenotypes. For example, experimental programs significantly altered the physical form of wild yam tubers within a score of years without any sexual reproduction in the plants (Chikwendu and Okezie 1989). Changes in growth environment including exposure to sunshine, tending, weeding, tillage and mound heaping were major factors inducing favourable changes to tuber morphology. These controlled variables could be mimicked by 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.

**Domesticatory relationships**

Phytogeographic, morphological, molecular and archaeobotanical evidence indicates variable histories of domestication across Island Southeast Asia and New Guinea for three major starch staples: banana, taro and the greater yam (Denham in press).

Banana

The domestication of Musa banana was complex and variable and appears to have involved hybridisation among species and subspecies in New Guinea and Southeast Asia. Phytogeography and DNA analyses support initial domestication of two subspecies of *Musa acuminata* spp. *errans* and *banksii* in the Philippine and New Guinea regions, respectively (De Langhe and De Maret 1999; Carreel et al. 2002). The initial stages of domestication of these two subspecies are complex and underpin the domestication process for the vast majority of bananas cultivated across the world today.

The earliest evidence of banana cultivation occurs on the wetland margin at Kuk Swamp, where elevated Musa phytolith frequencies were documented in the fills of features within cultivated plots in a grassed landscape (Denham et al. 2003). Based on archaeobotanical finds of Musa banana, presumably sterile (triploid) plantains in West Africa approximately 2500 years ago (Mbida et al. 2001), as well as more equivocal finds in Uganda (Lejju et al. 2006, problematic dating) and India (Fuller and Madella 2001, problematic identifications), the histories of banana domestication and dispersal precede the purported date for the arrival of Austronesian-speaking farmer-voyagers into Indo-Malaysia. Banana domestication histories are suggestive of long periods of interaction across Island Southeast Asia and Melanesia, including mainland Southeast Asia. A similar scenario has been proposed for the domestication of sugarcane (*Saccharum officinarum*; Grivet et al. 2004).

Rhizomes and tubers

The existing genetic evidence for taro (*Colocasia* *esculenta*) indicates distinctive genepools for diploid cultivars in Southeast Asia and New Guinea, which is suggestive of separate domestication events in each region (Lebot et al. 2004; Matthews 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, eg, aerial yam (*Dioscorea bulbifera*; Lebot 1999: 625), seem to 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 across these regions given that *Colocasia esculenta* was being exploited in Borneo by 20,000 BP (Barton and Paz 2007), the Solomon Islands at 28,000 BP (Loy et al 1992), and at Kuk Swamp in highland New Guinea at 10,000 BP (Fullagar et al. 2006). The analysis of starch granules and macroplant remains has recovered Pleistocene evidence for the exploitation of true taro (*Colocasia* elim *esculenta)*, swamp taro (*Cyrtosperma merkusii)* and a forest aroid (*Alocasia longiloba)*. People were also exploiting yam including the highly toxic but still widely eaten, gadong (*Dioscorea hispida).*

There is limited data for the greater yam (*Dioscorea alata*), only sterile clones of limited genetic diversity are known to exist, indicating that the domesticated form of this plant originated in one region and dispersed as a sterile clone across the globe (Lebot et al. 1998; Malapa et al. 2005). Pleistocene occurrences of starch granules that match those of *D. alata* at Niah Cave (Barton 2005; Barton and Paz 2007) suggest that the plant was available in Sundaland during the Pleistocene. However, until the archaeobotanical record is resolved, the history of cultivated *D. alata* remains enigmatic.

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. There is limited and spatially restricted information from well-investigated sites to fully understand the domesticatory relationships in which these plants were enmeshed across these regions in the Pleistocene or the Holocene. However, the evidence suggests a westward and eastward dispersal of starch-rich cultivars, creating widespread distributions of these plants beyond their natural range, and points to a time depth preceding the arrival of Austronesian farmer-voyagers.

In the Highlands of New Guinea there is overwhelming palaeoecological evidence for environmental manipulation through the clearance and burning of vegetation, which in the Highlands begins by at least 20,000 BP (Haberle 2007). More sustained and cumulative evidence for anthropic landscape transformation occurs in some highland valleys from the early Holocene (Haberle et al. 1991; Denham et al. 2004a) and becomes more widespread from approximately 4000 years ago (Powell 1982), although there is a high degree of regional variability in the directionality, nature and timing of change (Denham and Haberle 2008). There is also good archaeological evidence for the movement of plant and animal species by people during the terminal Pleistocene and early Holocene in the Melanesian region (Yen 1998). The archaeobotanical evidence and ethnobotany suggest broad ranges of plants have been exploited and the resource base augmented through landscape modification, transplantation and establishment of domesticatory relationships following the Last Glacial Maximum (LGM) (Groube 1989; Haberle 1995, 2007; Yen 1996, 1998; see Figure 1).

**Plant 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 though networks and connections maintained by people. The potential longevity of particular plants within this system of people-plant interaction is conceptually as well as technically different from other models of plant manipulation, allowing transgenerational management of plant resources (Ingold 2000 who discusses this point generally – also Terrell 2002). Managing clonal varieties of sago, as well as replanting the crown of a tuber or rhizome, or sucker of a banana, fit within this concept of plant longevity. In some sense, these vegetatively propagated species are plants with a ‘life span’ that far exceeds that of a human being – perpetuated by a particular form of physical and social interaction. Tellingly, ‘Although Nuaulu of Indonesia know of and understand sexual reproduction in sago and take advantage of it as a source of new diversity, there is no attempt to deliberately plant from seed’ (Ellen 2006:287).

Sexual reproduction of plants does allow for the formation of novel hybrids, but is also a process positively influenced by simple practices such as translocation. Recent genetic studies on three important south American domesticates have shown that the process of ‘backyard hybridisation’, 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 were equally important in the forests of Southeast Asia. A two-tier model of hybridisation events can be envisaged. At the local level, vegecultural practices of moving plants from forest to campsites would have over time led to increased rates of sympatric hybridisation. New varieties will have arisen, gradually, over time simply because of the interference of people with the forest. At larger scales, movements of people would disperse these plants over much wider geographic areas, namely 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 for the rate of hybrid formation over time. Such processes have been invoked in the generation of AA diploid cultivars of banana in New Guinea, with subsequent westward dispersal and hybridisation with other subspecies and species to generate AAA and AAB triploid cultivars that ultimately spread to Africa (De Langhe and De Maret 1999; Carreel et al. 2002).

The social and physical practices associated with asexual reproduction and translocation, with some management of the immediate surrounds with plants of interest, establish the necessary conditions for the formation of new genetic hybrids. Hunter-gatherer groups that move plants, whether residential mobility is high or low, will have increased local levels of patch productivity, as well as increased rates of local hybrid formation. Over long periods of time, this may well have had a significant impact on the composition of inhabited forest and influenced genetic changes as well. These processes establish the necessary precursor conditions for plant domestication – which may or may not occur depending on the biological nature of the plant, genetic isolation from wild stock and social nature of the domesticatory relationship. Over time people would have been living amongst a hybrid mosaic of exploited species, a genetic mosaic, gradually transforming as a direct and indirect result of human action and interaction. The conditions were set for more specific domestication events that may be linked but incidental to the people-plant relationship. These events may have occurred in relatively haphazard fashion in more than one location, and at more than one time. A general model similar to this would explain the separate domestication events postulated for species or varieties of banana, taro, and some yams in Melanesia and Southeast Asia.

Vegetative propagation involves living plants that have temporal and cultural, as well as practical, inertia. The distribution of plants through the forest reproduces and produces the social connections 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. Some cultivated plants, or plant stands, such as sago palm, Pandanus and fruit trees are often ‘owned’ by individuals or groups and passed down through successive generations. Given the method of propagation, what is actually being passed along is a particular genetic heritage, expressed through the phenotype or variety with those physical characteristics preferred by the owner. Given social and cultural embeddedness, or entanglements, people may not simply abandon one way of doing things just because another comes along; many societies across the world today display enormous resilience despite the onslaught of colonialism, neo-colonialism and globalisation, whereas others do not.

Social structures, practices and beliefs can all be intricately bound to the plants and forms of cultivation people rely on for food. Some cultivated plants, or plant stands, such as sago palm, Pandanus and fruit trees are often ‘owned’ by individuals or groups and passed down through successive generations. Supplanting one staple or way of doing things with another is not just about energetics and ecology. In New Guinea, cultural predispositions and inheritance are clearly visible in the enormous variability of staple crops cultivated by groups across New Guinea today despite the successive introduction of several new staples over the last few hundred years (Bourke and Harwood 2007). The relative success of recent introductions, especially sweet potato (*Ipomoea batatas*) and cassava (*Manioc esculenta*), is almost certainly because both plants are vegetatively propagated. Despite the energetic advantages of these introduced crops, many groups continue to cultivate more traditional staples – even if new varieties of these staples have spread rapidly since European/Australian colonisation.

The resilience of vegetative-based cultivation and staple crops is almost certainly a product of cultural entanglement. There are parallels between practices of plant translocation and asexual propagation and concepts of identity in Melanesia. Gosden (1999: 124) writes that Melanesians are ‘composites … created through sets of relationships to one another as well as to material culture.’ For example, Meldpa groups in the highlands of New Guinea, in whose territory Kuk is located, articulate their kinship relationships with reference to vegetative propagation – in terms of ‘ground-root-man’, or *mae pukl wua* (Strathern 1971; Ketan and Muke 2001), cuttings and transplants (John Muke, pers. comm. 2007). As the Meldpa example indicates, particular practices with plants co-evolved specific ways of doing things, ways of Being, and world views that have ultimately found expression in the ways that some people saw and made themselves.

**Social possibilities from vegecultural practices**

Starch-rich palm pith (also known as sago) is likely to have been widely exploited throughout the history of rainforest occupation of the Indo-Malaysian Archipelago and Melanesia (Townsend 1990). The recovery of starch granules from sago palm at Niah Cave in deposits dated to 40,000 years ago provides the first evidence of a long chronology for the use of this plant in Southeast Asia (Barton 2005). There are a wide variety of palms that produce ‘sago’ (Table 1). Of these, two genera are the most important food resources across the region, *Metroxylon* (New Guinea swamp sago)and *Eugeissona* (Borneo hill sago). These palms produce varieties that can reproduce asexually via suckers and produce multiple stems.

*Metroxylon sagu*, swamp sago, is the variety that is now most widespread geographically. Its original prehistoric distribution included New Guinea, the centre of its greatest diversity, and probably did not occur west of the Moluccas (Flach 1997:24). The palm is now widely dispersed throughout New Guinea and Southeast Asia, probably via human agency, though over what time period this occurred is presently unknown. While there are many described variants in the phenotype, or landraces, of the palm, recent 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). *Eugeissona utilis*, has a far more restricted distribution, confined to the Malay Peninsula and the highlands of Borneo. It is the species of sago primarily relied on by the Penan (Brosius 1986). Both species are very similar in their growth habit and the manner in which starch is extracted.

The extraction of starch from the pith of all palm sago is labour intensive (Anderson 1979; Brosius 1986; Harrisson 1949; Townsend 2003; Ulijaszek and Poraituk 1993) but the energetic yields are high (Table 1). Ellen (2006: 288) calculated for the Nuaulu of Seram that up to 902 kilocalories per head per day came from the production of *Metroxylon sagu*. A single day of sago extraction by a nuclear family of Penan near Bario produced c.19 kg wet weight of sago from about 8 m of trunk (Barton pers. obs. 2005). Sago palms are a singularly excellent source of carbohydrate in tropical rainforest.

Both Ellen (2006) for the Nuaulu and Puri (1997) and Brosius (1986) for the Penan, consider that monospecific stands of sago are anthropogenic artefacts, created and maintained through the method of harvesting and, for the Nuaulu, by vegetative propagation. While there is much more contextual information about the use of *Metroxylon sagu* from PNG and amongst groups such as Nuaulu, in both systems use/harvesting and transplanting is a socially embedded practice with particular rules of management and ‘ownership’. Amongst the Penan, the term ‘molong’ is used to refer to the practice of managing or preserving useful forest products. Puri defines the term as ‘in part a resource management technique, and in part a tree tenure system’ (Puri 1997: 209). In both groups ‘ownership’ by individuals is either denoted by marking the tree in some way, clearing surrounding vegetation, or rights may be established by the individual who first transplanted a sucker or seedling. Such rights may be passed on (Ellen 2006: 290; Puri 1997: 207). Ellen argues that ‘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’ (2006: 289). Among the Dusun of northeastern Borneo, as with fruit trees, every sago clump has an owner who may sell the standing trunk. These rights only include the trunk specified and do not give future rights to other trunks in the clump nor to future production from the same clump (Rutter 2007 [1929]: 96). Amongst other groups in Borneo such as the coastal Melanau and Iban, sago palms were personal property and heritable (Ling Roth 1980 [1896]: 420; Morris 1953, 1991).

Amongst the Penan Benalui, the first act of claiming a new sago palm involves marking the tree, either with a stick or by carving initials in the bark. For sago palms, the new owners will also prune branches and clear the area around the tree of weeds and vines that is also thought to encourage a better production of starch (Puri 1997:208; Townsend 2003: 9). Examples of small-scale social investments of this kind are widespread throughout the tropics, including examples from northern Australia:

Most importantly, some plant communities may have been not merely modified but created by Aboriginal cultural activity. Aboriginal interactions with plants are the outcome of strategies which include not only physical resource exploitation, but as well systems of locality and territoriality that recognize ties between particular individuals and groups and particular home environments (Hynes and Chase 1982: 38).

Cereal crops in a vegetative world

In contrast to this the production of rice by field and seed would appear to be physically and conceptually on another plane. Its success lies outside the forest, not within it. You have to cut a chunk of forest out and keep pushing at its edges to make spaces for rice. Within a forest that has become, over a long period of time, an artefact of human behaviour – a socio-biological domain, where and whom would have made the first cut?

Penan and resistance to rice

**Domesticated rice in a vegetative world?**

**Rice in island Southeast Asia**

The rice plant has a singular role in island Southeast Asia, it lives and thrives in a singular duality as a sacred and secular plant; a symbol of status and wealth and social stratification, and frequently important in ceremonial and ritual function (Hayden 2003; Janowski 2007; Persoon 1992: 196; Sellato 1994: 212;). Where rice cultivators live alongside non-rice dependent peoples, the latter are often looked down upon as inferior and uncivilised beings (Persoon 1992: 196) a view which may weigh heavily on the shoulders of those groups who themselves who for their own reasons are not reliant on rice (Nicolaisen 1986: 76). Amongst the Kelabit of Sarawak, respectable social adults ought to be able to provide enough rice for their family and may gain additional prestige if they can provide enough excess to shift rice into systems of feasting and the purchase of prestige items (Janowski 1996: 58). Rice fermented into an alcoholic beverage is often used in festival activities and for participants engaged in cooperative labour or the construction of major earthworks such as drainage ditches, …

The evidence for the appearance of domesticated rice (*Oryza sativa*) in island Southeast Asia is tantalisingly scant and also surprisingly early (Barker 2006; see Figure 1). Possibly the most reliable early date is that of charred rice remains and inclusions in pottery occur at the cave of Gua Sireh in western Sarawak dated to 4840-4100 cal BP (ANU 7049; Datan 1993: 116). A grain included in pottery fabric at Niah is dated by association within a burial to c.4,300 BP (Barker 2006: 223), and rice husks in pottery recovered from the site of Andarayan in northern Luzon date to c.3,500 BP (Bellwood 2004: 31). Most recently pollen grains identified as ‘unequivocal cereal grains in all aspects similar to modern rice pollen’ have been recovered from a core nearby the Niah caves dated to c.6,000 BP (Hunt and Rushworth 2005: 467). Given that four species of wild rice (*O. meyeriana, O. officinalis, O. ridleyi, O. rufipogon*) are known to grow in Borneo (Vaughan 2002;Vaughan et al. 2005) more work is required to secure this early evidence for the presence of domesticated rice in the region.

At this early period the rarity of domesticated rice in the archaeological record in island Southeast Asia, is currently argued to be largely a problem of visibility and taphonomy. It is thought to be somewhere in the landscape, but remains difficult to detect – as indeed are many plant remains. However, given the landscape transformations that might be associated with its growth and use, evidence of rice grains alone is not likely to represent evidence of widespread ‘cultivation’. Although the archaeobotanical evidence is scant, and the convincing archaeological evidence for rice cultivation is actually quite late in the region, it is still argued that rice cultivation is spread very rapidly through island Southeast Asia during the mid-Holocene (Bellwood 2004, 2005; Glover and Higham 1996: 426).

However much of the historic literature paints a very different picture of this enigmatic crop. Even as late as the early 20th century in locations where rice held centre-stage as a plant of pre-eminence, this did not necessarily reflect its role in the daily subsistence. Amongst many groups in interior Borneo, rice remained a relatively minor crop –supplementing other starchy staples, frequently root crops (Harrisson 1949: 142) that could be grown in greater quantity and were considered more reliable come harvest. 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 2007 [1929]: 75). Wild fruits and sago was also considerably important, thought the latter more so in the swampy lowlands (Rutter 2007 [1929]: 96) which suggests it may be the introduced swamp sago, *Metroxylon sagu* Rott. Root crops and sago (indigenous *Eugeissona utilis*, *Caryota* spp., and *Arenga* spp.) were also important foodstuffs in the interior uplands of Borneo (Harrisson 2008 [1959]: 66) though groups such as the Kelabit state emphatically that their staple food has always been rice (Janowski 1996: 56). However, even here the familiar range of taros and the South American plants, cassava, sweet potato, maize, may all contribute significantly to caloric intake. In a review of the Kelabit highlands, Harrisson (1964) considered it highly likely that root crops and sago palms were major staples until the early 20th Century and was certainly part of the diet of hunting and trading parties away from the villages (Harrisson 2008 [1959]: 66). In his assessment of the pre 1960s irrigated rice fields of the Kelabit, Harrisson thought them uncharacteristic of wet rice elsewhere and overly elaborate; possibly a relic of an early agricultural system; one that may have been based on root crops and sago (Harrisson 1964: 333, 1965: 139). Recent archaeological survey in the region (Barker *et al.* in press) noted that stands of hill sago, *Eugeissona utilis,* were common near old settlement locations, though local informants impressed upon us the role of this palm to provide ancillary materials such as fronds for thatching and wood for craft (Barton pers. obs. 2008). While undoubtedly these and other starch producing palms fulfilled a multiplicity of economic roles, it seems highly likely that these palms were, at some time, deliberately cultivated in the interior of Borneo. Other interior groups such as the Kajang, Kejaman, and Dusun remained heavily reliant on sago and taro as staples or important supplements when the rice crop was poor well into the 19th Century (Nicholaisen 1986; Rutter 2007 [1929]; Strickland 1985). Even where rice was considered the main staple, such as amongst the Kayan and Iban, gardens retained the familiar suite of root crops (taro, cassava, sweet potato) and sago (Christensen 2002; Freeman 1955: 54; Low 1980 [1896]: 407-408; Rousseau 1977: 146).

Stone tools thought to be associated with sago processing have been collected from various parts of the interior uplands (Sarawak, Sabah and Kalimantan) historically referred to as the Kelabit-Murut country (Harrisson 1951). These implements are as yet undated, and none were noted in use in the historic records or oral traditions of the interior. They are usually referred to as sago pounders and/or conical pounders (Collings 1949; Haddon 1900; Harrisson 1951, 1965), and mistakenly by Harrisson (1951) as ‘cyclons’ in reference to Australian tools of similar form, which should be properly referred to as ‘cylcons’ or cylindro-conical implements, after Etheridge (1916). Given the additional ritual significance and variation in form of the Australian material, the implements from Borneo are probably better referred to as ‘conical pounders’. None have yet been recovered from the Malay Peninsula, but within the collection of stone implements from the highland region these tools out number polished stone adzes by at least thirty to one (Harrisson 1951: 534). A recent usewear and residue analysis of four conical pounders from the Sarawak Museum collection confirms their role as pounding tools for processing palm starch (Barton pers. obs. 2008; Barton 2009, in prep). These implements were carefully manufactured, usually from quartzite, and are variously worn, sometimes with extensive silica gloss on their cupped working face (Barton pers. obs. 2008). These objects are usually found without provenance, in river beds or during work in rice fields. They are clearly from a period in the prehistoric past, when palm sago was extensively processed. It is not known to which group these implements properly belong, as the remaining nomadic and settled Penan now use a wooden adze called a *puloo* for the job of chopping out the pith from the felled trunks of sago palm.

Arguments about the late adoption of rice in island Southeast Asia are not new. Even Bellwood (1978) was willing to concede that rice as a major crop may have been as late as 1500 AD and possibly expanded only after European contact. Recent analysis of rice phytoliths from the site of Alangkanangnge, South Sulawesi indicate that rice may have persisted as a minor plant for several thousand years here (based on data from Paz (2005)), but only grew in importance after AD 1300 tied in with the fluorescence of trade and exchange systems regionally (Bulbeck and Caldwell 2008: 15). In the Marianas, Micronesia, rice remains occur in very low frequency after 1,000 AD and occur primarily as inclusions in pottery (Hunter et al. 1995). There is no real evidence that rice was pursued as a major staple until after European contact in the 14th Century, where it was linked with exchange systems and the movement of prestige goods (Hunter et al. 1995). Similarly, the late adoption of rice in the interior of Borneo has also been suggestively linked to the late spread and availability of iron tools there after AD 700 (Harrisson 1964). Iron, while it may not be a requirement for swidden systems of cultivation or for the clearance of timber, it was considered to make the job much easier. Several interior groups such as the Lun Dayeh, appear to have always traded for iron tools and individuals can still remember times a village of over twenty households owned only one bush knife (Padoch 1985: 286).

Small quantities of rice appearing in sites like Niah and Gua Sireh in Sarawak and Andarayan in Taiwan, might also be explained as the result of exchanges between people, which were perhaps more about cultivating social relationships than cultivating plants. Rice moved via exchange would readily accommodate early dates outside known centres of agricultural production. Perhaps rice represented more than just the idea of food, but the idea of another or exotic way of cultivating plants and living? In this context, we might only expect to find small quantities of rice in archaeological sites, and a pattern or distribution that would appear rather haphazard. It is also possible that the incorporation of small quantities of rice into other materials such as pottery might not have resulted from accidental or serendipitous events. It could also be explained as a result of deliberate strategies, recycling or transferring values associated with rice into other objects, such as Morris (1994) has argued for the use of ground up pot – grog - in other pots: an act of inclusion, transferring ancestral values through generations of pottery.

Long distance movements of other materials throughout island Southeast Asia include westward as well as eastward trajectories. Obsidian from Talaesea in New Britain appears at the site of Bukit Tengkorak in Sabah around 3,000-2,000 years ago; a journey of some 3000 kilometres (Bellwood 2005). The Asian trade in plumes from the New Guinea Birds of Paradise dates from just prior to 2000 years until 300 AD (Swadling 1996: 272). Systems of exchange appear to have a deep antiquity in island Melanesia with the exchange of obsidian dating back to at least 20,000 BP (Specht 2005). Trade valuables such as obsidian stemmed tools appear to have been circulating between mainland New Britain, New Guinea and smaller islands up to 2,000 kilometres away from c.5,900 cal BP to shortly after 3,600 cal BP (Rath and Torrence 2003; Torrence and Swadling, in press). The farmer-voyager model of Bellwood’s (e.g. 2005) is primarily a one-way system, pushing material through Oceania, but the prehistory of transactions in the region, indicates that this is unlikely to have been the only or dominant pattern of movement. For example, recent consideration of the antiquity of patterns of exchange in Melanesia, provide plausible alternatives to the rapid spread of material culture like Lapita pottery. Objects picked up on the circumference of one ‘sphere of influence’ are rapidly moved through a network of adjoining or abutting systems, covering vast geographic distances in the process (Torrence and Swadling, in press).

Alongside the potential value of rice as a commodity for exchange is a hypothesis of resistance to rice, or at least of much greater resilience, within systems of cultivation based on vegeculture. Are the behavioural differences necessary to cultivate and reproduce a plant such as rice significant for the way people respond to, or exploit that reproductive potential? What would a people make of a ‘practice’ of reproducing annually from seed rather than from the ‘body’ of the plant that is achieved with many vegecultural staples? What social conditions might regulate the adoption of planting seeds in a cultural milieu suffused with vegecultural meanings?

**Grafting *not* replacement**

The voyager model of Bellwood’s spread of Austronesian rice farmers presupposes the existence of absence in island Southeast Asia. Farmer-voyagers are seen as moving goods and new practices between islands, ultimately colonising a landscape of relatively unsophisticated hunter-gatherers. As people moved through these landscapes of islands with their rice, its disappearance eastwards is usually linked to problems of its cultivation and concomitant shifts by active farmers to new cultivated staples.

A long history of rainforest occupation across the regions of Island Southeast Asia and Melanesia, evidenced both by the albeit limited archaeological evidence and plant histories for several domesticates, offers another reading of the data. People-plant relationships across this region were being established from the Pleistocene. These domesticatory relationships entailed vegetative propagation and transplantation, accumulating in intra- and inter-regional dispersal of plants. Long-developed domesticatory relationships were not something that belonged to a separate ‘economic’, ‘energetic’ or ‘production’ realm, rather they were socially and spatially entangled. Domesticatory relationships, social structures, beliefs, places and identities were, and still are, commingled. The persistence of these domesticatory relationships in New Guinea is well-attested, and the resilience of such relationships in Borneo signifies a resistance to cultural assimilation by putatively dominant Austronesian-language speakers.

The mode of resistance can perhaps be seen through the relatively late adoption of rice by groups in Borneo; both archaeological and palaeoecological evidence to support an alternative interpretation are weak. Rice cultivation did not sweep all before it after the introduction of rice to the region. Instead rice may have primarily been an exotic trade item, or a minor sexually reproduced, seed crop in a vegetatively dominated world. Rice cultivation, and perhaps seed-based cultivation of plants, was grafted onto, or incorporated into, pre-existing practices. Perhaps the concept of grafting is more appropriate to understand the long interaction of Austronesian language-speakers with pre-existing populations in Borneo, and perhaps other regions of Island Southeast Asia, than replacement.

The histories of plant cultivation in Southeast Asia are likely to be far more complex than is currently allowed with a farmer-voyager hypothesis. Recent archaeobotanical analyses and studies on plant genetics suggest a far more nuanced and deeper history of people-plant relationships in the region. Long histories of plant manipulation, incipient cultivation and cultivation with domesticates are likely to constitute an entanglement of process giving rise to a variety of systems of cultivation based on genetically wild and domesticated plants, or combinations of both.

We believe that the archaeological and palaeo-environmental record at Kuk Swamp shows that agriculture there arose gradually from pre-existing foraging practices– of which vegeculture and transplanting were key and ancient practices. The archaeological and botanical record at Niah offers us a similar potential. It seems highly improbable that Borneo was isolated from wider social spheres of interaction before proposed Austronesian expansion in the mid-Holocene. The occurrence of obsidian from New Britain in Sabah, and the movement of other materials including plants from New Guinea westwards, indicates a rather dynamic picture of prehistoric interactions preceding hypothesised Austronesian expansion.

We suggest that the archaeological record at Niah and the early dates of rice in island Southeast Asia may be the artefact of a history of resistance to rice as a cultivar that might be better thought of as being *grafted* onto, rather than replacing, pre-existing and long-held people-plant relationships that had been established since the Pleistocene. People and plants were mutually entangled: changes in the forest and changes in plants were embedded in the way people used that landscape and were socially connected to each other. Large parts of island Southeast Asia and Melanesia may share a common heritage in a geographically dispersed people-plant continuum that was not swept aside with the introduction of new plants and new ways of doing things; rather the records exhibit considerable resilience in favour of maintaining existing social and domicultural practices.

**Tables**

**Table 1.** Starch producing palms from the Old World.

|  |  |
| --- | --- |
| Major Genera | Species |
| *†Arenga* | *brevipes* |
|  | *undulatifolia* |
|  | *pinnata* |
| *Corypha* | *utan* |
|  | *umbraculifera* |
|  | *utan* |
| *Caryota* | *mitis* |
|  | *no* |
| *†Eugeissona* | *insignis* |
|  | *utilis* |
| *†Metroxylon* | *sagu* |
| Minor Genera |  |
| *Acrocomia* |  |
| *Borassus* |  |
| *Phoenix* |  |
| *Pholidocarpus* |  |
| *Raphia* |  |

†multi-stemmed varieties which can be vegetatively propagated and one plant managed as a long-term resource.

(Ruddle et al. 1978)

**References**

Anderson, A J U (1979) Subsistence of the Penan in the Mulu Area of Sarawak, *Sarawak Gazette* 105.

Anshari, G, Kershaw, AP, van der Kaars, S (2001) A late Pleistocene and Holocene pollen and charcoal record from peat swamp forest, Lake Sentarum Wildlife Reserve, West Kalimantan, Indonesia *Palaeogeopgraphy, Palaeoclimatology, Palaeoecology* 171: 213-228.

Bailey, RC, Head, G, Jenike, M, Owen, B, Reichtman, and Zechenter, E (1989) Hunting and gathering in tropical rainforest: Is it possible? *American Anthropologist* 91: 59-82.

Barker, G (2006) *The Agricultural Revolution in Prehistory*, Oxford: Oxford University Press.

Barker, G, Barton, H, Beavitt, P, Chapman, S, Derrick, M, Doherty, C, Farr, L, Gilbertson, D, Hunt, C, Jarvis, W, Krigbaum, J, Maloney, B, McLaren, S, Pettit, P, Pyatt, B, Reynolds, T, Rushworth, G and Stephens, M (2000) The Niah Caves Project: Preliminary Report on the First (2000) Season, *Sarawak Museum Journal* 55: 111-149.

Barker, G., Badang, D., Barton , H., Beavitt, P., Bird, M., Daly, P., Doherty, P., Gilbertson, D., Glover, I., Hunt, C., Manser, J., McLaren, S., Paz, V., Pyatt, B., Reynolds, T., Rose, J., Rushworth, G., & M. Stephens. The Niah Caves Project: The Second (2001) Season of Fieldwork. *Sarawak Museum Journal* 56: 37-119.

Barker, G. Barton, H., Bird, M., Cole, F., Daly, P., Gilbertson, D., Hunt, C., Krigbaum, J., Lampert, C., Lewis, H., Lloyd-Smith, L., Manser, J., McLaren, S., Menotti, F., Paz, V., Piper P., Pyatt, B., Rabett, R., Reynolds, T., Stephens, M., Thompson, J., Trickett, M., & P. Whittaker. The Niah Cave Project: The third (2002a) season of fieldwork. *Sarawak Museum Journal* 57: 87-177.

Barker, G., Barton, H., Beavitt, P., Bird, M., Daly, P., Doherty, C., Gilbertson, D., Hunt, C., Krigbaum, J., Lewis, H., Manser, J., McClaren, S., Paz, V., Piper, P., Pyatt, B., Rabett, R., Reynolds, T., Rose, J., Rushworth, G., Stephens, M (2002b) Prehistoric Foragers and Farmers in South-east Aisa: Renewed Investigations at Niah Cave, Sarawak, *Proceedings of the Prehistoric Society* 68: 147-164.

Barker, G., Barton, H., Bird, M., Cole, F., Daly, P., Dykes, A., Farr, L., Gilbertson, D., Higham, T., Hunt, C., Knight, S., Kurui, E., Lewis, H., Lloyd-Smith, L., Manser, J., McLaren, S., Menotti, F., Piper, P., Pyatt, B. Rabett, R., Reynolds, T., Shimmin, J., Thompson, J., and M. Trickett. The Niah Cave Project: the fourth (2003) season of fieldwork. *Sarawak Museum Journal* 58: 45-119.

Barker, G., Barton, H., Bird, M., Daly, P., Datan, I., Dykes, A., Farr, L., Gilbertson, D., Harrisson, B., Hunt, C., Higham, T., Kealhofer, L., Krigbaum, J., Lewis, H., McLaren, S., Paz, V., Pike, A., Piper, P., Pyatt, B., Rabett, R., Reynolds, R., Rose, J., Rushworth, G., Stephens, M., Stringer, C., Thompson, G, and Turney, C. (2007) The ‘human revolution’ in lowland tropical Southeast Asia: the antiquity and behaviour of anatomically modern humans at Niah Cave (Sarawak, Borneo). *Journal of Human Evolution*, 52: 243-261.

Piper, P. J., Barker, G, and Szabo, K (submitted) Early Upper Palaeolithic Hunting and Gathering in a Tropical Rainforest. *American Antiquity*

Barton, H (2005) The case for rain forest foragers: the starch record at Niah Cave, Sarawak, in Baker, G, and Gilbertson, D (eds) *The Human Use of Caves in Peninsula and Island Southeast Asia*, Special volume of Asian Perspectives 44: 56-72.

Barton, H, Paz, V (2007) Subterranean Diets in the Tropical Rain Forests of Sarawak, Malaysia, in Denham, T, Iriarte, J, and Vrydaghs, L (eds) *Rethinking Agriculture: Archaeological and Ethnoarchaeological Perspectives*, One World Archaeology, pp 50-77, Walnut Creek: Left Coast Press.

Barton, H, White, JP (1993) Use of stone and shell artefacts at Balof 2, New Ireland, Papua New Guinea *Asian Perspectives* 32(2): 169-81.

Barton, H, Piper, P, Rabett, R, Reynolds, T, Paz, V with contributions by Gilbertson, D, Hunt, C, Kealhofer, L, Krigbaum, J, Lewis, H, Thompson, G, Szabo, K and Shimmin, J (in prep a) Late Pleistocene Foragers, c.38,000 to 12,000 years ago, in Barker, G, Gilbertson, D and Reynolds, T (eds), *Rainforest Foraging and Farming in Island Southeast Asia: The Archaeological and Environmental History of the Niah Caves, Sarawak*, Cambridge: McDonald Institute Monographs.

Barton, H, Piper, P, Rabett, R, and Reeds I (in prep b) Terminal Pleistocene organic technology from Southeast Asia; bone and stingray bipoints from Niah Cave, Sarawak, Malaysia.

Bellwood, P (1997) *Prehistory of the Indo-Malaysian Archipelago*, Revised Edition, Honolulu: University of Hawai’i Press.

Bellwood, P (2004) The Origins and Dispersals of Agricultural Communities in Southeast Asia, in Glover, I, and Bellwood, P (eds), *Southeast Asia: From prehistory to history*, pp. 21-40. London: RoutledgeCurzon.

Bellwood, P (2005) *First Farmers*, Oxford: Blackwell Publishing.

Bourdieu P (1990) *The logic of practice*, Oxford: Polity Press.

Bourke, RM and Harwood, T, editors, (2007) *Kaikai, mani na graun: agriculture in Papua New Guinea*, Canberra: Land Management Group, Australian National University.

Brosius,P (1986) River, Forest and Mountain: The Penan Gang Landscape, *Sarawak Museum Journal* 35: 173-184.

Burkill, IH (1966) *A Dictionary of the Economic Products of the Malay Peninsula*, Singapore: Government Printer.

Carreel, F, Gonzalez de Leon, D, Lagoda, P, Lanaud, C, Jenny, C, Horry, J P and Tezenas du Montcel, H (2002) Ascertaining maternal and paternal lineage within *Musa* chloroplast and mitochondrial DNA RFLP analyses, *Genome* 45: 679-92.

Christensen, H (2002) *Ethnobotany of the Iban and the Kelabit*, NEPCon, University of Aarhus: Forest Department Sarawak.

Chickwendu, V E, Okezie, C E A (1989) Factors responsible for the enoblement of African yams: Inferences from experiments in yam domestication, in Harris, D R, and Hillman, G C (eds), *Foraging and Farming: The Evolution of Plant Domestication*, pp. 344-357, London: Unwyn Hyman.

Datan, I (1993) *Archaeological excavations at Gua Sireh (Serian) and Lubang Angin (Gunung Mulu National Park), Sarawak, Malaysia,* The Sarawak Museum Journal, Special Monograph No. 6.

De Langhe, E and de Maret, P (1999) Tracking the banana: Its significance in early agriculture, in Gosden, C and Hather, J (eds), *The prehistory of food: Appetites for change,* pp.377–396. London & New York: Routledge.

Denham, T (2005a) Envisaging early agriculture in the Highlands of New Guinea: landscapes, plants and practices, *World Archaeology* 37(2): 290-306.

Denham, T (2005b) Agricultural origins and the emergence of rectilinear ditch networks in the highlands of New Guinea, in Pawley, A, Attenborough, R, Golson, J and Hide, R (eds), *Papuan pasts*: *cultural, linguistic and biological histories of Papuan-speaking peoples*, pp. 329-61. Pacific Linguistics 572. Canberra: RSPAS, ANU.

Denham, T (2007) Thinking about plant exploitation in New Guinea: towards a contingent interpretation of agriculture, in Denham, T, Iriarte, J and Vrydaghs, L (eds), *Rethinking agriculture: archaeological and ethnoarchaeological perspectives*,pp. 78-108. Walnut Creek: Left Coast Press.

Denham, T (submitted) From domestication histories to regional prehistory: Using plants to re-evaluate early and mid-Holocene interaction between New Guinea and Southeast Asia, *Food & History*

Denham, T and Barton, H (2006) The emergence of agriculture in New Guinea: A model of continuity from pre-existing foraging practices. In Kennett D.J. and Winterhalder. B. (eds), *Behavioral Ecology and the Transition to Agriculture*, pp. 237-264, California: University of California Press.

Denham, T and Haberle, S G (2008) Agricultural emergence and transformation in the Upper Wahgi valley during the Holocene: theory, method and practice. *The Holocene* 18(3): 499-514.

Denham, TP, Haberle, SG, Lentfer, C, Fullagar, R, Field, J, Therin, M, Porch, N, Winsborough, B (2003) Origins of agriculture at Kuk Swamp in the highlands of New Guinea *Science* 301: 189-193.

Denham, T, Golson, J and Hughes, P J (2004a) Reading early agriculture at Kuk (Phases 1-3), Wahgi Valley, Papua New Guinea: the wetland archaeological features, *Proceedings of the Prehistoric Society* 70: 259-98.

Denham, T, Haberle, S G and Lentfer, C (2004b) New evidence and interpretations for early agriculture in Highland New Guinea, *Antiquity* 78: 839-57.

Donoghue, D (1989) Carbonised plant fossils, in Beck, W, Clarke, A and Head, L (eds), *Plants in Australian Archaeology*, pp. 90-100. St Lucia: University of Queensland. Tempus 1.

Dwyer, P and Minnegal, M (1991) Hunting in lowland, tropical rain forest: towards a model fo non-agricultural subsistence. *Human Ecology* 19: 187-212.

Ellen, R (2006) Local Knowledge and Management of Sago Palm (*Metroxylon sagu* Rottboell) Diversity in South Central Seram, Maluku, Eastern Indonesia, *Journal of Ethnobiology* 26(2): 258-298.

Fairbairn, A S, Hope, G S, and Summerhayes, G (2006) Pleistocene occupation of New Guinea’s highland and subalpine environments, *World Archaeology* 38(3): 371-386.

Flach, M (1997) *Sago Palm* Metroxylon sagu *Rottb.*, International Plant Genetic Resources Institute, Rome.

Fullagar, R., Field, J., Denham, T., and Lentfer, C., (2006) Early and mid-Holocene tool-use and processing of taro (*Colocasia esculenta*), yam (*Dioscorea alata*) and other plants at Kuk Swamp in the highlands of Papua New Guinea, *Journal of Archaeological Science* 33, 595-614.

Fuller, D Q and Madella, M (2001) Issues in Harappan archaeobotany: retrospect and prospect, in Settar, S and Korisettar, P (eds) *Indian archaeology in retrospect. Vol. 2. Protohistory*, pp. 317-90. New Delhi: Manohar.

Gimlett, J D (1915) *Malay Poisons and Charm Cures*, London: J & A Chruchill.

Glover, I C, and Higham, C F W (1996) New evidence for early rice cultivation in South, Southeast and East Asia, in Harris, D (ed.) *The Origins and Spread of Agriculture and Pastoralism in Eurasia*, pp. 413-441, London: UCL Press Ltd.

Golson, J (1977) No room at the top: agricultural intensification in the New Guinea Highlands, in Allen, J, Golson, J and Jones, R (eds), *Sunda and Sahul: prehistoric studies in southeast Asia, Melanesia and Australia*, pp. 601-38. London: Academic Press.

Golson, J (1991) The New Guinea Highlands on the eve of agriculture. *Bulletin of the Indo-Pacific Prehistory Association* 11: 82-91.

Gosden, G (1999) *Antrhropology and archaeology: a changing relationship,* Routledge: London.

Groube, L (1989) The taming of the rain forests: a model for Late Pleistocene forest exploitation in New Guinea, in Harris, D R, and Hillman, G C (eds) *Foraging and Farming,* One World Archaeology, pp. 292-304, London: Unwyn Hyman.

Harrisson, T (1949) Notes on some nomadic Punans, *Sarawak Museum Journal* 5(1): 130-146.

Haberle, S G (1995) Identification of cultivated *Pandanus* and *Colocasia* in pollen records and the implications for the study of early agriculture in New Guinea, *Vegetation History and Archaeobotany* 4: 195-210.

Haberle, S G (2007) Prehistoric human impact on rainforest biodiversity in highland New Guinea. *Philosophical Transactions of the Royal Society (B)* 362, 219-28.

Haberle, S G, Hope, G S and de Fretes, Y (1991) Environmental change in the Baliem valley, montane Irian Jaya, Republic of Indonesia. *Journal of Biogeography* 18: 25-40.

Harris, DR (1989) An evolutionary continuum of people-plant interaction, in Harris, DR and Hillman, GC (eds) *Foraging and Farming: The Evolution of Plant Exploitation*, pp 11-26. London: Unwin-Hyman.

Hather, JG (1996) The origins of tropical vegeculture in Southeast Asia in Harris, DR (ed) *The Origins and Spread of Agriculture and Pastoralism in Eurasia*, pp 538-551. London: UCL Press.

Hodder, I (1990) *The Domestication of Europe: Structure and Contingency in Neolithic Societies,* Oxford: Basil Blackwell

Hope, G S and Golson, J (1995) Late Quaternary change in the mountains of New Guinea. *Antiquity* 69: 818-30.

Hope, G, Kershaw, AP, van der Kaars, S, Xiangjun, S, Liew, P-M, Heusser, LE, Takahara, H, McGlone, M, Miyoshi, N, Moss, PT (2004) History of vegetation and habitat change in the Austral-Asian region *Quaternary International* 118-119: 103-126.

Hughes, C E, Govindarajulu, R, Robertson, A, Filer, Denis, L, Harris, S A, and Donovan Bailey, C (2007) Serendipitous backyard hybridization and the origin of crops, *Proceedings of the National Academy of Sciences of the United States of America*, 104: 14389-14394.

Hunt, C O, and Rushworth, G (2005) Cultivation and human impact at 6000 cal yr B.P. in tropical lowland forest at Niah, Sarawak, Malaysia Borneo, *Quaternary Research* 64: 460-468.

Hynes, R A, and Chase, A K (1982) Plants, sites and domiculture: Aboriginal influence on plant communities in Cape York Peninsula, *Archaeology in Oceania* 17: 38-50.

Ingold, T (2000) *The Perception of the Environment*, London: Routledge.

Kealhofer, L (1994) The Human Environment During the Terminal Pleistocene and Holocene in Northeastern Thailand: Phytolith Evidence from Lake Kumphawapi. *Asian Perspectives*  35: 229-253.

Kennedy, J and Clarke, W (2004) *Cultivated Landscapes of the Southwest Pacific*, Resource Management in Asia-Pacific, Working Paper No. 50, Canberra: Resource Management in Asia-Pacific Program.

Ketan, J and Muke, J (2001) *A site management plan for the Kuk World Heritage project in Papua New Guinea*. Port Moresby: UNESCO (National Commission PNG) and University of PNG.

Kjær, A, Barfod, A S, Amussen, C B, Seberg, O (2004) Invegstigation of Genetic and Morphological Variation in the Sago Palm (*Metroxylon sagu*; Arecaceae) in Papua New Guinea, *Annals of Botany* 94: 109-117.

Lebot, V (1999) Biomolecular evidence for plant domestication in Sahul, *Genetic Resources and Crop Evolution* 46: 619-628.

Lebot, V, Prana, M S, Kreike, N, van Heck, H, Pardales, J, Okpul, T, Gendua, T, Thongjiem, M, Hue, H, Viet, N and Yap, T C (2004) Characterisation of taro (*Colocasia esculenta* (L.) Schott) genetic resources in Southeast Asia and Oceania, *Genetic Resources and Crop Evolution* 51: 381-92.

Lebot, V., Trilles, B, Noyer, J L and Modesto, J (1998) Genetic relationships between Dioscorea alata L. cultivars, *Genetic Resources and Crop Evolution* 45: 499-509.

Lejju, B J, Robertshaw, P and Taylor, D (2006) Africa’s earliest bananas?, *Journal of Archaeological Science* 33: 102-13.

Loy, T, Wickler, S, Spriggs, M (1992) Direct evidence for human use of plants 28,000 years ago: starch residues on stone artifacts from the northern Solomon Islands *Antiquity* 66: 898-912.

Malapa, R, Arnau, G, Noyer, J L and Lebot, V (2005) Genetic diversity of the greater yam (*Dioscorea alata* L.) and relatedness to *D. nummularia* Lam. and *D. transversa* Br. as revealed with AFLP markers, *Genetic Resources and Crop Evolution* 52: 919-29.

Matthews, P J (2004) Genetic diversity in taro, and the preservation of culinary knowledge, *Ethnobotany Research and Applications* 2: 55-71.

Mbida Mindzie C, Doutrelpont, H, Vrydaghs, L, Sewennen, R L, Swennen, R J, Beeckman, H, de Langhe, E and de Maret, P (2001) First archaeological evidence of banana cultivation in central Africa during the third millennium before present, *Vegetation History and Archaeobotany* 10: 1-6.

Morris, E L (1994) The pottery: In Excavations at a Late Bronze Age Settlement in the Upper Thames Valley at Shorncote Quarry near Cirencester, 1992, *Transactions of the Bristol and Gloucestershire Archaeological Society* CXII: 17-57.

Pavlides, C, and Gosden, C (1994) 35,000 year old sites in the rainforest of New Britain, Papua New Guinea. *Antiquity* 68: 604-610.

Powell, J M (1976) Ethnobotany, in Paijmans, K (ed), *New Guinea Vegetation*, pp 106-83, Canberra: Commonwealth Scientific and Industrial Research Organisation and Australian National University Press.

Powell, J M (1982) Plant resources and palaeobotanical evidence for plant use in the Papua New Guinea Highlands, *Archaeology in Oceania* 17: 28-37.

Puri, R K (1997) Penan Benalui Knowledge and Use of Tree Palms, in Sorensen, K W, and Morris, B (eds), *People and Plants of Kayan Mentarang*, pp 194-226, London: WWF-IP/UNESCO.

Ruddle, K, Johnson, D, Townsend, P.K, Rees, J. D (1978) Palm Sago: A Tropical Starch from Marginal Lands. Canberra: Australian National University Press.Torrence, R, Swadling, P, Kononenko, N, Ambrose, W, Rath, P, Glasock, M (2008) Mid-Holocene social interaction in Melanesia: new evidence from hammer-dressed obsidian stemmed tools, *in press*.

Rath, P and Torrence R (2003) Producing value: Stemmed tools from Garua Island, Papua New Guinea, *Australian Archaeology* 57: 119-127.

Roscoe, P (2002) The hunters and gatherers of New Guinea, *Current Anthropology* 43(1): 153-162.

Specht, J (2005) Revisiting the Bismarcks: some alternative views, in Pawley, A, Attenborough, R, Golson, J and Hide, R (eds), *Papuan Pasts: cultural, linguistic and biological histories of Papuan-speaking peoples*, pp. 235-288, Canberra: Pacific Linguistics Research School of Pacific and Asian Studies.

Spriggs, M. (1995) The Lapita culture and Austronesian prehistory in Oceania, in Bellwood, P, Fox, J, and Tryon, D (eds), *The Austronesians: historical and comparative perspectives*, pp. 112-33. Canberra: Department of Anthropology, The Australian National University.

Strathern, A J (1971) *The rope of Moka: big-men and ceremonial exchange in Mount Hagen, New Guinea*. Cambridge: Cambridge University Press.

Swadling, P (1996) *Plumes from Paradise: Trade Cycles in Outer Southeast Asia and their Impact on New Guinea and Nearby islands until 1920*, Coorparoo, Australia: National Museum of Papua New Guinea in associates with Robert Brown and Associates.

Swadling, P, Araho, N and Ivuyo, B (1991) Settlements associated with the inland Sepik-Ramu Sea. *Bulletin of the Indo-Pacific Prehistory Association* 11: 92-112.

Terrell, JE (2002) Tropical agroforestry, coastal lagoons, and Holocene prehistory in greater near Oceania, in Shuji Y, Matthews, PJ (eds), *Vegeculture in Eastern Asia and Oceania*, pp 195-216. International Area Studies Conference VII, JCAS Symposium Series 16.

Townsend, P K (2003) *Palm Sago: Further Thoughts of a Tropical Starch from Marginal Lands,* Resource Management in Asia-Pacific Working Paper No. 49, Canberra: Resource Management in Asia-Pacific Program.

Torrence, R, Swadling, P (in press) Interaction spheres in Mid-Holocene Melanesia and their implications for the origin of Lapita pottery. *Antiquity,* in press.

Townsend, P (1990) On the possibility/impossibility of tropical forest hunting and gathering. *American Anthropologist* 92: 745-747.

Ulijaszek, Stanley J., and Simon P. Poraituk (1993) Making sago in Papua New Guinea: is it worth the effort? In C.M. Hladik, A. Hladik, O.F. Linares, H. Pagezy, A. Semple, and M. Hadley (eds), Tropical Forests, People and Food, pp. 271-80. Paris: UNESCO.

Vaughan, D A (2002) Biogeography of the genus Oryza across the Malay Archipelago. <http:///www.gramene.org/newsletters/rice_genetics/rgn8/v8p73.html> (24/04/2008).

Vaughan, D A, Kadowaki, K, Kaga, A, Tomooka, N (2005) On the Phylogeny and Biogeography of the Genus Oryza. *Breeding Science* 55: 113-122.

Yen, D E (1996) Melanesian aboriculture: historical perspectives with emphasis on the genus *Canarium*, in Evans, B R, Bourke, R M and Ferrar, P (eds), *South Pacific Indigenous Nuts*, pp 36-44, Canberra: ACIAR.

Yen, DE (1998) Subsistence to commerce in pacific agriculture: some four thousand years of plant exchange, in Pendergast, HDV, Etkin, NL, Harris, DR, Houghton, PJ (eds), *Plants for food and medicine*, pp 161-83. Royal Botanic Gardens, Kew.

Zuraina Majid (1982) The West Mouth, Niah, in the prehistory of Southeast Asia, *Sarawak Museum Journal* 31, Special Monograph No. 3.

**FIGURE CAPTIONS**

**Figure 1.** Geographical and historical representation of key trends in plant exploitation for Indo-Malaysia and New Guinea. References are provided in the text for data displayed.

**Figure 2.** Schematic representation of inter-relationships between vegecultural (re)production and social (re)production (inspired by John Muke’s observations of Meldpa-speaking groups)