Fruits and arboriculture in the Indo-Pacific region

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ABSTRACT

One unconscious bias that commonly creeps into accounts of the development and spread of agriculture is an emphasis on cereals and tubers. Since these are the basis of agriculture in the developed world, when students of prehistory construct narratives in the tropics they tend to focus on these classes of cultigen and to downplay both trees and herbs. The classic feature of distinguishing crops from their wild forbears in such narratives is morphological change, a criterion which may apply only weakly or not at all to trees and herbs. The domestication of tree products must be identified principally on distributional grounds as they are used and discarded far from their 'home' area.

Although prehistory in the Indo-Pacific region has begun to emphasise the importance of arboriculture in overall subsistence, it has been hamstrung by weak synchronic accounts of the taxonomy, origin and spread of the major and minor fruit trees. Recent ethnographic work has begun to remedy this situation, but has yet to be absorbed into archaeological models. Biogeography can therefore be of considerable importance in determining the evolution of arboricultural subsistence, especially in a region with so many islands, where settlement can be associated with the introduction of new species.

Another tool which has barely been used is comparative linguistics. Despite a relatively strong empirical base for the description of Pacific languages in general, rich ethnobotanical accounts of cultivated and protected trees are still scarce, reducing the potential to reconstruct the history of cultivated trees. But a variety of lexical databases do exist incorporating terms for major fruit species which can enable us to reconstruct a notional history. In addition, the diversity of language phyla on the SE Asian mainland allows us to unravel the routes whereby fruit cultivation spread, through the analysis of loanwords. The paper attempts an broad-brush survey of the role of fruit cultivation in the East Asia/ Pacific region.

1. Introduction

An unconscious bias that commonly creeps into accounts of the development and spread of agriculture is an emphasis on cereals and tubers. Since these are the basis of agriculture in the developed world, when students of prehistory construct narratives in the tropics they tend to focus on these classes of cultigen and to downplay both trees and herbs (although Harris, 1977, mentioned 'wild nuts' as one of his 'alternative pathways to agriculture'). The classic feature used to distinguish crops from their wild forbears in such narratives is morphological change, a criterion which may apply only weakly or not at all to these vegetation classes. As a consequence, the pattern of tree domestication must be identified largely on grounds of biogeography and current ethnography.

Although prehistory in the Indo-Pacific region has begun to emphasise the importance of arboriculture in overall subsistence, it has been hamstrung by weak synchronic accounts of the taxonomy, origin and spread of both major and minor fruit trees. Recent ethnophytogeographic work has begun to remedy this situation, but has yet to be absorbed into archaeological models. A combination of ethnographic accounts and biogeography can therefore be of considerable importance in determining the evolution of arboricultural subsistence, especially in a region with so many islands, where settlement is often co-associated with the introduction of new species. DNA analysis of the affinities of tropical fruiting genera has only just begun, but we may well expect the results to emend or revise radically the conclusions of phenotypic analyses, as in the case of the persimmon, where Yonemori *et al.* (1998) showed from the amplified cpDNA of *Diospyros* spp. in Thailand that its affinities were quite different from those proposed in NG (1978).

In the last few decades, there has been an expansion of reference material on Southeast Asian and Pacific fruits, notably Guillamin (1954), Massal & Barrau (1956), Allen (1975), Chin & Yong (1982), Sillitoe (1983), Morton (1987), Eisemann & Eisemann (1988), Henderson & Hancock (1989), Piper (1989), Verheij & Coronel (1992), Tarepe & Bourke (1992), Bourke (1994), Cooper & Cooper (1994), Othman & Subardhabandhu (1995), Tirtawinata et al. (1995), CIFOR (1996), Hutton (1996), Fernandez (1997), Walter & Sam (1999, 2002), Tate (2000), Puri (2001), Jensen (2001) and Mazumdar (2004). Some of these accounts are more scientific than others, and many include statements about the origins of fruit species that are highly speculative.

The recognition of the importance of arboriculture in the Indo-Pacific region should be attributed above all to the work of Douglas Yen (Yen 1974, 1977, 1985, 1992, 1994). Other useful studies are Barrau (1956, 1962), Ng (1975, 1976), Powell (1976, 1977), Mogea (1991), Lepofsky (1992), Gosden (1995) and Athens, Ward & Murakami (1996). One of the distinctive features of arboriculture is the high degree of variability in use and degree of domestication. With cereal agriculture, once a plant is domesticated, it will often not survive except as a cultivated plant, perhaps because it no longer has a shattering head. Trees, in contrast, often survive very well when ignored by humans. Lepofsky (1992:202) highlights the role on 'encouraged volunteers', i.e. protecting self-seeded species, in the arboriculture of the Mussau islands. Hence the literature is full of conflicting reports; a tree that is intensively cultivated on one island may be 'wild' on another. A tree that is a famine food at one site can be a highly appreciated delicacy elsewhere. It may be eaten as a fruit, or only grown for its flowers or for shampoo. This reflects both the changing ecology, when a species that yields well on one island may be barren elsewhere, leading to it becoming wild or being used for quite another purpose. This is very much in contrast to cereal agriculture, where the failure of a species in a new ecology usually leads to its being dropped altogether.

Archaeobotany has begun to make contributions in some areas; macro-remains have been recorded from a number of Pacific islands (e.g. Kirch 1989; Hayes 1992; Powell 1982) and also the mainland (for overview see Kyle Latinis 1999, 2000; Kyle Latinis & Stark 1998). But results from flotation are still few and far between, although the next few years should see a significant increase in results. Nonetheless, an overview of synchronic use of fruits and recent distributional information ought to assist archaeologists in interpreting their finds. A problem particular to trees is that it is often difficult to distinguish natural occurrences from human use, except where the context is unambiguous.

Another tool which remains underused is comparative linguistics. Despite a relatively strong empirical base for the description of Pacific languages in general, rich ethnobotanical accounts of cultivated and protected trees are still scarce, reducing the potential to reconstruct the history of cultivated trees. But a variety of lexical databases do exist incorporating terms for major fruit species thereby enabling us to reconstruct a notional history. Several papers have covered the reconstruction of plant names at various levels of Austronesian, including Verheijen (1984), Wolff (1994), Tryon (1994), Li (1994), Ross (1996), Lynch (2001), Blust (n.d.) and Reid (in press). Unfortunately, nothing like this exists for mainland phyla such as Austroasiatic, Daic, Sino-Tibetan or Hmong-Mien, so accounts based purely on Austronesian tend to give a one-sided picture. Although occasional detailed accounts of individual languages exist (e.g. Vidal 1962 for Lao), without comparative lexical databases this does not advance the project. However, the diversity of language phyla on the Southeast Asian mainland will sometimes allow us to unravel the routes whereby fruit cultivation spread, through the analysis of loanwords (e.g. Mahdi 1998).

Before accepting too uncritically the results of linguistics it is worth pointing out that reconstruction not counterpointed by biogeography has resulted in the publication of very misleading results. Dempwolff (1938) posits proto-Austronesian **nanas* and Li (1994) **paŋuDaN* for 'pineapple'. In reality, as Blust (n.d.) points out, the pineapple was carried from South America around the world by the Portuguese in the 16th century. The cognate set that served as basis for Dempwolff's reconstruction of **nanas* were all borrowings from Portuguese *ananas* 'pineapple', which in turn derives from a Tupi-Guarani language of Brazil. The cognate set for **paŋuDaN* are terms that have been transferred from the pandanus, the fruit of which looks similar to the pineapple and there is also apparently confusion with *piña*, the Spanish name widely borrowed in Philippines languages. Speakers seeing the pineapple were immediately reminded of the pandanus independently throughout the area where Austronesian languages are spoken. Similarly, Ross (1996:167) flags the apparent reconstruction of *Citrus* spp. in proto-Oceanic but notes that the edible forms of this genus are only likely to have reached the Pacific after European contact. Either the Oceanic forms originally applied to the scarcely edible leech-lime, *Citrus hystrix*, or to other genera with similar-looking fruit, such as *Clymenia* spp. or *Microcitrus* spp. This type of shifting of the referent of a lexical item, whereby old terms are applied to entirely new species such as New World introductions, or to indigenous but related species encountered as a population moves, should warn historical linguists of the importance of taking care when reconstructing flora and fauna. It is not enough to get the linguistics right, the biology must also be accurate.

A fresh compilation of the evidence from ethnography, linguistics and archaeology for the history of fruits in this region therefore seems timely. This paper is intended to confront the archaeobotanical, ethnographic and linguistic data; it attempts a broad-brush survey of the role of fruit trees in the Indo-Pacific region and gives examples of the potential of comparative linguistics to model their history. This is not a zone chosen on a biogeographical basis, but is intended to add to the increasingly rich prehistory of the region revealed by archaeology.

2. Fruits of the Indo-Pacific region

2.1 What is a fruit?

The botanical definition of a fruit is broadly the seed-bearing part of the plant and by this definition most fruits are small, inedible and often toxic. Nuts are similarly the seeds inside the fruits. I have used a more colloquial idea of a fruit as a plant product with edible flesh and possibly edible seeds, thereby including some species with edible nuts. The list includes fruits which are cultivated at least in some localities and those which are more than simply famine foods. In this paper I have confined the listing to trees cultivated for their fruit, thus omitting for example, important staples, such as sago, fern palm and the banana, but also the many trees protected and cultivated for other reasons. Fruit-bearing cultivated and wild vines, such as the water-melon, are excluded, as are trees grown for their leaves, such as *Erythrina* spp.

2.2 Conspectus of fruits

Table 1 shows the most important fruits in the East Asian/Pacific region with their family, common English name and probable origin. Walter & Sam (1999:261 ff.) provide an important table of the claimed origin and likely dispersal to individual parts of the Pacific for each fruit. Walter & Sam (2002) is an English translation with slightly different pagination which has only recently become available, so the page numbers given here continue to refer to the original French edition. The first column is marked 'origin', but places of origin must be treated with scepticism for many plants; detailed work will undoubtedly revise these speculations. Where the claimed origin is marked *x* to *y*, this implies that the species is indigenous to that geographical range; there is as yet no specificity as to the original locale of domestication. The alphabetic coding for the probable origin is explained in Table 2; this is intended to give some weight to different regions, but the uncertainties mean that it is not worth attributing statistical validity to these zones. Distribution tries to capture current range either worldwide or in the Indo-Pacific area; sometimes this may the same as the range given in 'Origin'. Many of the major tropical fruits are now cultivated worldwide, but at least some have extended their range in prehistory through human agency. The Column marked LD? stands for Linguistic Data and a plus sign implies that an analysis of names for the tree in at least some vernaculars exists. Discussion of these is given in §3. The archaeobotanical data (AD) are essentially adopted unchanged from Kyle Latinis (2000); I have only cited the oldest dates and I have not included the references, since these are set out in the original publications.

Table 1. Cultivated fruits of SE Asia and the Pacific

No.	Binomial	Family	English	Origin	Distribution	Code	LD?	AD	References
1.	Adenanthera pavonina	Fabaceae	Coral pea, Red bead tree	Malesia	Pan-Pacific	F			Tryon (1994:485), Walter & Sam (1999:80)
2.	Aegle marmelos	Rutaceae	Bael	India	India, SE Asia, Philippines	H			Tate (2000:12)
3.	Aleurites moluccana	Euphorbiaceae	Candlenut	South India ?	Worldwide tropics	H	+	13,000 BP, Timor	Whistler (1991:52), Walter & Sam (1999:83)
4.	Anacardium occidentale	Anacardiaceae	Cashew	Brazil	Worldwide tropics	J			Fernandez (1997:52), Tate (2000:14)
5.	Ananas comosus	Annonaceae	Pineapple	Brazil	Worldwide tropics	J			Fernandez (1997:98), Puri (2001:26)
6.	Annona muricata	Annonaceae	Soursop	West Indies	Worldwide tropics	J			Fernandez (1997:36), Tate (2000:18), Puri (2001:9)
7.	Annona reticulata	Annonaceae	Bullock heart	West Indies	Worldwide tropics	J			Tate (2000:20)
8.	Annona squamosa	Annonaceae	Sweetsop, sugar apple	Mexico	Worldwide tropics	J			Tate (2000:22)
9.	Antidesma bunius	Euphorbiaceae	Chinese laurel, Bignay, Salamander tree	India, Southeast Asia, W. Australia	India, Southeast Asia, W. Australia	A			Fernandez (1997:16), Tate (2000:24)
10.	Areca catechu	Palmae	Betel palm	NE Indonesia ?	Pan-Pacific, mainland SE Asia	F	+	13,000 BP, Timor	Whitmore (1979), Puri (2001:110)
11.	Artocarpus altilis	Moraceae	Breadfruit	New Guinea ?	Worldwide tropics	C	+		Barrau (1957); Whistler (1991:55), Ragone (1991, 1997); Walter & Sam (1999:87)
12.	Artocarpus heterophyllus	Moraceae	Jackfruit	India	Worldwide tropics	H	+		Fernandez (1997:78), Tate (2000:28), Puri

No.	Binomial	Family	English	Origin	Distribution	Code	LD?	AD	References
									(2001:95)
13.	Artocarpus integer	Moraceae	Chempedak	Malesia	SE Asia	F			Tate (2000:30), Puri (2001:96)
14.	Averrhoa bilimbi	Oxalidaceae	Bilimbi, cucumber tree	Malesia	Mainland SE Asia	F	+		Fernandez (1997:48), Tate (2000:32)
15.	Averrhoa carambola	Oxalidaceae	Carambola, star-fruit	SE Asia	Worldwide tropics	F	+		Fernandez (1997:10), Tate (2000:34), Puri (2001:109)
16.	Baccaurea motleyana	Euphorbiaceae	Rambai	Sumatra	Southeast Asia	F			Morton (1987:220), Puri (2001:45)
17.	Baccaurea racemosa	Euphorbiaceae	Kapundung	Java	Indonesia	F			Morton (1987:220)
18.	Baccaurea ramiflora	Euphorbiaceae	Burmese grape	India, China, SE Asia	India, China, SE Asia	F			
19.	Barringtonia edulis	Lecythidaceae	Cut nut	NE New Guinea, Vanuatu, Solomons, Fiji	NE New Guinea, Vanuatu, Solomons, Fiji	B	+		Jebb & Wise (1992), Yen (1995:839), Walter & Sam (1999:107)
20.	Barringtonia novae-hiberniae	Lecythidaceae	Cut nut	NE New Guinea,Vanuatu, Solomons	NE New Guinea,Vanuatu, Solomons	B	+		Jebb & Wise (1992), Yen (1995:839), Walter & Sam (1999:110)
21.	Barringtonia procera	Lecythidaceae	Cut nut	NE New Guinea, Vanuatu, Solomons	NE New Guinea, Vanuatu, Solomons	B	+		Jebb & Wise (1992), Yen (1995:839), Walter & Sam (1999:113)
22.	Borassus flabellifer	Palmae	Palmyra palm, sugar palm, sea-apple	India, SE Asia	Worldwide tropics	A			Whitmore (1979), Tate (2000:36)
23.	Bouea macrophylla	Anacardiaceae	Gandaria	Malaysia, Indonesia	SE Asia	F			Tate (2000:38)
24.	Burckella fijiensis	Sapotaceae	Tortoise pear	Fiji	Fiji, Futuna	D			Walter & Sam (1999:117)

No.	Binomial	Family	English	Origin	Distribution	Code	LD?	AD	References
25.	Burckella obovata	Sapotaceae	Burckella	Moluccas to Vanuatu	Moluccas to Vanuatu	B	+	3200 BP, Bismarcks	Walter & Sam (1999:119)
26.	Canarium harveyi	Burseraceae	Canarium nut, pili nut	Solomons to Tonga	Solomons to Tonga	B	+		Leenhouts (1965); Whistler (1991:63), Yen (1995:839), Walter & Sam (1999:125)
27.	Canarium indicum	Burseraceae	Java almond	Moluccas to Vanuatu	Pan-Pacific	B	+	14,000 BP, Sepik-Ramu	Leenhouts (1965), Yen (1995:839), Coronel (1996), Spriggs (1997:55), Walter & Sam (1999:128)
28.	Canarium odontophyllum	Burseraceae	Danau majang	Malaysia and Western Indonesia	Malaysia and Western Indonesia	F			Puri (2001:27)
29.	Canarium ovatum	Burseraceae	Pili nut	Philippines	Philippines	F			Yen (1995:839), Coronel (1996)
30.	Canarium vulgare	Burseraceae	?	Sulawesi to the Aru islands	Insular SE Asia, Sri Lanka	B			Yen (1995:839)
31.	Carica papaya	Caricaceae	Pawpaw	New World	Worldwide tropics	J			Tate (2000:40), Puri (2001:30)
32.	Casimiroa edulis	Sapotaceae	Casimiroa, white sapote	New World	Worldwide tropics	J			Tate (2000:42)
33.	Chrysophyllum caimito	Sapotaceae	Star apple	West Indies	Philippines	J			Fernandez (1997:18)
34.	Citrus aurantifolia	Rutaceae	Lime	Northern Burma	Worldwide tropics	G			Tate (2000:46)
35.	Citrus hystrix	Rutaceae	Leech-lime	Origin not known	Thailand to Bismarck archipelago	M			Puri (2001:136)
36.	Citrus macroptera	Rutaceae	Ghost-lime	Thailand to New Guinea	Introduced to Solomons, Vanuatu, New Caledonia	F			Whistler (1991:56), Walter & Sam (1999:134)
37.	Citrus maxima	Rutaceae	Shaddock, pomelo	Malesia	Worldwide tropics	F			Whistler (1991:56), Tate (2000:48), Puri

No.	Binomial	Family	English	Origin	Distribution	Code	LD?	AD	References
									(2001:137)
38.	Citrus reticulata	Rutaceae	Tangerine	Malesia	Worldwide tropics	F			Puri (2001:138)
39.	Citrus sinensis	Rutaceae	Sweet orange	South China, Việt Nam	Worldwide tropics	I			Fernandez (1997:40)
40.	Cocos nucifera	Palmae	Coconut	Malesia?	Worldwide tropics	F	+	5830 BP, New Guinea, Sepik	Child (1974); Harries (1990); Whistler (1991:61), Fernandez (1997:82), Puri (2001:117)
41.	Cordia subcordata	Boraginaceae	Sea trumpet	Malesia	Pan-Pacific seashores and adjacent lowlands from east Africa to Polynesia.	F		4250-4050 BP, Bismarcks	Walter & Sam (1999:135)
42.	Corynocarpus cribbianus	Corynocarpaceae	Corynocarp	North Queensland, New Guinea, Solomons	North Queensland, New Guinea, Solomons	C		3200 BP, Bismarcks	Foreman (1978:111), Walter & Sam (1999:147)
43.	Dimocarpus longan	Sapindaceae	Longan	South China, Myanmar	China, SE Asia	I			Tate (2000:54), Puri (2001:139)
44.	Diospyros blancoi	Ebenaceae	Mabolo, butterfruit	Philippines	SE Asia	F			Fernandez (1997:60), Tate (2000:56)
45.	Diospyros kaki	Ebenaceae	Persimmon	China, Japan	Worldwide tropics except Africa	I			Utsunomiya *et al.* (1998), Tate (2000:58)
46.	Diospyros major	Ebenaceae	Fiji Persimmon	Fiji ?	Fiji, Tonga, Uvea and Futuna	D			Whistler (1991:52)
47.	Dracontomelon dao	Anacardiaceae	New Guinea walnut	India to Solomons	India to Solomons	A	+		Lepofsky (1992:209), Walter & Sam (1999:150)
48.	Dracontomelon lenticulatum = D. edule	Anacardiaceae	?	Malaysia	Introduced into New Guinea	F			Walter & Sam (1999:150)
49.	Dracontomelon vitiense	Anacardiaceae	Dragon plum	Bismarcks, Santa Cruz, Vanuatu, Fiji, Samoa	Bismarcks, Santa Cruz, Vanuatu, Fiji, Samoa	B	+	3200 BP, Bismarcks	Tryon (1994:27), Walter & Sam (1999:150)

No.	Binomial	Family	English	Origin	Distribution	Code	LD?	AD	References
50.	Durio zibethinus	Bombacaceae	Durian	Malaya, Indonesia	Widespread in mainland and island SE Asia	F			Foreman (1995:221-270), Tate (2000:60)
51.	Ficus scabra	Moraceae	Oceania fig	New Caledonia to Tonga and Samoa	New Caledonia to Tonga and Samoa	B			Walter & Sam (1999:157)
52.	Ficus tinctoria	Moraceae	Red dye fig	India to the Marquesas	India to the Marquesas	A			Whistler (1991:55), Walter & Sam (1999:161)
53.	Finschia chloroxantha	Proteaceae	Chrysocarp	Moluccas to Vanuatu, Palau, Aru islands	Moluccas to Vanuatu, Palau, Aru islands	B			Croft (1981:13), Walter & Sam (1999:162)
54.	Flacourtia rukam	Flacourtiaceae	Indian plum	Malaysia to the Solomons	China, SE Asia, Fiji, Tonga, Carolines	F			Walter & Sam (1999:164)
55.	Garcinia mangostana	Clusiaceae	Mangosteen	Indochina	Widespread in mainland and island SE Asia	G			Fernandez (1997:70), Tate (2000:62), Puri (2001:76)
56.	Gnetum gnemon	Gnetaceae	Spanish joint fir	Assam to Fiji	Introduced to Sumatra, Java, Andaman islands	F	+		Walter & Sam (1999:170)
57.	Inocarpus fagifer	Fabaceae	Tahiti chestnut	Java to Fiji	Introductions to Polynesia, Philippines, Micronesia	F	+	3200 BP, Bismarcks	Whistler (1991:53), Walter & Sam (1999:172)
58.	Lansium domesticum	Meliaceae	Langsat, Duku	Malaysia, Indonesia	Mainland SE Asia, S. India, Philippines	F			Fernandez (1997:56), Tate (2000:64), Puri (2001:89)
59.	Litchi chinensis	Sapindaceae	Litchi	South China/Việt Nam	Worldwide tropics except Africa	I			Morton (1987:249–259), Tate (2000:66)
60.	Mangifera altissima	Anacardiaceae	Paho	Indonesia, Philippines, Solomons	Indonesia, Philippines, Solomons	F	+		Fernandez (1997:87)
61.	Mangifera foetida	Anacardiaceae	Horse mango	Thailand, Malaysia, Indonesia	Introduced to southern Myanmar, Cambodia and Vietnam.	G			Verheij & Coronel (1992)
62.	Mangifera indica	Anacardiaceae	Mango	India, Burma	Worldwide tropics	G	+		Mukherjee (1972),

No.	Binomial	Family	English	Origin	Distribution	Code	LD?	AD	References
									Fernandez (1997:64), Tate (2000:68)
63.	Mangifera minor	Anacardiaceae	Wild mango	New Guinea, Solomons	New Guinea, Solomons	C	+		
64.	Mangifera odorata	Anacardiaceae	Kuwini, huani	? Malaya	Insular and mainland SE Asia	F			Puri (2001:6)
65.	Manilkara zapote	Sapotaceae	Sapodilla	Central America	Worldwide tropics except Africa	J			Fernandez (1997:22), Tate (2000:70)
66.	Morinda citrifolia	Rubiaceae	Indian mulberry, noni, cheesefruit	Disputed Northern Australia/ Southeast Asia	Worldwide sea-coasts	M			Whistler (1991:56), Groenendijk (1992), Morton (1992), Tryon (1994:500), Walter & Sam (1999:193)
67.	Muntingia calabura	Elaeocarpaceae	Aratiles, capulin, Jamaica cherry	Tropical America	Philippines	J			Fernandez (1997:4)
68.	Neisoperma oppositifolium	Apocynaceae	Twin apple	?	Seychelles to the Marquesas	M			Walter & Sam (1999:197)
69.	Nephelium lappaceum	Sapindaceae	Rambutan	Malaysia, Indonesia	SE Asia	F			Tate (2000:74), Puri (2001:143)
70.	Pandanus conoideus	Pandanaceae	Red pandanus	Moluccas, New Guinea	Moluccas, New Guinea, Bismarcks	C	+		Walter & Sam (1999:199)
71.	Pandanus dubius	Pandanaceae	Knob-fruited screwpine	Malaysia to Vanuatu	Malaysia to Vanuatu	F	+		Walter & Sam (1999:201)
72.	Pandanus jiulianettii	Pandanaceae	Highand pandanus	New Guinea	New Guinea	C		12,100 BP, New Guinea, Yuku	Walter & Sam (1999:203)
73.	Pandanus tectorius	Pandanaceae	Pacific pandanus	Malaysia, Philippines to Austral islands, N Australia	Malaysia, Philippines to Austral islands, N Australia	F			Whistler (1991:61), Walter & Sam (1999:205)
74.	Pangium edule	Flacourtiaceae	Payang, Pangi	insular SE Asia	Malaysia to Vanuatu	F	+	5800 BP, New Guinea, Sepik,	Walter & Sam (1999:208), Puri

No.	Binomial	Family	English	Origin	Distribution	Code	LD?	AD	References
								Dongan	(2001:67)
75.	Parartocarpus venenosus	Moraceae		?	Insular SE Asia, Melanesia	M	+		Ross (1996:187)
76	Passiflora edulis	Passifloraceae	Passion fruit	Brazil	Worldwide tropics	J			Fernandez (1997:94), Tate (2000:76)
77.	Passiflora quadrangularis	Passifloraceae	Giant granadilla	New World	SE Asia	J			Morton (1987:328–330), Fernandez (1997:94), Tate (2000:78)
78.	Persea americana	Lauraceae	Avocado	Central America	Worldwide tropics	J			Fernandez (1997:8), Tate (2000:80)
79.	Phyllanthus acidus	Euphorbiaceae	Otaheite gooseberry	? South Asia	SE Asia	H			Jensen (2001:173)
80.	Phyllanthus emblica	Euphorbiaceae	Indian gooseberry	? Burma	China, SE Asia	G			Jensen (2001:173)
81.	Pithocellobium dulce	Leguminosae	Madras thorn fruit, Manila tamarind	Central America	Philippines	J			Fernandez (1997:20)
82.	Pometia pinnata	Sapindaceae	Taun tree, Fiji longan	Sri Lanka, Yunnan, Samoa	SE Asia, pan-Pacific	F		5800 BP, New Guinea, Sepik, Dongan	Walter & Sam (1999:216)
83.	Pouteria sapota	Sapotaceae	Marmelade plum	Mexico	Philippines, Vietnam	J			Morton (1987:398–402), Fernandez (1997:20)
84.	Psidium guajava	Myrtaceae	Guava	Mexico	Worldwide tropics	J			Tate (2000:82), Puri (2001:106)
85.	Punica granatum	Punicaceae	Pomegranate	Central Asia	Old World tropics	L			Tate (2000:82), Jensen (2001:181)
86.	Salacca zalacca	Palmae	Snakefruit	Indonesia	Indonesia, Indo-China	F			Tate (2000:86), Puri (2001:122)
87.	Sandoricum koetjape	Meliaceae	Santol	Indo-China	Southeast Asia	G			Jensen (2001:183)
88.	Spondias cytherea	Anacardiaceae	Ambarella,	?	Pan-Pacific	M	+	4250-4050 BP,	Whistler (1991:50),

No.	Binomial	Family	English	Origin	Distribution	Code	LD?	AD	References
	(= S. dulcis)		Tahiti apple					Bismarcks, Arawes, Kumbun, Apalo	Walter & Sam (1999:223)
89.	Sterculia vitiensis	Sterculiaceae	Sterculia	Vanuatu, Fiji	Vanuatu, Fiji	B			Walter & Sam (1999:234)
90.	Syzygium aqueum & S. samarangense	Myrtaceae	Water apple, Curacao apple	Southeast Asia	Southeast Asia	F			Fernandez (1997:62)
91.	Syzygium cumini	Myrtaceae	Java plum, Jambolan	India, Burma, Andaman Islands	Worldwide tropics	H			Morton (1987: 375–378), Fernandez (1997:20)
92.	Syzygium jambos	Myrtaceae	Rose apple, Malabar plum	Malesia	Worldwide tropics	F			Jensen (2001:195)
93.	Syzygium malaccense	Myrtaceae	Malay apple	?	SE Asia, pan-Pacific	M			Weisler (1991); Whistler (1991:55), Walter & Sam (1999:236), Tate (2000:88), Jensen (2001:197)
94.	Tamarindus indica	Leguminosae	Tamarind	Africa	Worldwide tropics	K			Gunasena & Hughes (2000), Tate (2000:90)
95.	Terminalia catappa	Combretaceae	Indian almond, sea almond	Malaysia	Worldwide tropics	F	+	4250-4050 BP, Bismarcks, Arawes, Kumbun, Apalo	Coode (1978:72), Morton (1985); Whistler (1991:51), Yen (1995:840), Walter & Sam (1999:240)
96.	Terminalia kaernbachii	Combretaceae	Okari nut	New Guinea, Aru islands	introduction in the Solomons	C			Coode (1978:82), Yen (1995:840), Walter & Sam (1999:244)
97.	Xanthophyllum	Polygalaceae	Kayu batu	Western Indonesia	Western Indonesia	F			Puri (2001:131)

No.	Binomial	Family	English	Origin	Distribution	Code	LD?	AD	References
	obscurum								
98.	Ziziphus mauritiana	Rhamnaceae	Indian jujube, Ber	India ?	India, China, Mainland SE Asia	H			Pareek (2001)

Sources: Burkill (1966), Corner (1988), Verheij & Coronel (1992), McKee (1994), Fernandez (1997), Walter & Sam (1999), Tate (2000), Dy Phon (2000), Puri (2001), Jensen (2001),

3. Origins and spread

3.1 Where do common fruits originate?

Table 2 provides a simplified analysis of the origins of the fruits cultivated today in the Indo-Pacific region. I have used 'Malesia' as a catch-all category for trees domesticated in the large area between eastern India and insular Southeast Asia.

Table 2. Sources of fruits currently grown in the Indo-Pacific region

Region of origin	Code	No.
Indo-Pacific	A	4
Moluccas to Vanuatu	B	10
New Guinea	C	6
Fiji	D	2
Micronesia	E	0
Malesia	F	36
Indochina	G	6
India	H	6
China	I	4
New World	J	16
Africa	K	1
Europe/Central Asia	L	1
Unknown	M	6
		98

An aspect of this study that deserves greater emphasis is the relative importance of arboriculture in the Vanuatu/Solomons area, something noted by Douglas Yen some time ago (Yen 1974). A large number of species seem to originate in the zone between the Solomons and western Polynesia, most still having quite a limited distribution. It suggests they should be given considerably more linguistic and archaeological attention.

3.2 Notes on individual species

The following text is intended to provide a brief commentary on some of the species tabulated here. I have cited both the (somewhat variable) English and scientific names in the text, and in each case these are referenced numerically to their entry in Table 1. Even scientific names are not very stable, witness the recent change of *Eugenia* spp. to *Syzygium* spp., so I have tried to use the most recent ones available.

Solomons and Vanuatu

The most important species domesticated in this region are *Barringtonia* spp., the cutnuts (19, 20, 21) (Jebb & Wise 1992). Yen (1995:839) notes evidence for the domestication of *B. procera* and *B. novae-hiberniae* in the Solomons; *B. novae-hiberniae* is wild in New Guinea and the seeds are toxic. Ross (1996:213) proposes *(*w,v*)*ele* as the proto-Oceanic form for these three species, whose vernacular names regularly interchange. He notes that only *Barringtonia novae-hiberniae* would have been present in the Bismarcks at the time of the split-up of proto-Oceanic and so the reconstruction must refer to this species. Still confined largely to this zone, the cutnuts have been introduced into other regions such as New Guinea relatively recently. Tryon (1994:488) quotes a reconstruction for proto-Philippines, **butun*, although this is for another species, *Barringtonia asiatica*, used principally as a fish-poison. *Burckella obovata* (25) is found from the

Moluccas to Vanuatu, including the Polynesian outliers Anuta, Rennell, Takuu and Tikopia (Biggs n.d.), and has been introduced to Fiji and Tonga as a domesticate. Ross (1996) reconstructs **ñatu(q)* for proto-Oceanic, although related lexemes in Philippines languages refer to *Palaquium spp.* (Reid n.d.). The corynocarps, almost all of which are eaten in times of famine, have been studied by Wagstaff & Dawson (2000). *Corynocarpus cribbianus* (42) is recorded in the Bismarcks at 3200 BP (Kirch 1989:234). Although found 'wild' throughout Melanesian lowland forests, the corynocarps are rarely cultivated today and their presence may be a record of a period when they were once more intensively exploited.

The New Guinea walnut, *Dracontomelon dao* (47), might have been domesticated anywhere in Malesia but is recorded in the Bismarcks 3200 BP (Kirch 1989:229). Intriguingly, given its previous importance, it is hardly used in Mussau today (Lepofsky 1992:209). Blust has proposed a proto-Austronesian reconstruction **daqu*, which has a proto-Oceanic reflex **raqu*(*p*) (Ross 1996:213) and is transferred to the dragon plum, *Dracontomelon vitiense* (49), native to Vanuatu, Fiji and Samoa (Walter & Sam 1999:274). The chrysocarp, *Finschia chloroxantha* (53), seems to be indigenous to the Moluccas-Vanuatu region (including the Aru islands), but has also been recorded from Palau. The sterculia, *Sterculia vitiensis* (89), is confined to Vanuatu and Fiji.

The Spanish joint fir, *Gnetum gnemon* (56), is spread from Assam to Fiji and introduced in Java and Sumatra. Ross (1996:191) notes a rather local reconstruction in Western Oceanic, **wayu*. The edible *Gnetum*s are also very widespread across Africa and have been carried by human groups throughout the equatorial rainforest, so it is it conceivable that the present-day wide distribution in the Indo-Pacific region is partly anthropic.

Tree species with extensive archaeobotanical remains and considerable problems attached to their precise identification are the *Canarium* spp. Yen (1994, 1995:839) shows the distribution of six domesticated and additional large-seeded edible wild species *Canarium* species in the southwest Pacific (Table 3).

Table 3.Wild and domesticated *Canarium* spp. in the Indo-Pacific region

Status	Section	Group	Species	Distribution
Domestic	Canarium	Vulgare	*C. indicum*	Moluccas to Vanuatu
			C. ovatum	Northern Philippines
			C. vulgare	Eastern Indonesia
		Maluense	*C. lamii*	North coast of New Guinea
			C. salomonense	Solomons, SE New Guinea, New Britain
			C. harveyii	Solomons to Tonga
Wild	Pimela			wild and cultivated species in insular and mainland SE Asia, with *C. australianum* in SE New Guinea and Australia
Wild	Canariellum		six species	NE Australia, New Caledonia, Loyalty Islands

Adapted from Yen (1995:839)

Two of the most widespread species, the pili nut, *Canarium harveyi* (26) and the Java almond, *Canarium indicum* (27), occur across a wide area from the Moluccas to Vanuatu, and many related species also occur in Southeast Asia (Walter, Sam & Bourdy 1994). The earliest dates are 14,000 BP in the Sepik-Ramu area, but it is not possible to distinguish between species (Yen 1994). The Java almond (27), *Canarium indicum*, appears to be indigenous to the region from Northern Sulawesi to Vanuatu and Ross (1996:213) cites the reconstructions, proto-PCEMP, **kanaRi* and proto-Oceanic **[ka]ŋari* also noting reflexes in Central Malayo-Polynesian. Kirch (1989:234) makes the interesting observation that the cultivated forms of the Java almond correspond closely with the geographic distribution of the Lapita dispersal. Ross (1996:214) notes two other terms for *Canarium spp.*, proto-Oceanic **qalip* and proto-West-Oceanic **pinuaq* but does not propose particular species are the referents.

New Guinea

The breadfruit, *Artocarpus altilis* (11), was probably domesticated in New Guinea. Seeded breadfruit appears to occur wild only in New Guinea where, along with breadnut, it is a dominant member of secondary forests in lowland areas (Ragone 1997:18). It was carried to many regions of the Pacific in pre-European times, but only introduced to the Philippines from Guam in the historical era (Barrau 1957; Ragone 1991). Tryon (1994:486) quotes a reconstruction for proto-Austronesian, **kama(n)si*, but this is evidently suspect if the breadfruit was so recent in the Philippines and Taiwan. More probably the Philippines name *kamansi* originally applied to another *Artocarpus* sp., shifted to the breadfruit and was then taken to Taiwan. Blust (n.d.) suggests a quite different form for proto-Malayo-Polynesian **kulu(R)*, but even this is problematic since it implies a spurious antiquity in the Philippines. These issues can only be resolved with more detailed ethnobotanical data on the near relatives of the breadfruit. There are several other *Artocarpus spp.* in the Malesian area, for example shiny tampang, *A. nitidus*, monkey jackfruit, *A. rigidus* and marang, *A. odoratissimus*, cultivated locally for their fruits (Puri 2001:98-100).

Ross (1996:205) gives proto-Oceanic **padran* for 'coastal pandanus' which, he observes, usually applies to *Pandanus tectorius* (73) but is also a generic for *Pandanus spp.* in the Pacific. A second proto-Oceanic form, **kiRe* also applies to *P. tectorius* and is also attested at proto-Malayo-Polynesian level. The red pandanus, *Pandanus conoideus* (70), and the highland pandanus, *Pandanus jiulianettii* (72), are confined to New Guinea and parts of the Moluccas. Ross (1996:206-7) gives **pakum* as proto-Oceanic for *Pandanus dubius* and *$*m^{w}a\eta a$*, probably for the red pandanus, *P. conoideus*. *Parartocarpus venenosus* (75), which occurs widely throughout the region and is often compared to breadfruit. has a reconstruction in proto-Western Oceanic, **lapuka* (Ross 1996:187). The okari nut, *Terminalia kaernbachii* (96), occurs between the Moluccas and New Guinea and has been carried to the Solomons in recent times.

Fiji

The tortoise-pear, *Burckella fijiensis* (24), is the most significant domesticate in Fiji and still confined to the Fijian islands and Futuna. However, the Fiji persimmon, *Diospyros major* (46), seems also to originate in Fiji and has subsequently spread to Tonga, Uvea and Futuna (Whistler 1991:52).

Malesia

The coral pea, *Adenanthera pavonina* (1), is apparently native to the Malesian region but was carried to much of Melanesia in an unknown past era, although its introduction to Fiji, Polynesia and Micronesia is apparently post-European (Walter & Sam 1999:80). Tryon (1994:485) proposes a reconstruction for proto-North Central Vanuatu, **bisa*. Walter & Sam (1999:83) claim that the candlenut, *Aleurites moluccana* (3), only occurs wild in India, but evidence for candlenuts in Timor at 13,000 BP and on Morotai at 11,000 BP rather suggests it is indigenous to a wider area. Archaeobotanical dates for the betel palm, *Areca catechu* (10), are extremely old, although whether the nut was in use for chewing at 13,000 BP is open to question. Mahdi (1998:405) has a useful discussion of the linguistic sources for betel chewing, noting that terms for 'fruit' in Austronesian (PAN **Buaq*) are intertwined with those for areca nut, suggesting that it was perceived as the fruit *par excellence* and notes that betel pepper (*Piper betle*) appears to have been borrowed into Austronesian from Austroasiatic. The durian, *Durio zibethinus* (50), perhaps originating in insular SE Asia, has only recently become a major traded fruit both east and west of its core area and most mainland names reflect the Malay term *durian*. Other durians of more limited distribution are the Kutai durian, *Durio kutejensis*, confined to Borneo, and the leaf durian, *Durio oxleyanus*, found in Malaysia and western Indonesia (Puri 2001:23-4).

The mangos, *Mangifera* spp. (60, 61, 62, 63, 64), constitute an interesting problem. The mango proper, *Mangifera indica*, originates in India or Burma but probably spread to Southeast Asia during the last two millennia, and was subsequently carried around the Pacific in the post-European era (Ross 1996:210). One of the Malay names, *mempelam,* is from Sanskrit via Tamil and etymologises as *maha pahala*, the 'great fruit' (Tate 2000:68). The English name 'mango' is from a Sundanese word *mangga*, which in turn probably derives from Sanskrit via Tamil and this suggests that India was the source of the domestic plant (Mukherjee 1972). Li (1994:246) shows that the mango must have been brought to Taiwan from the Philippines, along with the persimmon. The reconstruction **pau*(*q*) in proto-Oceanic, cognate with PMP **pahuq* for *Mangifera* sp. (Blust n.d.), probably applies to the *paho*, *Mangifera altissima* (60), and not *M. indica*, as this would place it in the Austronesian region too early. Other reconstructions for proto-Oceanic are **wai*(*wai*) as 'generic' for *Mangifera* spp. and **koRa*, given as 'wild' mango, *Mangifera minor* (63) (Ross 1996:209). The fourth mango, *Mangifera foetida*, seems to be confined to Southeast Asia and virtually no linguistic data are available. The origin of the kuwini, *Mangifera odorata* (64), is disputed, but may be Malaysia; it is now distributed widely throughout the mainland and islands of SE Asia. Other highly local cultivated mangoes in this region include *Mangifera quadrifida* and *M. pajang*, the sherbert mango (Puri 2001:5,7).

The Tahiti chestnut, *Inocarpus fagifer* (57), is one of the most widespread fruits in the Pacific and was probably carried from the Moluccas and Eastern Indonesia throughout Polynesia and Melanesia, with post-European introductions to Micronesia and the Philippines. Ross (1996:215) cites proto-Oceanic *(*q*)*ipi*, but the Philippines cognates (**ipi*(*l*)) appear to refer to another plant, *Intsia bijugata* (Reid in press). The names for Tahiti chestnut in Polynesian languages also suggest some crossover with the Tahiti apple, *Spondias cytherea* (88). The twin apple, *Neisosperma oppositifolium* (68) occurs from the Seychelles to the Marquesas, but it has been shown to float on ocean currents, so this may be the explanation for its broad distribution.

The exact origin of the Malay apple, *Syzygium malaccense* (93), is unknown, but it is now found from Indochina to the Austral islands, and was presumably carried through the region at a very early period, although Captain Bligh was responsible for carrying it to Jamaica. Weisler (1991) records its use in house construction in Hawai'i in the proto-historic period. Ross (1996:211) reconstructs **kapika* for proto-Oceanic and some of these forms look cognate with those in Philippine languages (Reid in press). However, the names in Thai, *chompoo*, and Khmer, *chumpu krâhâ:m*, are transparently borrowed from Malay *jambu*, suggesting that it has only recently been traded and grown in the interior of the mainland. The forms for the rose apple, *Syzygium jambos* (92), are quite distinct in the Philippines, suggesting that both reconstructions will separate out when the data are more complete. The sea almond, *Terminalia catappa* (95), probably originated in Malaysia and has been carried to all tropical regions in post-contact times (Morton 1985; Whistler 1991:51). Linguistic evidence suggests it was well-known to the early Austronesians. Ross (1996:215) cites proto-Oceanic **talise*, and Dempwolff (1938) **talisay* for proto-Malayo-Polynesian, a form with extensive Philippines cognates (Reid in press).

The Indian plum, *Flacourtia rukam* (54) is native to the region from Malaysia to the Solomons but has been widely distributed to both the Southeast Asian mainland, India, China and the Polynesian islands, west of the Solomons. The knob-fruited screwpine, *Pandanus dubius* (71), occurs from the east coast of Malaysia to Vanuatu, but curiously, was never carried to Polynesia and is only cultivated on Vanuatu. The most widespread pandanus is the Pacific pandanus, *Pandanus tectorius* (73), whose exact taxonomy remains debated. At the western end of of its range it shades into *P. odoratissima*. Its many subtypes are probably the result of widespread and ancient cultivation, although the cultivars are most diverse at the extreme end of its range in the Marshalls and Kiribati. Blust (n.d.) reconstructs a form **paŋdan* for proto-Malayo-Polynesian and Ross (1996:205) gives proto-Oceanic **padran.* Cognates occur on Taiwan, but in Formosan languages the term is now applied to 'pineapple' in most languages, implying a recent transfer of the referent. The pangi, *Pangium edule* (74), occurs from Indochina to Vanuatu and was carried to Micronesia in the post-European era. Blust (n.d.) quotes a PMP reconstruction **pa'i*.

The taun, *Pometia pinnata* (82), is indigenous to a broad zone from Sri Lanka to Vanuatu with outliers in South China and Indochina, and was later carried to further Polynesia in the post-European era. Kirch (1989:236) who recorded the taun in the Mussau islands at 3200 BP notes its coincident distribution with the Lapita area, like the Java almond (27). Ross (1996:212) reconstructs **tawan* for proto-Oceanic (hence the name of the tree) and this clearly has cognates in Philippines languages. Li (1994:264) proposes a proto-Austronesian reconstruction for the taun, **cayi*, but some of Li's forms, such as Amis *kowawi*, are cognate with Philippines witnesses such as Tagalog *kayawi*, warranting a different reconstruction. The sea-trumpet, *Cordia subcordata* (40), is apparently native to Malesia but has been spread throughout the Pacific and along Indian Ocean seashores and adjacent lowlands from east Africa to Polynesia.

India

Fruits seem to have been transmitted from India both at an early period and in the historical era. The Indian jujube, *Ziziphus mauritiana* (102), may have reached Southeast Asia earlier than the main period of Indian influence. Although cultivated in many places, it is now regarded as 'wild' fruit in Yunnan, for example (Jin *et al.* 1999). Archaeological evidence for trade between India and the Southeast Asian region dates from the fourth century BC, and Indian pottery has been found on Bali from the 1st century BC onwards (Bellwood 1997: 294). The Hindu religious influence on the Southeast Asian region dates from the sixth century and fruits brought at this time include the bael, *Aegle marmelos* (2), the bignay, *Antidesma bunius* (9), the jackfruit, *Artocarpus heterophyllus* (12) and the mango, *Mangifera indica* (62). These fruits often bear some recognisable version of a Sanskrit name; the bael, for example, is known in Java as *majapahit* (Sanskrit 'great' + 'bitter'), a term later applied to the 14th century Javanese Empire. The Malay name of the bignay, *berunai*, may be the origin of the names of both Brunei and Borneo (Tate 2000:24). The candlenut (3) grows wild in South India and seems to have been spread from there to Pakistan, China, north-eastern Australia, the Philippines, Malaysia, and all the islands from Sumatra to Tonga, including New Caledonia (Walter & Sam 1999:84). Whistler (1991:52) claims that it was spread into Polynesia at an early period. Although the sugar palm, *Borassus flabellifer* (22), is probably indigenous to Malesia as well as India, the Malay name, *lontar*, derives from Sanskrit (*pala* 'palm' + *ron* 'leaf') because the dried leaves of this species were preferred for writing (Tate 2000:36). It must also have been carried to Africa at a very early period, as it has long been regarded as indigenous under its synonym, *B. aethiopum*. The red dye fig (52) is only eaten in certain locations, but seems to have been introduced into Tokelau for its edible fruits (Whistler 1991:55). Although the tamarind, *Tamarindus indica* (94), was domesticated in Africa, it was carried to India prior to 1300 BC, to judge from charcoal analyses and literary references (Blench 2003:284). Literary references suggest that it only spread to Java and the rest of Southeast Asia in the medieval period (Gunasena & Hughes 2000).

China

Given its size and the overall importance of agriculture, China has domesticated few fruits overall and even fewer that have had a major impact on the arboriculture of regions further south. One fruit in particular, the sweet orange (39), has become of world significance, but others, such as the longan, *Dimocarpus longan* (43) and the litchi, *Litchi chinensis* (59), have recently begun to enter world trade on a significant scale. Morton (1987:249–259) observes that the litchi was first mentioned in Chinese literature in the 11th century and was carried around the region in the later Middle Ages. The persimmon, *Diospyros kaki* (45) is native to Japan, China, Burma and the Himalayas and Khasi Hills of northern India. Ng (1978) argued that it arose from *Diospyros roxburghii* on the China/Burman borderland, but Yonemori *et al.* (1998) show that the persimmon is monophyletic with the subtropical species, *Diospyros ehretioides*.

New World

A significant number of fruits that are important today in the Indo-Pacific region are of New World origin. The great majority were brought by the Portuguese and Spanish in the sixteenth and seventeenth centuries.

The Spanish connection to the Philippines brought a number of species which were then subsequently distributed around Southeast Asia, such as the aratiles, *Muntingia calabura* (67). The sapodilla, *Manilkara zapote* (65), from Central America, came with Amerindian names, so that Aztec *chiki* became Malay *chiku* (and also *chiclet* for chewing-gum). The custard apple group, *Annona* spp. (6, 7, 8) are known in the Philippines as *anonas*, which suggests some confusion with the pineapple, *ananas*. The Malay names for soursop, *Annona muricata* (6), are *durian belanda* and *durian mekah* (i.e. Dutch or Meccan durian), but also *nangka manila* (Manila jackfruit), suggesting that the soursop arrived in Malaya from two directions. The guava, *Psidium guajava* (84), seems to have been brought separately by the Portuguese and Spanish. One Malay name, *jambu portugis*, compares the guava to the rose apple, *Syzygium jambos* (92), and also points to the Portuguese connection, although the guava was also introduced by the Spanish to the Philippines. Table 4 shows some names of Southeast Asian fruits that derive from Amerindian languages.

Table 4. SE Asian fruit names derived from Amerindian languages

		Southeast Asian name		Amerindian name	
Species	No.	Language	Term	Language	Term
pineapple	5	Portuguese	ananas	Tupi-Guarani	*nanas* 'pleasant-smelling'
sweetsop	8	Tagalog	atis	Aztec	ahate
sapodilla	69	Malay	chiku	Aztec	chiki
avocado	82	Thai	avocado	Aztec	ahuacatl
Madras thorn fruit	85	Tagalog	kamatsili	Nahuatl	cuaumochitl
guava	90	Tagalog	bayaba	?	

A wide variety of fruits were introduced in the twentieth century through missionaries, and latterly agricultural projects. One of the most notable of these is the avocado, *Persea americana* (78), which might have been brought by the Spanish but seems to be recent, to judge by vernacular names. In the Philippines, present-day varieties derive from the United States Bureau of Agriculture and were brought in 1903 (Fernandez 1997:8). The caimito, *Chrysophyllum caimito* (33), is of similar origin and date. The pomegranate, *Punica granatum* (85), ancient in Central Asia, is a twentieth century introduction in Southeast Asia.

Unknown

The origin of the coconut, *Cocos nucifera* (40) is much disputed; it was formerly claimed that it originated in the New World because its nearest botanical relatives are located there. Harries (1990, Website 3) argues that its origin lies in Malesia and the distribution of *Cocos* spp. is a relic of the splitting-up of Gondwanaland. Zizumbo-Villareal & Quero (1998) in a re-examination of the earliest Spanish sources, argue that it was definitely present on the west coast of Central America in the pre-Spanish era, although they remain agnostic about whether this was a result of human intervention or simply transport by ocean currents. The very early dates for coconut in the Sepik (see Table 1) show that it had been distributed much prior to Austronesian expansion, although whether by human transport or chance floatation is unclear. Ross (1996:195) quotes a reconstruction **niuR* for coconut in proto-Oceanic, Wolff (1994:533) proposes *ñiyuɣ* and Mahdi (1998:395) **niəuR* for proto-Philippines. There are also many local reconstructions for stages of coconuts growing or being processed. Mahdi (1998:396) argues that the coconut was carried to Sri Lanka and India prior to the 2nd century BC and that by the 5th century it was known to the Greeks, who borrowed the name *argellia* from Sanskrit *nārikela*.

The leech-lime, *Citrus hystrix* (35), is found throughout the region and may be the referent of the proto-Oceanic **molis* (Ross 1996:210) although this could also be the ghost-lime, *Citrus macroptera* (36). The vernacular terms for the ghost-lime are highly diverse in the Philippines, suggesting it is a more recent introduction there (Reid in press). The ghost-lime (36) presently occurs from Thailand to Micronesia and Polynesia (Walter & Sam 1999:134). It has clearly been carried by human action throughout much of its range but its precise origin remains unknown. Mahdi (1998:409) sees the widespread forms in Malayo-Polynesian of the type *limaw* as metathesising in Oceanic to produce **moli* but it is still unclear exactly to which *Citrus sp.* this might refer. Not all linguists would accept such a metathesis without a mechanism to explain it. The shaddock, *Citrus maxima* (37), is also referred to by the term **moli*, but this reached only as far as Tonga in pre-European times. Blust (n.d.) quotes a reconstruction of **muntay* for PMP 'kind of citrus tree and its fruit', which could be either of these.

The Tahiti apple, *Spondias cytherea* (88), is presently spread from Malaysia to the Marquesas and was carried to Hawai'i and elsewhere in the world in post-European times. Ross (1996:210) gives a reconstruction of **quRis* for proto-Oceanic. Its origin is much disputed, with Whistler (1991:50) giving Indo-Malaysia, while Walter & Sam (1999:223) canvas a range of other possibilities but conclude that it is unknown. In Melanesia, it is generally a gathered forest species, but it was cultivated in Polynesia, and its names, *wi/vi* and variants thereof, mark its transport from island to island as the expansion took place.

Fruits that originate in Australia are rare, partly because fruit culture was of limited interest to the inhabitants. However, one of the most widespread fruits in the Pacific, and which has spread to India, the Seychelles and the Caribbean, was the noni or Indian mulberry, *Morinda citrifolia* (66), which Walter & Sam (1999:193) claim originated in Northern Australia, the home of many related species. However, Morton (1992:241) points out that the noni can spread on ocean currents and has become established along sea-coasts in many parts of the world and it may also originate in Southeast Asia (Morton 1992; Websites 1,2). Its importance as fruit, dye and medicinal plant clearly made it a priority with early navigators (Dittmar 1993). Two reconstructions to proto-Oceanic exist, ***ñoñum** and **kurat* (Ross 1996:211), possibly referring separately to the fruit and the red dye obtained from its roots. A quite different root has been reconstructed in proto-Philippines, **baŋkudu* (cf. Reid in press), arguing that the tree must have been of interest early in the expansion of the Austronesians.

A minor mystery in this region worth noting is the distribution of the baobab or boab (*Adansonia* spp.). Baobabs are members of the Bombacaceae, a pantropical family containing a number of better-known economically important plants like kapok, balsa wood, and durian. Six of the eight species of baobabs are restricted to western and southern Madagascar, a seventh is endemic to northwestern Australia, and the eighth is widespread in sub-Saharan Africa but now introduced by humans throughout the warm tropics (Armstrong 1983). It has been speculated that the Australian boab may have originated from seed pods carried for food by seafarers from Madagascar or Africa, although at what period this might have been and why the baobab remains isolated in Australia is unclear (Blench in press).

3.3 Who was moving fruit trees around?

The linguistic data cited in this paper are far from complete, but they do suggest that the expanding Austronesians encountered a large number of fruiting trees that had *already* been translocated from their area of origin. Remarkably, many species seem to have travelled in a contrary direction, especially in insular Southeast Asia. By this I mean that they seem not to follow the usually accepted direction of demographic expansion of early Austronesian, south and east from Taiwan; indeed a surprising number of species appear to have moved in the opposite direction. A significant number of economic trees can be reconstructed to quite a high level in Austronesian, but this does not mean that they were domesticated by, for example, speakers of proto-North Philippines. Many species domesticated in the Moluccas to Vanuatu region and were apparently effectively distributed throughout much of the Austronesian zone prior to its expansion.

Recent ethnographic evidence for the importance attached to fruit culture suggests that popular species spread extremely quickly; the New World imports, such as pineapple, guava and sweetsop are all well-established throughout the region and are now regarded as 'indigenous'.

One explanation is that many species were not initially spread by the Austronesians but by the former inhabitants of insular Southeast Asia. Promising fruiting and other useful trees were moved from one island to another, just as animals were translocated (Flannery & White 1991), to provide low-management food sources. This is not only the case with trees; yams seem to have undergone a parallel movement. Spriggs (1997) has discussed the surprisingly early settlement of island Melanesia and the movement of likely food resources using still unknown maritime technology. The evidence from fruit trees suggest that the Pleistocene and early Holocene populations were very active long before the Austronesian expansion (Spriggs 1993; Yen 1995).

4. Conclusions

4.1 Summary

This paper has focused on the very large number of fruit trees found in the East Asian/Pacific region which are not just exploited in the wild, but intentionally planted and cultivated, though often not domesticated to the point where morphological change becomes evident. Particularly in the Pacific, where island floras tend to be very depauperate, human intervention has moved numerous species from island to island, often allowing unfashionable species to become wild, making it difficult to determine the 'natural' range of such species. Although fruit trees are the focus of this paper, trees and indeed many other plants were moved for a wide variety of other reasons, including flowers, perfumes, medicines, barkcloth and timber.

Biogeography is presently the main means to determine the area of origin of particular species, but this is an uncertain tool at best, partly because post-European vegetation change has been so marked in certain places, but also because naturalisation of many species makes their 'wild' status difficult to determine. No doubt, DNA studies in the future will improve the quality of the database; in the meantime assertions as to the region of origin of fruit species should be treated with appropriate scepticism.

Approaching the study of fruit trees from an ethnographic standpoint also underlines the divide with archaeobotany. Ethnographic accounts of the identity, distribution and uses of plant species in the present or recent past can be meshed with biogeography to explore the likelihood that particular species were translocated, as opposed to being indigenous. Such ethnographic mapping should also correlate with the evidence from vernacular names, as there is a strong relationship between cultural salience and the persistence of specific roots across a wide geographic and linguistic space. To date, archaeobotanical confirmation for the hypotheses that underlie biogeographical assertions remains slight; identified species are few and dates are sometimes late. No doubt more evidence will gradually come to light, but in the mean time, careful descriptive work on plant use has a substantial contribution to make to the reconstruction of prehistoric subsistence.

4.2 An expanded role for arboriculture?

Although difficult to substantiate on a quantitative basis, in comparison to Europe and Africa, the role of arboriculture in the Indo-Pacific region is exceptional in global terms. This in turn argues that we should be rewriting the history of agriculture, balancing useful trees against the cereals and tubers that normally dominate the textbooks. At present, evidence for the scale of human activity in moving economic trees comes mainly from biogeography. Linguistic studies have made some contribution, especially in the Austronesian area, but richer hypotheses might be derived from existing information.

There is something else, however, more speculative, but worth noting. Some areas inhabited by large language groupings do seem to exhibit cultural biases for or against fruit cultivation. Africa is a good example of a whole region, where, except for Ethiopia, fruit plays little or no role in either eating preferences or cultural life. In most areas of West-Central Africa, fruit-eating is regarded as a low-status activity fit only for children; only very recently have introduced crops such as oranges and mangoes begun to be widely consumed. This cultural bias shows up persistently in agronomic research; cereals and tubers are heavily emphasised and trees largely ignored. This situation contrasts strongly with, say, South America, where fruiting trees play a major role in the subsistence and ceremonial life of many Amerindian groups. In the Indo-Pacific region, arboriculture is a central activity and its peoples attribute high cultural value to fruit and the pattern of adoption and domestication in the area is striking enough to need an explanatory framework rather richer than those at present available.

This synthesis points to one very obvious imbalance; the significant body of work on island Southeast Asia and the Pacific and the relative absence of studies of the mainland, whether linguistic, ethnographic or archaeobotanical. This partly results from the very different political histories of these regions since the 1950s and partly because of different scholarly traditions. Archaeology has tended to direct resources to monuments, anthropologists are engaged in slow suicide and linguists have concentrated on languages with scripts. It is to be hoped that the coming decades will see a significant re-orientation in these areas.

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References

Allen, B.M. 1975. *Common Malaysian fruits.* Kuala Lumpur: Longman Malaysia.

Armstrong, P. 1983. The disjunct distribution of the genus *Adansonia*. *National Geographical Journal of India* 29:142-163.

Athens, J.S., J.V. Ward & G. Murakami 1996. Development of an agroforest on a Micronesian high island; prehistoric Kosraen agriculture. *Antiquity* 70:834-46.

Barrau, J. 1956. *L'agriculture vivrière autochtone de la Nouvelle Calédonie*. Nouméa: Commission du Pacifique sud.

Barrau, J. 1957. L'arbre à pain en Océanie. *Journal d'agriculture Traditionnelle et de Botanique Appliquée* 4:117-123.

Barrau, J. 1962. *Les plantes alimentaires de l'Océanie, origines, distribution et usages*. Marseille: Musée Coloniale.

Barrau, J. 1965. Histoire et préhistoire horticoles de l'Océanie tropicale. *Journal de la Société de Océanistes* 21:55-78.

Bellwood, P. 1997. *Prehistory of the Indo-Malaysian archipelago*. [2nd revised ed.] Honolulu: University of Hawai'i Press.

Biggs, B. (n.d.) *POLLEX*. Electronic database of comparative Polynesian.

Blench, R.M. 2003. The movement of cultivated plants between Africa and India in prehistory. In K. Neumann, A. Butler & S. Kahlhaber (eds.). *Food, fuel and fields: progress in African Archaeobotany*. pp. 273-292. Köln: Heinrich-Barth-Institut.

Blench, R.M. in press. The intertwined history of the silk-cotton and baobab in West Africa. In R.T.J. Cappers (ed.). *Proceedings of the 4th International Workshop for African Archaeobotany, Groningen 2003*. Groningen: Department of Archaeology.

Blust, R. (n.d.) *Austronesian Comparative Dictionary*. Electronic file.

Bourke, R.M. & V. Kesavan (eds.). 1982. *Proceedings of the Second Papua New Guinea Food Crops conference*. [3 vols.] Port Moresby: Department of Primary Industry.

Bourke, R.M. 1994. Edible indigenous nuts in Papua New Guinea. In M.L., Stevens, R.M. Bourke & B.R. Evans (eds.), *South Pacific Indigenous Nuts*. pp. 45-55. ACIAR Proceedings No. 69. Canberra: ACIAR.

Burkill, I.H. 1966. *A dictionary of the economic products of the Malay Peninsular*. Kuala Lumpur: Ministry of Agriculture.

Child, R. 1974. *Coconuts*. London: Longman.

Chin, H.F. & H.S. Yong. 1982. *Malaysian fruits in colour*. Kuala Lumpur: Tropical Press.

CIFOR 1996. *Manual of forest fruits, seeds and seedlings*. CD-ROM. Jakarta: CIFOR.

Coode, M.J.E. 1978. Combretaceae. In Womersley, John S. (ed.) *Handbooks of the flora of Papua New Guinea. Vol 1*. 43-110. Melbourne : Melbourne University Press for the Government of Papua New Guinea.

Cooper, W. & T. Cooper. 1994. *Fruits of the rain forest: a guide to fruits in Australian tropical rain forests*. Australia: RD Press.

Corner, E.J.H. 1988. *Wayside Trees of Malaya*. [2 vols.] 3rd edition. Kuala Lumpur: Malayan Nature Society.

Coronel, R.E. 1996. *Pili Nut: Canarium ovatum Engl*. Rome: International Plant Genetic Resources Institute (IPGRI).

Croft, J.R. 1981. Proteaceae. In Henty, E.E. ed. *Handbooks of the flora of Papua New Guinea. Vol. 2*. 4-18. Melbourne : Melbourne University Press on behalf of the Government of Papua New Guinea,

Dempwolff, O. 1938. *Vergleichende Lautlehre des austronesichen Wortschatzes*. *Band 3: Austronesiches Wörterverzeichnis*. Beihefte zur Zeitschrift für Eingeborenen-Sprachen 19. Berlin: Dietrich Reimer.

Dittmar, Alexander 1993. *Morinda citrifolia* L. -Use in Indigenous Samoan Medicine. *Journal of Herbs and Medicinal Plants*,1(3).

Dy Phon, P. 2000. *Plants used in Cambodia. Plantes utilisées au Cambodge*. Phnom Penh: Imprimerie Olympic.

Eisemann, F. & M. Eisemann 1988. *Fruits of Bali*. Berkeley: Periplus Editions.

Fernandez, D.G. 1997. *Fruits of the Philippines*. Manila: Bookmark.

Flannery, T. & J.P. White. 1991. Animal trans-locations. *National Geographic Research & Exploration* 7:96-113.

Foreman, D.B. 1978. Corynocarpaceae. In Womersley, John S. (ed.) *Handbooks of the flora of Papua New Guinea. Vol 1*. 111-113. Melbourne : Melbourne University Press for the Government of Papua New Guinea.

Foreman, D.B. 1995. Bombacaceae. In Conn, Barry J. *Handbooks of the flora of Papua New Guinea. Vol. 3*. 221-270. Carlton, Vic. : Melbourne University Press on behalf of the Government of Papua New Guinea.

Gosden, C. 1995. Arboriculture and agriculture in coastal Papua New Guinea. *Antiquity* 69:807-817.

Groenendijk, J.J. 1992. <*Morinda citrifolia* L.>. In R.H. Lemmens, and N. Wulijarni-Soetjipto (eds.) *Plant Resources of South-East Asia, II-dye and Tannin-producing plants*. pp. 94-96. Bogor: PROSEA.

Guillamin, A. 1954. Les plantes utiles des Nouvelles Hébrides. *Journal d'agriculture Traditionnelle et de Botanique Appliquée* 1:293-297 & 10:453-460.

Gunasena, H.P.M. & A. Hughes 2000. Tamarind: *Tamarindus indica* L. Southampton: University of Southampton.

Harries, H.C. 1990. Malesian origin for a domestic *Cocos nucifera*. In P. Baas, K. Kalkman & R. Geesink (eds.). *The Plant Diversity of Malesia*. pp. 351-357. Dordrecht: Kluwer.

Harris, D. 1977. Alternative pathways to agriculture. In Reed, C.A. (ed.). *Origins of agriculture*. The Hague, Paris: Mouton.

Hayes, L.T. 1992. Plant macro-remains from archaeological sites in the Arawe islands, Papua New Guinea: a study of tree exploitation and the interpretation of archaeobotanical remains in Melanesian prehistory. B.A. Thesis. Melbourne: LaTrobe University. [summarised in Spriggs 1997: 79].

Henderson, C.P. & I.R. Hancock. 1989. *A guide to the useful plants of the Solomon islands*. Honiara: Ministry of Agriculture and Land.

Hutton, W. 1996. *Tropical fruits of Malaysia and Singapore*. Singapore: Periplus Editions.

Jebb, M. & R. Wise. 1992. Edible Barringtonias. *Kew magazine,* 164-180.

Jensen, M. 2001. *Trees and fruits of Southeast Asia: an illustrated field guide*. Bangkok: Orchid Press.

Jin, C. *et al.* 1999. Ethnobotanical studies on wild edible fruits in Southern Yunnan: folk names; nutritional value and uses. *Economic Botany* 53:2-14.

Kirch, P.V. 1989. Second millennium arboriculture in Melanesia: archaeological evidence from the Mussau islands. *Economic Botany* 43:225-240.

Kyle Latinis, D. & M. Stark. 1998. Prehistory, Subsistence and Arboriculture in Central Maluku. In S. Pannell & F. Von Benda-Beckmann (eds.) *Old World Places, New World Problems: Exploring Issues of Cultural Diversity, Environmental Sustainability, Economic Development and Local Government in Maluku, Eastern Indonesia*. pp. 34-65. Canberra: Centre for Resource and Environmental Studies, Australian National University.

Kyle Latinis, D. 1999. Subsistence system diversification in southeast Asia and the Pacific: where does Maluku fit? Ph.D. dissertation, University of Hawai'i.

Kyle Latinis, D. 2000. The development of subsistence models for Island Southeast Asia and Near Oceania: the nature and role of arboriculture and arboreal-based economies. *World Archaeology* 32(1):41-67.

Leenhouts, P.W. 1965. Notes on Canarium (Burseraceae) in the Solomon Islands. *Blumea* XIII (1):163-166.

Lepofsky, D. 1992. Arboriculture in the Mussau Islands, Bismarck Archipelago. *Economic Botany* 46(2):192-211.

Li, P.J-K. 1994. Some plant names in Formosan languages. In A.K. Pawley and M.D. Ross (eds.), *Austronesian terminologies: continuity and change*. Pacific Linguistics C-127. pp. 241-266. Canberra: ANU.

Lynch, J. 2001. *The linguistic history of southern Vanuatu*. Pacific Linguistics 509. Canberra: ANU.

Mahdi, W. 1998. Linguistic data on transmission of Southeast Asian cultigens to India and Sri Lanka. In R.M. Blench and M. Spriggs (eds.) *Archaeology and Language II*. pp. 390-415. London: Routledge.

Massal, E. & J. Barrau. 1956. *Food plants of the South Sea Islands*. South Pacific Community Technical Paper 94. Noumea.

Mazumdar, B.C. 2004. Minor Fruit Crops of India : Tropical and Subtropical. Delhi: Daya.

McKee, H.J. 1994. *Catalogue des plantes introduits et cultivées en Nouvelle-Calédonie*. Paris: Muséum National d'Histoire Naturelle.

Mogea, J.P. 1991. Indonesia: palm utilization and conservation. In D. Johnson (ed.). *Palms for Human Needs in Asia.* pp. 37-74. Netherlands: A.A. Balkema.

Morton, J.F. 1985. Indian almond (*Terminalia catappa*), salt-tolerant, useful, tropical tree with 'nut' worthy of improvement. *Economic Botany* 39(2):101-112.

Morton, J. 1987. *Fruits of warm climates*. Winterville, N.C.: Creative Resource Systems.

Morton, J.F. 1992. The ocean-Going Noni, or Indian Mulberry (*Morinda Citrifolia*, Rubiaceae) and some of its colorful relatives. *Economic Botany* 46(3): 241-256.

Mukherjee, S.K. 1972. Origin of mango (*Mangifera indica*). *Economic Botany* 26(3): 260-264.

Ng, F.S.P. 1975. The fruits, seeds and seedlings of Malayan trees I – XI. *Malaysian Forester* 38:33-99.

Ng, F.S.P. 1976. The fruits, seeds and seedlings of Malayan trees XII - XIV. *Malaysian Forester* 39:110 - 146.

Ng, F. 1978 *Diospyros roxburghii* and the origin of *D. kaki*. *Malaysian Forester* 41(1):43-50.

Othman, Y. & S. Subardhabandhu. 1995. *The production of economic fruits in South-East Asia*. Kuala Lumpur: Oxford University Press.

Pareek, O.P. 2001. *Ber*. Southampton: University of Southampton.

Pawley, A.K. & M.D. Ross (eds.). 1994. *Austronesian terminologies: continuity and change*. Pacific Linguistics C-127. Canberra: ANU.

Piper, J.M. 1989. *Fruits of South-East Asia: facts and folklore.* Singapore: Oxford University Press.

Powell, J.M. 1976. Ethnobotany. In K. Paijmans ed. *New Guinea vegetation*. pp. 106-183. Amsterdam: Elsevier Scientific Publishing Company.

Powell, J.M. 1977. Plants, man and environment in the island of New Guinea. In J.H. Winslow (ed.), *The Melanesian Environment*. pp. 11-20. Australian National University Press, Canberra.

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

Puri, R.K. 2001. *Bulungan Ethnobiology Handbook*. Bogor: CIFOR.

Ragone, D. 1991. Ethnobotany of breadfruit in Polynesia. In P.A. Cox & S.A. Banack (eds.) *Islands, plants and Polynesians: an introduction to Polynesian ethnobotany*. pp. 203-220. Portland: Dioscorides Press.

Ragone, D. 1997. Breadfruit. *Artocarpus altilis* (Parkinson) Fosberg. Rome: IPGRI.

Reid, L. (in press). *Philippines Botanical Dictionary*. Electronic ms.

Ross, M. 1996. Reconstructing food plant terms and associated terminologies in Proto-Oceanic. In J. Lynch & Fa'afo Pat (eds.) *Oceanic studies: proceedings of the first International Conference on Oceanic Linguistics*. pp. 163-221. Canberra: Pacific Linguistics.

Sillitoe, P. 1983. *Roots of the earth, crops in the Highlands of Papua New Guinea*. Manchester: Manchester University Press.

Spriggs, M. 1993. Pleistocene agriculture in the Pacific: why not? In M.A. Smith, M. Spriggs & B. Frankhauser, *Sahul in Review: Pleistocene Archaeology in Australia, New Guinea and Island Melanesia*. Occasional Papers in Prehistory, No. 24. pp. 137-143. Canberra: Department of Prehistory, Research School of Pacific Studies, Australian National University.

Spriggs, M. 1997. *The Island Melanesians*. Oxford: Blackwell Publishers.

Stevens, M.L., R.M. Bourke & B.R. Evans (eds.). 1994. *South Pacific Indigenous Nuts*. ACIAR Proceedings No. 69, Canberra.

Tarepe, P. & R.M. Bourke. 1992. Fruit crops in the Papua New Guinea Highlands. In Bourke, R.M. & V. Kesavan (eds.) *Proceedings of the Second Papua New Guinea Food Crops conference*. pp. 86-100. Port Moresby: Department of Primary Industry.

Tate, D. 2000. *Tropical fruit of Thailand*. Bangkok: Asia Books.

Teide, B. 1967. *Wildpflanzen in der Ernährung der Grundbevölkerung Melanesiens*. Berlin: Akademie-Verlag.

Tirtawinata, M.R., Othman, Y. Veevers-Carter, W. & A. Sidharta. 1995. *Fruit of Indonesia*. Jakarta: Taman Buah Mekarsari.

Tryon, D. 1994. Oceanic plant names. In A.K. Pawley and M.D. Ross (eds.) *Austronesian terminologies: continuity and change*. pp. 481-510. Pacific Linguistics C-127. Canberra: ANU.

Utsunomiya, N. et al. 1998. Diospyros species in Thailand: their distribution, fruit morphology and uses. *Economic Botany* 52(4):343-351.

Verheij, E.W.M. & R.E. Coronel (eds.). 1992. *Edible fruits and nuts*. Bogor: PROSEA.

Verheijen, J.A.J. 1984. *Plant Names in Austronesian Linguistics*. NUSA Linguistic Studies of Indonesian and other Languages in Indonesia vol. 20. Jakarta: Universitas Katolik Atma Jaya.

Vidal, J. 1962. *Noms vernaculaires de plantes (Lao, Mèo, Kha) en usage au Laos*. Paris: EFEO.

Wagstaff, Steven J. & Murray I. Dawson 2000. Classification, Origin, and Patterns of Diversification of Corynocarpus (Corynocarpaceae) Inferred from DNA Sequences. *Systematic Botany* 25(1):134-149.

Walter, A.E. & C. Sam. [trans. P. Ferrar] 2002. *Fruits of Oceania*. ACIAR/Paris: Canberra/IRD.

Walter, A.E. & C. Sam. 1999. *Fruits d'Océanie*. Paris: IRD.

Walter, A.E., Sam C. & G. Bourdy. 1994. Étude ethnobotanique d'une noix comestible: les *Canarium* du Vanuatu. *Journal de la société de Océanistes* 98(1):81-98.

Weisler, M. 1991. The use of mountain apple (*Syzygium malaccense*) in a prehistoric Hawaiian domestic structure. *Economic Botany* 45(2): 281-285.

Whistler, A. 1991. Polynesian plant introductions. In P.A. Cox & S.A. Banack (eds.) *Islands, plants and Polynesians: an introduction to Polynesian ethnobotany*. pp. 41-66. Portland: Dioscorides Press.

Whitmore, T.C. 1979. *Palms of Malaya*. Kuala Lumpur: Oxford University Press.

Wolff, J.U. 1994. The place of plant names in reconstructing proto-Austronesian. In A.K. Pawley and M.D. Ross (eds.) *Austronesian terminologies: continuity and change*. pp. 511-540. Pacific Linguistics C-127. Canberra: ANU.

Yen, D.E. 1974. Arboriculture in the subsistence of Santa Cruz, Solomon islands. *Economic Botany* 28: 247-284.

Yen, D.E. 1977. Hoabinhian horticulture: the evidence and the questions from northwest Thailand. In J. Allen, J. Golsen & R. Jones (eds.), *Sunda and Sahul: Prehistoric Studies in Southeast Asia, Melanesia and Australia*. pp. 567-600. Sydney: Academic Press.

Yen, D.E. 1985. Wild plants and domestication in Pacific Islands. In V. Misra & P. Bellwood (eds.) *Recent Advances in Indo-Pacific Prehistory*. pp. 315-326. New Delhi: Oxford and IBH.

Yen, D.E. 1992. Domestication: the lessons from New Guinea. In A. Pawley (ed.) *Man and a Half: Essays in Pacific Anthropology and Ethnobiology in Honour of Ralph Bulmer*. pp. 558-569. Auckland: The Polynesian Society.

Yen, D.E. 1994. Melanesian arboriculture: historical perspectives with emphasis on the genus Canarium. In M.L. Stevens, R.M. Bourke & B.R. Evans (eds.), *South Pacific Indigenous Nuts*. ACIAR Proceedings No. 69. pp. 36-44. Canberra: ACIAR.

Yen, D.E. 1995. The development of Sahul agriculture with Australia as a bystander. *Antiquity* 69:831-847.

Yonemori, K. *et al.* 1998. Phylogenetic relationship of Diospyros kaki (persimmon) to Diospyros spp. (Ebenaceae) of Thailand and four temperate zone Diospyros spp. from an analysis of RFLP variation in amplified cpDNA. *Genome/Génome* 41(2): 173-182.

Yoshida, Shuji & P.J. Matthews (eds.). 2002. *Vegeculture in Eastern Asia and Oceania*. JCAS Symposium Series 16. Osaka: National museum of Ethnology.

Zizumbo-Villareal, Daniel & Hermilo J. Quero 1998. Re-evaluation of early observations on coconut in the New World. *Economic Botany* 52(1):68-77.

Websites

1. http://www.naturia.per.sg/buloh/plants/morinda.htm
2. http://rsscomp.freeyellow.com/morindacitrifoliastory.htm
3. http://www.geocities.com/harrieshc/coconut.htm