

Harries, H.C. (1990) Malesian origin for a domestic *Cocos nucifera*.  
In *The Plant Diversity of Malesia* ed P. Baas, K. Kalkman and R. Geesink 351-357. Leyden.

## MALESIAN ORIGIN FOR A DOMESTIC *COCOS NUCIFERA*

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### ABSTRACT

At one time it was thought that the ancestors of modern *Cocos nucifera* reached the Western Pacific area by long distance dispersal along a southern route from America, with a fossil (*Cocos zeylandica*) in New Zealand as a remnant of such a pathway. The concept of a southern route is an unnecessary complication. An origin for the whole *Cocoeae* tribe in western Gondwanaland seems most compatible with the present day distribution. The tribe probably differentiated shortly before the break up of that super-continent. Members radiated and became very diverse in the Americas; some rafted on the African and Madagascar Plates, where they survive to the present day; others rafted on the Indian plate, where they are now extinct. With its ability to float the coconut became independent of plate tectonics for its dispersal. The wild type evolved by floating between the volcanic islands and atolls where these fringed the continental plates and not on the lands masses at all. Islands in the Tethys Sea could have been the ancestral home of the coconut, from where it dispersed by floating to other islands in the Pacific and Indian Oceans but not into the Atlantic. It would also have floated to continental coastlines but would have stood less chance of surviving competition from other plants or predation by animals until domesticated by early man. The continental coast and larger islands of Malesia was the site for such domestication long before both wild and domestic types were taken into agricultural cultivation.

### INTRODUCTION

The argument that *Cocos nucifera* reached the Western Pacific area by long distance dispersal along a southern route from America, with a fossil (*Cocos zeylandica*) in New Zealand as a remnant of such a pathway, was originally based on the need to explain the relationship between the coconut and cocosoid palms that occurred in South America). Even when these were assigned to other genera the apparent lack of a "wild" relative in Asia or the Pacific kept this argument alive (Purseglove, 1972). Similarly, the possibility that the modern distribution of the coconut was due mainly to human intervention also confused the issue. In effect, domestication was thought to have produced the coconut we know today and cultivation to have displaced the "wild" relative (Fosberg, 1960).

However, by considering and describing what the likely appearance and properties of a wild type coconut might be it was possible not only to show these might be found as far apart as Palmyra Island in mid Pacific and the Seychelles in the Indian Ocean (Harries 1978) but also to locate previously unsuspected specimens in Australia (Buckley & Harries, 1984) and in the Philippines (Gruezo & Harries, 1984) and on the Malay peninsula in Thailand (Harries et al, 1982). This helps to confirm reports in the literature of coconuts found growing wild in Australia (Bentham, 1863-1878) and Indonesia (Koorders, 1911) and elucidate previously reported, but unexplained, different forms found in Papua New Guinea (Dwyer, 1939) and Borneo (Harries, 1981a).

The purpose of this paper is to make five points:

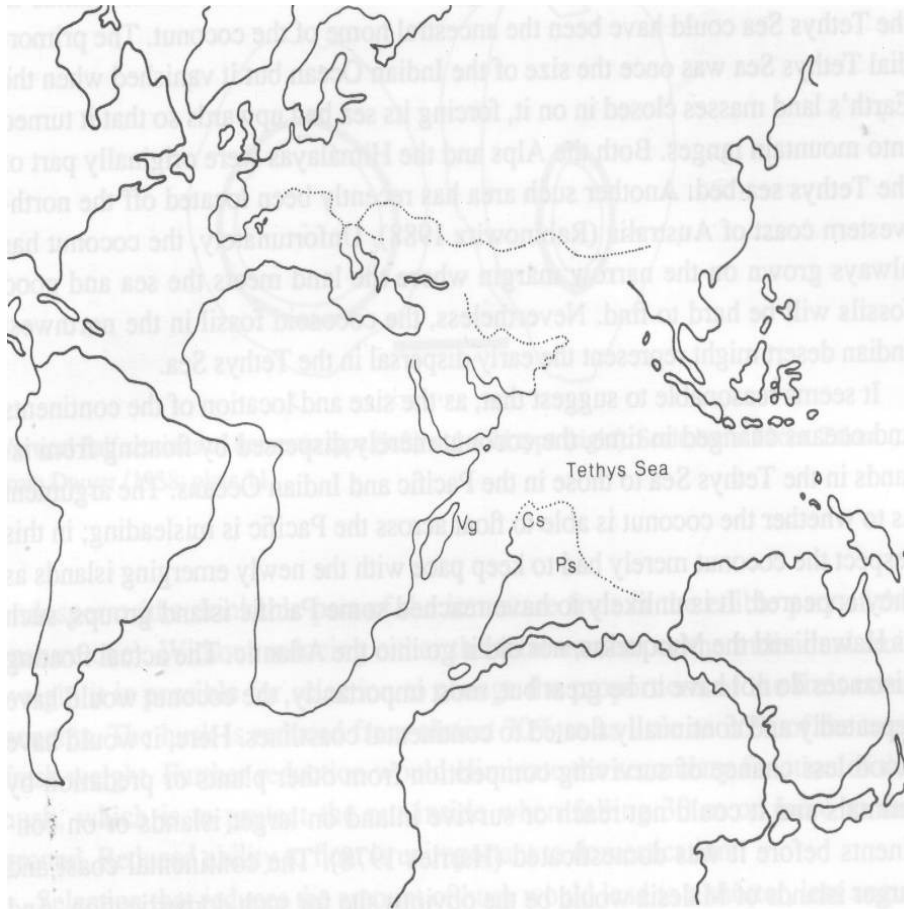
1. that the coconut originated on the fringes of Gondwanaland;
2. that it spread by floating comparatively short distances on the margins of oceans rather than long distances across them;
3. that it had evolved to the recognisable coconut phenotype before man ever met it;
4. that the process of domestication modified it without obliterating the original wild type;
5. that the domestication probably took place in Malesia.

### EVOLUTIONARY DISPERSAL

The general consensus until fairly recently was that the coconut had its origins in Melanesia - an area extending southward (from the Equator) to the Tropic of Capricorn between 145 E - but that it could not have evolved there from any progenitors now alive or extinct. The postulated ancestor was assumed to have carried by ocean currents from South America to Polynesia, or by a southerly migration via Antarctica at a time when the polar climate was very much warmer and when it was part of Gondwanaland (Child, 1974; Purseglove, 1972). This sub-tropical

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continent, may have been vastly bigger than anyone thought with the addition of the Kerguelan Plateau, which stretches for more than 3,000 miles but now lies about half a mile below the surface of the southern Indian Ocean. Fragments of dinosaur teeth and pieces of charcoal have been recovered by the ocean drilling vessel Joides, indicating the one-time presence of dense forests and animal life (Palmer, 1988).



Map locating living (Vg) and fossil (Cs, Cz, Ps) coccosoid palms and modern continental land masses relative to the Tethys Sea. Based on Smith & Briden, 1977; map 7; 100 million years).  
Vg: *Voanioala gerardii*; Cs: *Cocos sahnii*; Cz: *Cocos zeylandica*; Ps: *Palmoxyton sundaram*.

Indeed, it is possible to consider an origin for the whole *Cocoeae* tribe in western Gondwanaland, modern South America (Uhl & Dransfield, 1987). It is suggested that the tribe probably differentiated shortly before the break up of that super-continent. There would have been every ecological niche available, from montane to coastal from temperate to tropical. It was from the coastal tropical group that the coconut emerged. Whilst the other members of the palm family radiated and become very diverse in the Americas; some rafted on the African and Madagascar Plates, where they survive to the present day (Dransfield, 1989); others rafted on the Indian Plate, where now only fossils are found (Sahni, 1946; Kaul, 1951). But it is suggested here that the coconut did not raft on any particular tectonic plate. Nor did it wait to be found and carried by man. With its ability to float the coconut became independent of plate tectonics for its dispersal, and for development of (almost) all of its characteristic features which were subsequently modified by domestication.

The wild type evolved by floating between the volcanic islands and atolls, where these fringed the coastal margins of the continental plates. The coral atoll is considered to be the world's most stable ecosystem and the coconut palm

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is its most successful plant form (Harries, in press). Although it is now seen as part of the typical strand vegetation of coral atolls and an early pioneer of newly emergent volcanic islands - its true location and origin is on coastlines (island or continental) which are submerging. It stands to reason that only when the land began to sink did the coconut learn to swim. It follows that islands in the Tethys Sea could have been the ancestral home of the coconut. The primordial Tethys Sea was once the size of the Indian Ocean but it vanished when the Earth's land masses closed in on it, forcing its sea bed upwards so that it turned into mountain ranges. Both the Alps and the Himalayas were originally part of the Tethys sea bed. Another such area has recently been located off the north western coast of Australia (Rabinowitz, 1988). Unfortunately, the coconut has always grown on the narrow margin where the land meets the sea and good fossils will be hard to find. Nevertheless, the coccosoid fossil in the north west Indian desert might represent the early dispersal in the Tethys Sea.

It seems reasonable to suggest that as the size and location of the continents and oceans changed in time the coconut merely dispersed by floating from islands in the the Tethys Sea to those to the Pacific and Indian Oceans. The argument as to whether the coconut is able to float across the Pacific is misleading; in this respect the coconut merely had to keep pace with the newly emerging islands as they appeared. It is unlikely to have reached some Pacific island groups, such as Hawaii and the Marquesas, nor did it go into the Atlantic. The actual floating distances do not have to be great but, most importantly, the coconut would have repeatedly and continually floated to continental coastlines. Here, it would have stood less chance of surviving competition from other plants or predation by animals and it could not reach or survive inland on larger islands or on continents before it was domesticated (Harries, 1978). The continental coast and larger islands of Malesia would be the obvious site for such domestication. And this must have happened long before the wild and the domestic types were both taken independently into agricultural cultivation. In this respect it is important to realise that domestic coconuts are not necessarily the same as cultivated coconuts. Nor are wild coconuts primitive or small fruited (Harries, 1981b).

## DOMESTIC SELECTION

The ethnobotanical pathways of domestic selection detailed elsewhere (Harries, 1978) are briefly restated here. Successful natural dissemination depends on a balance between fruit number and fruit size. Selection for one would be antagonistic to the other. If the palm produces a large number of fruit this would improve the chances of reaching more sites at which to become established. If it produces bigger fruit this would increase the distance over which it could travel and remain viable. Thus wild type coconuts found in the Laccadive Islands are small fruited, as are those in Vanuatu, since both these island groups consist of many small islands. The wild type fruit size in more remote islands such as the Seychelles, Palmyra and Christmas Island are bigger.

In contrast, the selection value of increased fruit size or number is irrelevant to domestication. The important selection to be emphasised is for increased endosperm (the drinkable part of the immature fruit or the edible part of the mature one). Without reducing either the total number or the individual fruit weight it is possible for selection to change the proportions of the fruit components. The husk which is reduced from almost 70% to as little as 35% of the total fresh weight. Further reduction would eliminate the secondary function of the husk, which is to protect the nut inside when falling 30m or more to the ground. Reduced ability to float is unimportant to domestication.

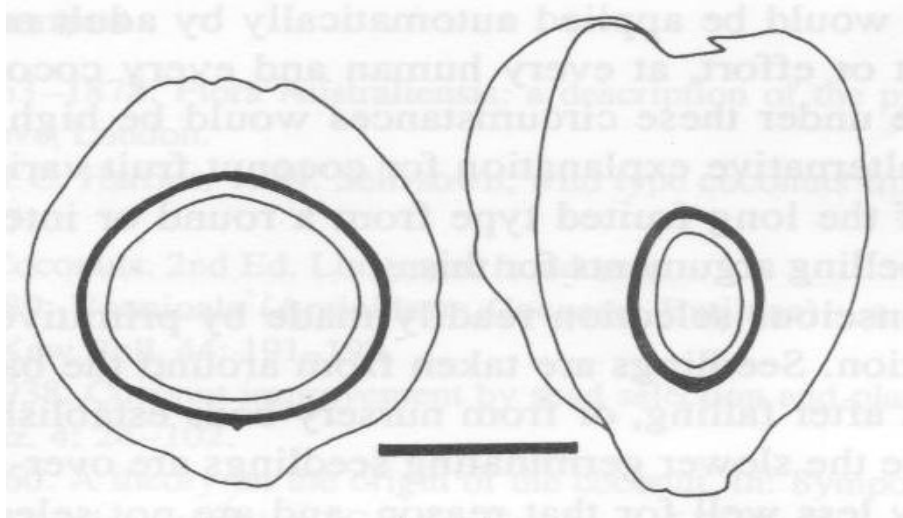
Selection that reduces the amount of husk would lead to a shorter, less angular and, eventually, almost spherical fruit. The facile explanation for the domestication of crop plants, that human selection increased the number or size of the edible parts, is inappropriate for an already large-fruited coconut. Although the weight of the fruit might be increased marginally by selection the shape of the fruit is radically altered. The coconut fruit with a high proportion of husk is long and angular. These characters favour dissemination by floating as well as preventing it rolling in the surf so that it remains on the beach to root and does not easily wash away again. The shape of the fruit is reflected in the shape of the nut inside. The long fruit has a long, spindle-shaped nut, pointed at the end opposite the embryo, and with a thick shell.

In contrast the reduction in husk thickness and increase in water content lead to a spherical fruit has a spherical or oblate nut and, because the proportion of shell does not change, the increased volume results in a thinner shell. A thin shell, more liable to crack, is a disadvantage to natural dissemination. A large nut with a flat base is useful as a bottle, a cup or a bowl, and the "bottle" comes already filled with a drinkable liquid. Indeed, the coconut must come high on a list of plants first used by Palaeolithic man (Harries, 1979).

The desirability of individual palms would become well known and they would be identified by name (as still occurs today). Visual selection for fruit shape is easy and would be applied automatically by adult or child, without

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conscious thought or effort, at every human and every coconut generation. Selection pressure under these circumstances would be high, despite cross-pollination. Any alternative explanation for coconut fruit variation would involve selection of the long-fruited type from a round or intermediate form. There are no compelling arguments for this.



Vertical half section of domestic type (left) and wild type (right). Scale bar = 10cm. Taken from Dyer, (1938: plate 11).

A further unconscious selection readily made by primitive farmers is for speed of germination. Seedlings are taken from around the base of the palm, where they sprout after falling, or from nursery beds established for the purpose. In either case the slower germinating seedlings are over-shaded by early germinators, grow less well for that reason, and are not selected at planting time. Where there are differences in husk thickness, the sprout emerges sooner from the thin husk. As the fruit gets less elongated and more spherical, they would come to rest after falling, or they would be set, on their base rather than their side. This is common practice because the position gives quicker germination. It also gives lower total germination, which is a disadvantage to natural dissemination and to commercial production but is immaterial to primitive cultivators who often allow a natural understory of seedlings to develop at higher plant densities than are desirable (Wickremasuriya, 1975). Ultimately, selection could result in germination on the bunch, as with *Nypa*. This has been observed under conditions of high humidity on the round fruited varieties. It has never been reported under any condition from long fruited varieties. The fruit of these fall from the palm when ripe. It need hardly be said that early germination is absolutely undesirable for dissemination by floating. Conversely, there is no reason to consider slow germination agriculturally desirable. The germination rate of the coconut, *Cocos nucifera* L., its long distance dissemination by floating and the fact that the speed of germination turned out to be a characteristic of taxonomic significance also showed how the genetic uniformity of the coconut populations on remote oceanic islands might be maintained (Harries, 1981c).

Archeological evidence in support of the domestication theory was subsequently located in Borneo (Harries, 1981a) but efforts to identify shell fragments in Papua New Guinea (Hossfeld, 1948; Kirch, personal communication, 1987) and Solomon Islands (Spriggs, 1984) have been less successful. Until and unless more archaeological and palaeological coconut remains are unearthed in the Malesian region the probability that coconuts were domesticated there can remain only a speculation. In the meantime, taxonomists and other botanists should not assume that coconut is merely a cultivated species with no wild relatives. Closer examination of small groups of palms found outside obvious cultivations and particularly in isolated areas might reveal whether they resemble wild or domestic types. The presence of human populations, either now or in the past, is not necessarily a criterion for successful establishment of the coconut palm on the seashore but is essential to its survival inland.

#### ACKNOWLEDGEMENTS

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The author is indebted to Professor Baas, Professor Kalkman, Dr. Geesink and to the members of the Flora Malesiana Symposium Organising Committee for the opportunity to participate in this meeting.

## REFERENCES

- Bentham, G. 1863-1878 *Flora Australiensis: a description of the plants of the Australian Territory*. Reeve, London.
- Buckley, R. & Harries, H.C. 1984 Self-sown, wild type coconuts from Australia. *Biotropica* 16, 148-151.
- Child, R. 1974 *Coconuts*. Lonoman, London second edtion.
- Dransfield, J. 1989 Voanioala (Areioidece; Cocoeae; Butiinae) a new paalm genus from Madagascar. *Kew Bull.* 44 (2) 191-198.
- Dwyer, R.E.P. 1938 Coconut improvement by seed selection and plant breeding. *New Guinea Agricultural Gazette* 4, 24-102.
- Fosberg, F.R. 1960 A theory on the origin of the coconut. In: *Symposium on the impact of man on humid tropics vegetation*. Goroka, Territory of Papua New Guinea pp.73-75. Comm. Govt. Printers, Canberra.
- Gruezo, W.Sm. & Harries, H.C. 1984 Self-sown, wild-type coconuts in the Philippines. *Biotropica* 16, 140-147.
- Harries, H.C. 1978 The evolution, dissemination and classification of *Cocos nucifera*. *Botanical Review* 44, 265-320.
- Harries, H.C. 1979 Nuts to the Garden of Eden. *Principes* 23, 143-148.
- Harries, H.C. 1981a The antiquity of the coconut in Western Borneo. *J. Sarawak Mus.* XXXIX 50, 239-242.
- Harries, H.C. 1981b Practical identification of coconut varieties *Oleagineux* 36,63-72.
- Harries, H.C. 1981c Germination and taxonomy of the coconut palm. *Ann. Bot.* 48, 873-883.
- Harries, H.C. (in press) The biogeography of the coconut palm. *Principes*
- Harries, H.C., Thirakul, A. & Rattanapruk, V. 1982 Coconut genetic resources of Thailand. *Thai. J. Agric. Sci.* 15 2, 141-156.
- Hossfeld, P.S. 1948 The stratigraphy of the Aitape skull and its significance. *Trans. Roy. Soc. S. Aust.* 72, 201-207.
- Kaul, K.N. 1951 A palm fruit from Kapurdi (Jodhpur, Rajasthan Desert) *Cocos sahnii* Sp. Nov. *Current Science (India)* 20 (5), 138.
- Koorders, S.H. 1911 *Exkursion flora von Java*.
- Palmer, A. 1988 Joides Resolution Expedition, Texas A&M U. In: Berry, A. "Continent found under ocean", *Daily Telegraph*, 20th June 1988.
- Purseglove, J.W. 1972 *Tropical Crops: Monocotyledons*. Longman, London.
- Rabinowitz, P. 1988 Joides Resolution Expedition, Texas A&M U. In: Berry, A. "Clue to ancient 'jigsaw puzzle'" *Daily Telegraph*, 10th October 1988.
- Sahni, B. 1946 A silicified *Cocos*-like palm stem, *Palmoxydon (Cocos) sundaram*, from the Deccan Intertrappean beds. *J. Indian Bot. Soc.* Iyengar commemorative volume, pp. 361-374.
- Smith, A.G. & Briden, J.C. (1977) *Mesozoic and Cenozoic paleocontinental maps*. Cambridge Earth Science Series, CUP.
- Spriggs, M.J.T. 1984 Early coconut remains from the South Pacific. *Polynesian Society J.* 93, 71-77.
- Uhl, N.W. & Dransfield, J. 1987 *Genera Palmarum*. Allen Press, Lawrence.
- Wickremasuriya, C.A. 1975 Situation of the coconut industry in the Republic of the Maldives. *FAO 4th Technical*

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Map locating living (Vg) and fossil (Cs, Cz, Ps) cocosoid palms and modern continental land masses relative to the Tethys Sea. (Based on Smith & Briden (1977), Map 7: 100 million years).

Vg = *Voanioala gerardii*

Cs = *Cocos sahnii*; Cz = *Cocos zeylandica*; Ps = *Palmoxylon sundaram*

Figure showing half section of domestic type left and wild type right after Dwyer (as used in Buckley & Harries, 1984)