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Current cruising coconuts: a new record of viable *Cocos nucifera* reaching New Zealand shores, and a brief review of New Zealand drift disseminule literature

Timothy J Martin

Introduction

Ocean dispersed plant parts, including fruits, seeds, and viviparous seedlings, are termed 'drift disseminules' (Smith 1992). Drift disseminules can be categorised as local, originating from a nearby source; refuse, arriving near the place of deposition by human dispersal; and 'peregine', seeds that truly exhibit long distance oceanic dispersal (Nelson 2000). In terms of ecological significance, the maintenance of seed viability for the duration of the journey is critical, if the movement is to result in successful dispersal for the species involved. Seeds capable of oceanic dispersal while retaining viability are less dense than water, for example by the presence of a fibrous coat or air pockets, and have a tough seed coat that is impermeable to water when intact (Nelson 2000).

The two key vectors of dispersal once a seed has entered a body of water are currents and wind. If a seed floats on or below the water surface, its direction will be primarily determined by current. If a seed rides high in the water, direction will be mainly determined by the prevailing wind direction (Nelson 2000). Whether a seed arrives at its destination viable or not, depends upon the viability period in seawater for the species involved, and the length of time the seed has been in transit. Therefore, the speed of ocean currents and prevailing winds play an important role in oceanic seed dispersal.

Coconut (*Cocos nucifera*) seeds washed up at Takou Bay, Northland

Takou Bay is an exposed sandy beach that lies between the Purerua Peninsula and Matauri Bay in Eastern Northland. The beach faces north east and typically has a well developed strand-line composed of seaweed, driftwood, and human rubbish. The beach also receives a significant amount of locally sourced debris from the Takou River, which enters the sea at the northern end of the beach. During the course of a summer in the late 1990's six coconuts with husk still attached were found along the strand-line at Takou Bay. Any coconuts that were in good condition (not foul smelling or encrusted with barnacles) were collected. The seeds were sown onto the surface of a sandy mix on a heat-pad maintained at c. 30ºC. One coconut germinated and has since grown in a greenhouse to c. 2 m tall (AK 257792 TJM 165, Fig. 1). As light frosts occur at Takou Bay during cold winters, the survival of this plant is dependent on greenhouse temperatures. The arrival of a viable coconut on a Northland beach raises the question of its' origin. Coconuts are not grown in New Zealand; therefore the coconut was either discarded locally, or arrived here from a distant source. Experiments on coconuts when floated in saltwater have shown that viability can be maintained under these conditions for c. 100 days (Nelson 2000). Viable coconuts arrive on the shores of Rodriques Island in the Indian Ocean, a distance of c.4800 kilometres from the nearest possible source. Dennis and Gunn (1971) claimed that a journey of this distance would take c. 3 – 4 months in several of the worlds' ocean current systems. Dennis and Gunn also noted that c.4800 kilometres appears to be the maximum voyage a coconut can travel while still remaining viable.

Possible origins of North Island drift disseminules

Drift disseminules arriving on New Zealand shores potentially originate from anywhere in the southern Pacific Ocean, including Tonga, Fiji, New Caledonia, Vanuatu, Australia, and possibly even New Guinea and the Solomon Islands (Smith 1990, 1992). The south Equatorial Current moves westward through the Pacific south of the equator, and upon reaching Australia is diverted southwards to become the East Australian Current. The West Wind Drift then sweeps drift disseminules in this current east and north east towards New Zealand (Smith 1990, Smith *et al.* 1990). The most probable source for tropical seeds arriving on the New Zealand coast is therefore the western South Pacific Ocean.

Other drift seeds on New Zealand beaches: a brief review

A search of the relevant literature revealed that c. 14 species of drift seeds have been recorded as arriving on the New Zealand coastline (including the Kermadec Islands and Chatham Islands). This number includes species endemic to New Zealand found on landmasses where the species is not known to be present as plants, for example *Sophora chathamica* (as *S. microphylla*) seeds on the Kermadec Islands (Sykes and Godley 1968). Applying a stricter criterion, with all endemic species and species known from cultivation in New Zealand eliminated, the number of confirmed drift seed species in New Zealand may number as few as 11. Records of drift disseminules in New Zealand are summarised in Table 1.

Fig. 1. Coconut palm (*Cocos nucifera*) grown from a seed washed up at Takou Bay, Northland

Mason (1961) wrote an account of seeds washed up on Ninety Mile Beach in the winter of 1956 and the following summer. Drift disseminules identified included *Aleurites fordii* (Euphorbiaceae), *Barringtonia asiatica* (Lecythidaceae), *Cocos nucifera* (Arecaceae), *Entada* sp. (Leguminosae), *Caesalpinia bonduc* (as *Guilandina crista*) (Leguminosae), *Mucuna gigantea* (Leguminosae), and seeds of two other *Mucuna* species. Seeds of an unidentified cycad and a red leguminous seed [possibly *Erythrina* sp.?] were also reported. Seven of the 22 *Entada* seeds germinated 21 months after sowing.

A search of coastlines on the Kermadec Islands in 1968 found seeds of *B. asiatica*, *Entada phaseoloides* (as *E. scandens*), *Ipomoea pes-caprae* ssp. *brasiliensis* (Convolvulaceae) and *Canavalia rosea* (as *C. maritima*) (Leguminosae) (Sykes and Godley 1968). Seeds of the *I. pes-caprae* ssp. *brasiliensis* and *C. rosea* may have originated from the Kermadec Islands, but Sykes and Godley suggested that the other tropical species arrived during summer when currents are mainly from the north-east. Plant material of New Zealand mainland origin was also found, including trunks of *Podocarpus totara* or *P. hallii*, and 32 seeds of *Sophora chathamica*. A sample of the *Sophora* seeds were sown and found to have high viability (12 out of 13 seeds). Sykes and Godley suggested these seeds were carried to the Kermadec Islands by a current that flows north-eastward from northern New Zealand, which occurs during the winter months. Viable seed of *S. microphylla* have also been found on the Chatham Islands, 800 kilometres south east of New Zealand (Norton *et al.* 2002, Molloy 2002).

Recently, Waller (1995) found a *Aleurites moluccana* (candlenut) seed and an *Entada phaseoloides* seed on Rangatira Beach, north west of Auckland; and a seed of *Barringtonia asiatica* was found on Whangapoua Beach, Great Barrier Island in January 2002 (Cameron *et al.* 2002).

Coconuts have also been found on several beaches near North Cape, and in July 1982, a sprouting coconut that had been killed by frost was found by Peter Anderson on Taharoa Beach, western Waikato (Peter de Lange *pers. comm.*, specimen held at WAIK!). Young coconut trees are a common occurrence on Kermadec Island beaches. Sykes and West (1996) suggested the most likely source for these plants was discarded coconuts from locally passing ships.

The only known case of a tropical strand plant species establishing to maturity on the New Zealand mainland presumably from (as we don't know for sure) drift disseminules, is that of *Ipomoea pes-caprae* ssp. *brasiliensis* on Ninety Mile Beach (Cooper 1967, Sykes 1970). This species has a widespread distribution in the South Pacific and is able to establish on exposed, sandy coasts. The temperate strand-plants *Atriplex billardierei* and *Atriplex cinerea* (Chenopodiaceae) appear to have established successfully here after ocean dispersal from Australia. The distribution of *A. billardierei* on Tasmania, and only Chatham Island in the New Zealand region, is explained by an eastward flowing current that passes to the south of New Zealand, linking these two disjunct populations (de Lange *et al.* 1998, 2000).

Conclusions

Viable seeds of *Entada* sp., *Ipomoea pes-caprae* ssp. *brasiliensis*, and *Cocos nucifera*, arrive on the New Zealand coast. The presence of viable *Entada* seeds on

North Island beaches is perhaps the best evidence for viable seeds of tropical origin reaching New Zealand, because unlike coconuts, *Entada* is not a species commercially imported into New Zealand. It is therefore very unlikely that these seeds originated from locally discarded refuse. The most probable source for these seeds is northern Australia and the western Pacific (Wagner *et al.* 1990). The natural dispersal of viable coconuts from the tropics to New Zealand is therefore also possible, and the distances involved are certainly within its known viable dispersal range.

Table 1. Recorded drift disseminules in New Zealand (inclusive of records determined to genus or species level only)

Species	Location & date	Possible origin	Viable?
Atriplex billardierei	South Island (now extinct) Chatham Islands (plants)	Australia, Tasmania1	Yes
Atriplex cinerea	Cook Strait region (plants)	Australia, Lord Howe Is., Norfolk Is. [2]	Yes
Aleurites fordii	90 Mile Beach, 1956	Widespread in Pacific[3], cultivated in NZ (significantly at Te Paki)	Not tested
Aleurites moluccana	Rangatira Beach, 1990's	Widespread in Pacific [3]	Not tested
Barringtonia asiatica	90 Mile Beach, 1956	Widespread in the tropical Pacific, Asia	Not tested
	Whangapoua Beach, 2002	[4]	Not tested
	Kermadec Islands, 1966		Not tested
Canavalia rosea	Kermadec Islands, 1966	Widespread in the Pacific [3]	Not tested
Cocos nucifera	90 Mile Beach, 1956	Widespread in the tropical Pacific [3]	Not tested
	Taharoa Beach, 1982 (dead seedling)		Yes
	Waikuku Beach 1990		Not tested
	Tom Bowling Bay, 1991		Not tested
	Ngakengo Beach, 1996		Not tested
	Takou Bay, late 1990's		1 from 6
Entada phaseoloides	Rangatira Beach, 1990's	Australia, western Pacific[5]	Not tested
	Kermadec Islands, 1966		Not tested
Entada sp.	90 Mile Beach, 1956	America, Africa, Australia[3]	7 from 22
Caesalpinia bonduc	90 Mile Beach, 1956	Tropical Pacific6	Not tested
Ipomoea pes-caprae ssp. *brasiliensis*	Kermadec Islands, 1966	Widespread in the Pacific[3]	Not tested
	90 Mile Beach 1960's (plants now dead due to forestry)		Yes
	Twilight Beach (plants)		Yes
Mucuna gigantea	90 Mile Beach, 1956	Old and New World Tropics [3]	Not tested
Mucuna sp.	90 Mile Beach, 1956	Old and New World Tropics [3]	Not tested
Sophora chathamica	Kermadec Islands	North Is., New Zealand [7]	12 from 13
Sophora microphylla	Chatham Islands	South Is., New Zealand [8]	Yes
		South Is., New Zealand [9]	12 from 12
			>126 from 256

1. de Lange *et al.* 2000, 2. de Lange *et al.* 1998, 3. Mabberley 1997; 4. Cameron *et al.* 2002; 5. Wagner *et al.* 1990, 6. Smith 1990, 7. Sykes and Godley 1968, 8. Norton *et al.* 2002. 9. Molloy 2002.

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The current status of biogeography in New Zealand

Michael Heads

A recent biogeography symposium held in Lincoln, New Zealand brought together a wide range of authors to discuss aspects of Southern Hemisphere biogeography. Although the full papers have not been published together, the abstracts were collated (Stewart 2000) and these allow a summary analysis of the authors' views. Many of the abstracts supported either a recent center of origin/long distance dispersal (l.d.d.) paradigm or ancient vicariance for the origin of the various groups studied. (Vicariance is a term and concept introduced by Leon Croizat 1958, 1964, and subsequently developed by several Ph.D. students in New Zealand through the 1970s and 80s, cf. Matthews 1990, Craw *et al.* 1999). Not all the symposium papers could be allocated to one or other model, but the 20 that could revealed an interesting pattern, as the following table shows.

Author	Taxon studied	Author's country	Model	Notes
Bickel	Diptera	Australia	vicariance	
Burckhardt	Hemiptera	Switzerland	vicariance	
Cameron	orchids	U.S.A.	vicariance	
Hansen & Richardson	Parastacidae	Australia	vicariance	
Harvey	Arachnida	Australia	vicariance	
Swenson *et al.*	*Nothofagus*	Sweden/Australia	vicariance	(basally in the subgenera)
Henderson & Gullan	Hemiptera	NZ/Australia	vicariance	
Smith *et al.*	molluscs	Australia	vicariance	
Smith & Villouta	benthic taxa	Chile/NZ	?vicariance	('Gondwanic links')
Johns	Orthoptera	NZ	?vicariance	('late in the Cretaceous')
Sponer *et al.*	echinoderms	NZ	?vicariance	(l.d.d. at 100 Ma)
Hoare	Lepidoptera	NZ	l.d.d.	
Jordan	angiosperms	Tasmania	l.d.d.	
Simon *et al.*	cicadas	NZ/USA	l.d.d.	
Wagstaff *et al.*	plants	NZ/Chile	l.d.d.	
Waters & Wallace	galaxiid fishes	NZ	l.d.d.	
Winkworth & Lockhart	angiosperms	NZ	l.d.d.	
Winkworth *et al.*	*Myosotis*	NZ	l.d.d.	
Stöckler	*Nothofagus*	NZ		(Pleistocene glaciation)
Wagstaff & Dawson	*Corynocarpus*	NZ	l.d.d.	('Centre of origin')
Wagstaff & Swenson	*Tetrachondra*	NZ/Sweden	l.d.d.	