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Drift disseminules on Fijian beaches

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Abstract Drift disseminule assemblages were studied on nine beaches on and near Viti Levu, Fiji. Seventy-three species were recorded, largely belonging to beach forest and mangrove communities, but including several species from freshwater habitats and several species introduced to Fiji. Seeds of many species had germinated. Most taxa represented have been shown elsewhere to have disseminules capable of floating over long periods and distances. Some disseminules from Fiji and nearby islands may be carried to eastern Australia and New Zealand.

Keywords Fiji; drift disseminules; seed dispersal; sea currents

INTRODUCTION

The dispersal of seeds by sea currents has long interested botanists in the tropical Pacific region, in particular Guppy (1906) and Ridley (1930) whose detailed accounts remain fascinating and informative reading today. Many of Guppy's original observations, both of seed dispersal by sea and of the littoral plant communities mainly involved, were undertaken in Fiji. The precise sites where he worked are not recorded. However, his observations of riverine drift were made mostly in the Rewa estuary, and in this case comparisons with the present work are made below. There has been a dearth of such studies since these pioneering works. Specimens collected on Viti Levu by Mrs Clocker in 1972 have been illustrated in a global catalogue by Gunn et al. (1976), but for Fiji little else has been published recently. This contrasts with the more extensive literature on tropical "drift seeds" from Atlantic beaches (e.g., Gunn et al. 1976; Nelson 1978, 1989).

Disseminules (seeds, viviparous seedlings, fruits, and their fragments) were studied on nine Fijian beaches in August 1988, as part of a broader investigation of seed dispersal by sea currents in the south-west Pacific region. Investigation over a longer period, including more beaches and at other seasons, no doubt would have yielded a more complete picture. Nevertheless, in the absence of similar published data, it is considered worthwhile presenting the results of this investigation here.

STUDY SITES

Beaches investigated are located on and near Viti Levu, largest island in the Fiji group, as shown in Fig. 1. Some of their characteristics are given in Table 1, and they are further described below. Authorities for species names are given in Table 2, or at first mention in the text for species not named in Table 2.

Beaches on the small island Nananu-i-Ra were partly sheltered by fringing reefs, and backed by beach forest (little disturbed in many parts) in which *Cocos nucifera, Cordia subcordata, Erythrina variegata, Hernandia nymphaeifolia, Scaevola taccada, Terminalia catappa,* and *Thespesia populnea* were locally common, and many other plants occurred; *Canavalia sericea* A. Gray and *Ipomoea pes-caprae* were the commonest beach vines. Beaches to either side of the island's north-west peninsula were not exposed to prevailing winds and waves (from the south-east or east), unlike the east-facing beach. Mangroves grow along the south-west shore, but hardly at all near the studied beaches.

Two beaches probably receive riverine drift from the Rewa River, as well as oceanic drift across the

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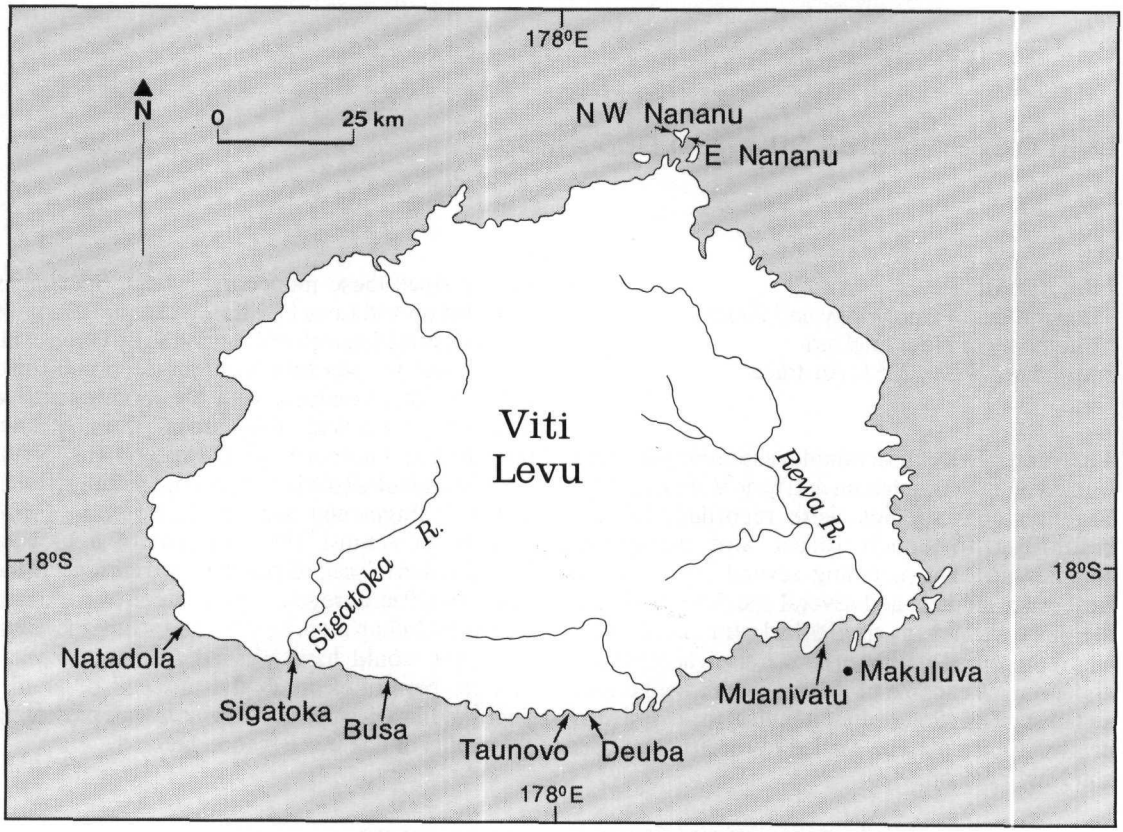

Fig. 1 Locations of study sites.

fringing reef. The cay Makuluva, lying near the edge of the reef, is well exposed to the open sea. It is covered by disturbed beach forest in which *Leucaena leucocephala* (Lam.) de Wit, *Scaevola taccada*, and *Terminalia catappa* are prominent, with *Canavalia rosea* (Sw.) DC, *Ipomoea pes-caprae*, and *Vigna marina* as common beach vines. The greatly disturbed vegetation along the very sheltered shore at Muanivatu is mainly mangrove forest.

Deuba and Natadola beaches both face wide gaps in the fringing reef, and are exposed to heavy wave action. Taunovo and Busa receive ocean drift only across a sheltering reef, and Taunovo also receives drift from a small river draining through an area of mangrove forest behind the beach. All four of these beaches are backed by disturbed beach forest. *Scaevola taccada* is prominent at each, although its population is apparently being invaded and replaced by *Chrysobalanus icaco* at Deuba. *Cocos nucifera* and *Sophora tomentosa* are prominent at Busa, as are *Argusia argentea* (L.f.) Heine, *Calophyllum inophyllum*, and *Thespesia populnea* at Natadola.

Sigatoka is an estuarine site, probably receiving disseminules from riverine drift but not from the ocean to which it is connected by a narrow, winding channel. Mangrove forest lines nearby shores.

Table 1 Some characteristics of beaches studied. **B**: Beach forest, **M**: Mangrove forest, **O**: Oceanic drift, **R**: Riverine drift.

Site	Aspect(s)	Local disseminule source(s)	Distant disseminule source(s)	No. disseminule taxa recorded
NW Nananu	N,S	B	O	32
E Nananu	E	B	O	51
Makuluva	All	B	O,R	43
Muanivatu	SE	M	R,O	33
Deuba	S	B	O	33
Taunovo	S	B,M	O,R	33
Busa	S	B	O	25
Sigatoka	SW	M	R	19
Natadola	SW	B	O	30

METHODS

At each site, general and vegetational characteristics were noted. A careful survey was undertaken of strandline disseminules, taking 0.5–3.0 hours depending on length of beach and quantity of drift material. Representative specimens were collected, and an estimate made of the abundance of all taxa on a four-point scale using the following values, averaged across the whole beach: a – at least one per metre of strandline; b – at least one per 10 m of strandline; c – at least one per 100m of strandline; d – present at lower abundance than c.

Small disseminules were specifically searched for at suitable places. Nevertheless, values in Table 2 should not be interpreted too literally. Large, conspicuous disseminules (e.g., *Atuna racemosa, Barringtonia asiatica, Cocos nucifera, Entada phaseoloides*) will have been recorded more fully and accurately than much smaller ones, especially those only a few millimetres in length (e.g., *Colubrina asiatica, Hibiscus tiliaceus, Vigna marina, Vitex trifolia*). Time constraints precluded more systematic searching which prior experience suggested would be time-consuming and relatively unproductive.

At some sites, especially on the south coast, sand movement by wind along the beach had buried much of the strandline debris including disseminules, and two potential sites were abandoned due to the extent of this problem. At Makuluva and Natadola, storm waves had pushed much of the strandline debris into the edge of the beach forest. For these reasons disseminule abundances at different sites cannot be compared closely.

Common strandline drift materials included wood and pumice, as well as disseminules. Plastic and other materials of human manufacture were generally scarce, except at Muanivatu (on the outskirts of the capital, Suva).

IDENTIFICATIONS

Most common drift disseminules of the tropical Pacific region are well known to local botanists. Confirmation of identity was made in many cases by finding disseminules still attached to plants. Herbarium specimens were collected where desirable, and identified and deposited at the South Pacific Herbarium, Suva. A residue of indeterminate disseminules remains, all being small and uncommon. In the following genera determination to species is problematic, and notes are provided below in clarification. Reference specimens of disseminules have been incorporated into a collection held at the author's address; specimen numbers are quoted in Table 2.

Annona: A single fruit matching that of *A. squamosa* was found. Far commoner were seeds matching those of *A. glabra* illustrated in Gunn et al. (1976) and that name is given to them here. However, other *Annona* species are grown in Fiji and their seeds have not been examined.

Canarium: Although fruit size is variable in *C. harveyi*, specimens from Taunovo appear to belong to this native species. A single, larger fruit from Muanivatu probably belongs to either *C. indicum* L. or *C. vulgare* Leenh., both being commonly cultivated in Fiji.

Erythrina: Most seeds found matched specimens collected from littoral trees of *E. variegata*. A single seed from Makuluva belongs to a different species (also recorded on New South Wales beaches), possibly *E. crus-galli* L. but provisionally called *Erythrina* sp. 3.

Mucuna: Most *Mucuna* seeds found on Fijian strandlines are rather uniform in size and shape. They always have a black hilum but vary greatly in general coloration from brownish pink through chestnut to black, with varying degrees of black speckling. Of about 80 seeds collected on the east-facing beach at Nananu-i-Ra c. 15% were black and c. 10% had some degree of black speckling on a brown background. Probably they all belong to *M. gigantea*. A herbarium specimen of *M. gigantea* in the South Pacific Herbarium, collected on Nananu-i-Ra by J. E. Ash, bears pinkish brown seeds of this type, although the species is usually described as having seeds that are black (Gunn et al. 1976), or either black or brown mottled with black (Verdcourt 1979). Black seeds on Fijian strandlines commonly were more shrunken and found further up the beach than paler ones, and it appears that seeds tend to darken with age and exposure to sunshine.

Less common is another type of *Mucuna* seed, somewhat larger and less consistently circular in outline than *M. gigantea*, and usually with a conspicuous central bulge. Most are black, with either a black or partly tan hilum; rarely seeds of the same shape and size are found which are bright red-brown with a tan hilum: these match seeds collected at Swain Reefs, Queensland, and named *Mucuna* sp. 1 and *Mucuna* sp. 6, respectively (Smith et al. 1990). The former might represent either or both of the two other Fijian native *Mucuna* species (*M. platyphylla* A. Gray, *M. stanleyi* C.T. White; Smith 1985) and the latter might be *Dioclea* sp. (Smith 1985) but in

the absence of suitable herbarium specimens or descriptions this cannot be checked.

Pandanus: The taxonomy of this large genus is complex. Stone (1976) has proposed that numerous littoral taxa from the tropical Pacific region cannot properly be separated, and ought to be grouped within the single species *P. tectorius*. Pyrenes from strandlines in the present study are given this name.

Canavalia, Endiandra, Merremia, Psidium, Rhizophora, Xylocarpus: In each of these genera more than one species grows in Fiji, and disseminules collected on strandlines could not be identified to species level. In these cases only the genus name is used here.

RESULTS

Drift disseminules recorded at the nine studied beaches are listed in Table 2. Seventy-three taxa were recorded overall. Eight were found at every beach, and a further eight were absent from only one

Table 2 Disseminules recorded on nine Fijian beaches. *1: Alien; 2: Observed germinating on strandline; 3: Recorded at Swain Reefs; 4: Recorded at Canton Island; 5: Known to be capable of floating one month. See Discussion for details of 3, 4, 5. For definition of abundance scale see Methods.

Taxon	Ref. Spec.	Notes*	Abundance								
			NW Nananu	E Nananu	Maku-luva	Muani-vatu	Deuba	Tau-novo	Busa	Siga-toka	Nata-dola
Albizia saman (Jacq.) Muell.	1043	1	-	c	-	-	-	-	-	c	-
Aleurites moluccana (L.) Willd.	1058	345	b	a	b	a	b	b	c	a	c
Annona glabra L.	1088	125	-	c	c	b	b	d	d	a	d
Annona squamosa L.	1080	15	-	-	-	-	-	-	-	-	d
Atuna racemosa Raf.	1000	345	c	b	a	a	c	c	c	-	c
Barringtonia asiatica (L.) Kurz	-	2345	b	a	c	a	a	b	a	b	c
Barringtonia racemosa (L.) Spreng.	1014	25	d	c	a	a	b	b	c	-	c
Bruguiera gymnorrhiza (L.) Lam.	1018	25	-	c	b	a	a	a	c	a	d
Caesalpinia bonduc (L.) Roxb.	1077	345	-	c	-	-	-	d	-	-	-
Calophyllum inophyllum L.	1010	2345	a	a	c	a	b	c	a	d	c
Canarium harveyi Seem.	1095	-	-	-	-	-	-	d	-	-	-
Canarium sp.	1004	1	-	-	-	d	-	-	-	-	-
Canavalia sp./spp.	1115	4	c	d	b	-	-	-	-	-	d
Casuarina equisetifolia L.	1089	4	-	d	d	-	-	-	-	d	-
Cerbera manghas L.	1005	345	-	d	d	d	-	-	-	-	-
Chysobalanus icaco L.	1101	125	-	-	d	d	b	d	-	-	-
Clerodendrum inerme (L.) Gaertn.	1087	45	-	-	d	-	-	-	-	-	d
Cocos nucifera L.	-	2345	a	a	c	a	b	b	a	b	b
Colubrina asiatica (L.) Brongn.	1120	2345	-	-	d	-	-	-	-	-	-
Cordia subcordata Lam.	1074	2345	c	a	c	c	c	c	-	d	c
Cycas rumphii Kanehira	1055	345	-	d	-	-	-	-	-	-	-
Dalbergia candenatensis (Dennst.) Prain	1056	2	b	b	c	b	-	d	-	-	-
Delonix regia (Hook.) Raf.	-	15	-	-	d	d	-	-	-	-	-
Derris trifoliata Lour.	1019	2	-	d	c	-	c	d	-	-	-
Dioscorea bulbifera L.	1057	-	-	d	-	-	-	-	-	-	-
Endiandra sp./spp.	1067	-	-	d	-	-	d	d	-	-	-
Entada phaseoloides (L.) Merr.	1001	2345	b	a	a	b	b	b	c	b	c
Erythrina variegata L.	1042	245	b	c	d	-	-	d	d	d	d
Erythrina sp. 3	1123	-	-	-	d	-	-	-	-	-	-
Guettarda speciosa L.	1069	345	a	b	d	c	d	-	a	-	b
Gyrocarpus americanus Jacq.	1082	5	-	-	-	-	-	-	-	-	c
Heritiera littoralis Dryander	1031	2345	c	b	d	b	c	b	b	-	c
Hernandia nymphaeifolia (Presl) Kubitzki	1076	2345	-	b	-	-	d	d	-	-	-
Hevea brasiliensis Muell. Arg.	1100	15	-	-	-	-	-	c	-	-	-
Hibiscus tiliaceus L.	1904	45	-	-	-	-	c	d	-	-	-

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of the nine sites. At least 36 plant families are represented, of which Fabaceae has by far the highest diversity with about 14 species. All other families are represented by two taxa or fewer, except Convolvulaceae and Euphorbiaceae with three each.

The most abundantly recorded disseminule overall was the coconut *Cocos nucifera*. This may be partly due to the fruits' large size, making them conspicuous. Most beach coconuts had been cut open by people (though many others were intact, and frequently sprouting); in some cases the nuts had probably deliberately been carried to the beaches, especially green ones for drinks, and cannot be considered drift fruits. Other disseminules (e.g., *Mangifera indica*) might also have been carried to beaches by people, but in all species this source is likely to be less important than river and/or sea drift.

In several taxa (*Canavalia, Colubrina asiatica, Cordia subcordata, Hernandia nymphaeifolia, Ipomoea pes-caprae, Phaleria disperma, Sophora tomentosa, Terminalia catappa, Ximenia americana*, etc.), local abundance on strandlines was frequently

Table 2 (*continued*)

Taxon	Ref. Spec.	Notes*	Abundance								
			NW Nananu	E Nananu	Maku-luva	Muani-vatu	Deuba	Tau-novo	Busa	Siga-toka	Nata-dola
Inocarpus fagifer (Parkinson) Fosb.	1052	245	b	b	a	b	b	c	d	b	c
Intsia bijuga (Colebr.) Kuntze	1105	45	-	d	-	-	b	d	-	-	-
Ipomoea alba L.	1040	5	d	b	-	-	-	-	-	-	-
Ipomoea pes-caprae (L.) R.Br.	1086	2345	c	a	a	b	c	d	-	-	c
Mangifera indica L.	-	135	c	c	c	b	b	b	c	b	c
Merremia sp./spp.	1106	-	-	d	-	-	d	-	-	d	-
Metroxylon vitiense (H. Wendl.) Benth. et Hook.f.	1048	-	-	d	-	b	d	d	-	-	-
Mucuna gigantea (Willd.) DC.	1079	345	c	b	d	d	d	-	d	-	d
Mucuna sp. 1	1113	3	-	d	d	-	-	-	-	-	-
Mucuna sp. 6	1064	3	-	d	-	-	-	-	-	-	-
Ochrosia oppositifolia (Lam.) K. Schum.	1081	2345	c	c	c	c	d	d	b	-	c
Pandanus tectorius Parkinson	1051	2	c	b	b	c	c	b	c	-	c
Passiflora edulis Sims	-	1	-	-	-	-	-	-	d	-	-
Passiflora maliformis L.	1050	1	-	d	-	-	-	d	d	d	-
Phaleria disperma (Forst.f.) Baillon	1037	-	b	-	-	-	-	-	-	-	-
Pongamia pinnata (L.) Pierre	1107	45	d	-	-	-	c	d	d	-	d
Psidium sp./spp.	1054	1	c	c	a	b	-	-	-	d	-
Rhizophora sp./spp.	-	3	-	-	d	a	d	-	-	-	-
Ricinus communis	1046	-	-	d	d	-	-	-	-	-	-
Scaevola taccada (Gaertn.) Roxb.	1039	25	a	a	a	c	b	-	a	-	c
Smythea lanceata (Tul.) Summerh.	1066	5	-	c	b	c	d	-	-	-	-
Sophora tomentosa L.	1912	245	-	d	-	-	-	-	b	-	-
Spondias dulcis Parkinson	1025	145	d	-	-	-	-	-	-	-	-
Strongylodon lucidus (Forst.f.) Seem.	1078	345	-	d	d	d	-	-	-	-	-
Terminalia catappa L.	1030	2345	a	a	c	a	b	c	c	c	c
Terminalia litoralis Seem.	1075	-	-	c	-	-	-	d	-	-	-
Thespesia populnea (L.) Correa	1021	45	c	c	d	-	c	-	c	d	c
Triumfetta procumbens Forst.f.	1084	45	-	-	-	-	-	-	-	-	d
Vigna marina (Burm.f.) Merr.	1122	5	-	-	c	b	-	-	c	-	-
Vitex trifolia L.	1073	5	c	a	b	-	-	-	-	-	-
Xanthium occidentale Bertol.	1116	12	-	-	b	d	-	-	-	a	d
Ximenia americana L.	1036	45	b	b	-	-	d	-	-	-	d
Xylocarpus sp./spp.	1015	2	c	a	a	a	-	d	-	-	-
Indet. 1	1026	-	d	-	-	-	-	-	-	-	-
Indet. 2	1029	-	d	-	-	-	-	-	-	-	-
Indet. 3	1059	-	-	d	-	-	-	-	-	-	-
Indet. 4	1061	-	-	d	-	-	-	-	-	-	-
Indet. 5	1118	-	-	-	d	-	-	-	-	-	-

due to disseminules having fallen on to the beach directly from overhanging plants. This was often confirmed by the uneroded condition of the disseminules (e.g., *Ipomoea* seeds still with testa hairs, *Hernandia* and *Sophora* seeds still within intact fruits).

Seed viability was not investigated explicitly. However, seeds of many species were noted as having germinated after burial by sand on beaches, as indicated in Table 2. The list of germinated seeds might well have been much longer had the investigation followed a period of rainy rather than dry weather. Seeds of some other species, when collected from strandlines, apparently were always dead. These included *Aleurites moluccana, Canarium, Endiandra, Hevea brasiliensis, Mangifera indica, Metroxylon vitiense, Psidium,* and *Ricinus communis*, none of which is a regular member of littoral plant communities. Only half-pods, lacking seeds, were found in the case of *Delonix regia.*

DISCUSSION

There appear to be few clear correlations, whereby assemblages might be "explained", between disseminule assemblages and site characteristics. As well as being a result of diverse factors mentioned under Methods above, this no doubt is largely because of the substantial contribution to assemblages made by plants of the beach forest, whose disseminules can reach all beaches (except Sigatoka) either from local sources or in ocean drift. The smallest variety of disseminules was recorded at Sigatoka, which lacked several otherwise common and widespread types. The largest variety was recorded at east Nananu-i-Ra and Makuluva, the sites most exposed to the prevailing wind and current from the south-east and east.

A small suite of species can be distinguished, whose disseminules tended to occur more commonly on beaches receiving riverine drift. This includes *Canarium, Metroxylon vitiense, Xanthium occidentale*, and perhaps *Aleurites moluccana, Annona glabra*, and *Psidium.* None of these contributes regularly to littoral vegetation, and most (excepting *A. glabra* and *X. occidentale*) have seeds that appear never to be viable when found on beaches.

A comparison can be made between presently reported disseminule assemblages on beaches exposed to riverine drift, and disseminules recorded from drift in the Rewa and other Fijian rivers by Guppy (1906). Many types occur on both lists. Guppy included several taxa not noted here, mostly with small seeds and often from herbaceous plants. In some cases these might be produced only at a different season, or have sunk before reaching the sea beaches studied here. A larger number of types recorded here was not listed by Guppy, who probably did not include all uncommon ones; it is of interest, however, that among these are nine species not native in Fiji (in *Annona, Canarium, Chrysobalanus, Delonix, Hevea, Mangifera, Psidium, Ricinus,* and *Xanthium*) which probably were not as widely established there late last century as they now are.

Seeds observed germinating after dispersal by sea currents also included those of some species not native in Fiji (in *Annona, Chrysobalanus* and *Xanthium*, the last being a noxious weed). This suggests a possibly unexpected way in which these invading plants might be being spread into new habitats and areas following initial human introduction into Fiji. For instance, for *X. occidentale* this observation represents an addition to what generally is known of its reproductive ecology. Fruits of this species are burrs, well known for becoming entangled in mammal fur, but also dispersed by floodwater and locally in other ways (Liddle & Elgar 1984). Dispersal of *X. occidentale* fruits across the Rewa estuary and fringing reef to Makuluva is merely an extension of dispersal by freshwater. However the occurrence there of fruiting plants (admittedly of low stature) growing from strandline debris shows, apparently for the first time, that the seeds are unharmed by drift over several kilometres of sea, and can then establish a new population in a littoral habitat.

In many other cases, such dispersal and germination are unlikely to lead to establishment because the beach habitat is inappropriate (see also Degener & Degener 1974; Smith et al. 1990). In the present study for example, recorded beach seedlings of *Annona glabra, Barringtonia racemosa,* and *Inocarpus fagifer* are unlikely to survive because mature plants of these species grow in moist, inland habitats (Ash & Ash 1984). In such cases, sea dispersal of seeds appears to be "accidental" and not adaptively evolved.

Even some of the most spectacularly successful tropical drift seeds, which can be carried in viable condition for thousands of kilometres, belong to species which cannot depend wholly on this means of seed dispersal. For example, a viable seed of *Caesalpinia bonduc* has been collected on Macquarie Island (Costin 1965); and *Entada phaseoloides* seeds

found on eastern Australian beaches as far south as southern New South Wales can also be germinated (E. C. Nelson, pers. comm.). Both species grow in Fijian forests up to 900 m altitude (Smith 1985), obviously well beyond the reach of seed dispersal by the sea. As Liddle & Elgar (1984) remark, the range of dispersal pathways open to seeds is probably wider than usually considered; this may even be the case in species such as these where a single mechanism is superbly developed.

Not all disseminules here recorded on beaches can be considered true "drift seeds", capable of flotation in the sea for many weeks and potentially travelling hundreds of kilometres. For example, pods of *Albizia saman* were found only on beaches near trees of the species; they are brittle and easily broken, and separated seeds cannot float. Nevertheless, the majority can be so considered. Those species whose disseminules have been recorded on sparsely vegetated coral islands remote from fertile plants (Swain Reefs, 190 km off the Queensland coast on the south-east Great Barrier Reef, Smith et al. 1990; Canton Island, Phoenix Group, Degener & Degener 1974, van Zwaluwenburg 1942), and which have been shown to be capable of floating in seawater for at least one month (Gunn et al. 1976; Guppy 1906), are noted in Table 2. Disseminules of *Canarium, Canavalia, Mucuna, Pandanus, Scaevola,* and *Xylocarpus* which might be conspecific with Fijian disseminules, also occurred at Canton Island; and of *Canarium, Erythrina, Ipomoea, Mucuna, Pandanus, Rhizophora,* and *Xylocarpus*, at Swain Reefs. Gunn et al. (1976) also list as "true drift seeds" species of *Canarium, Canavalia, Merremia, Mucuna, Pandanus, Passiflora, Psidium, Rhizophora,* and *Xylocarpus* which may be conspecific with disseminules found in the present study.

Fiji lies in the path of the west-flowing south Equatorial Current. It is likely that many seeds reaching Fijian beaches, especially those facing east or south, come from Tonga or elsewhere. However, they belong to widespread species which also occur in Fiji, so such distant origins cannot be certain. Further to the west a major part of the South Equatorial Current is diverted southward to become the East Australian Current (Church 1987), which in turn is swept east and north-east as part of the West Wind Drift towards and beyond New Zealand. Floating disseminules may be carried from islands in the tropical south-west Pacific region and from tropical Queensland in these currents, in some cases as far as New Zealand where they have been recorded particularly from Ninety Mile Beach (Gunn et al. 1976; Mason 1961). Only the most robust drifters presumably travel so far. Mason (1961) recorded from Ninety-Mile Beach, *Aleurites, Barringtonia asiatica, Caesalpinia, Cocos nucifera, Entada, Mucuna gigantea,* possibly two other *Mucuna* species, a cycad, and two unknown taxa one of which might have been *Canavalia* or *Erythrina*. *Ipomoea pes-caprae* has established a small population there (Sykes 1980), no doubt from stranded drift seeds. New South Wales beaches, upcurrent from New Zealand, receive a larger variety. My collaborators and I have collected disseminules of *Atuna racemosa, Calophyllum inophyllum, Hernandia nymphaeifolia, Intsia bijuga, Mucuna* sp. 1, *Mucuna* sp. 6, *Ochrosia oppositifolia,* and *Strongylodon lucidus* there, in addition to possibly all the above taxa recorded from New Zealand.

However, even in those cases where seeds remain viable, such extra-tropical dispersal cannot usually extend the ranges of these tropical taxa beyond their mostly already broad limits. Its demonstration nevertheless shows how such wide ranges may have been achieved in the past.

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