Bulletin of the Auckland Museum

Volume 20 | 2015

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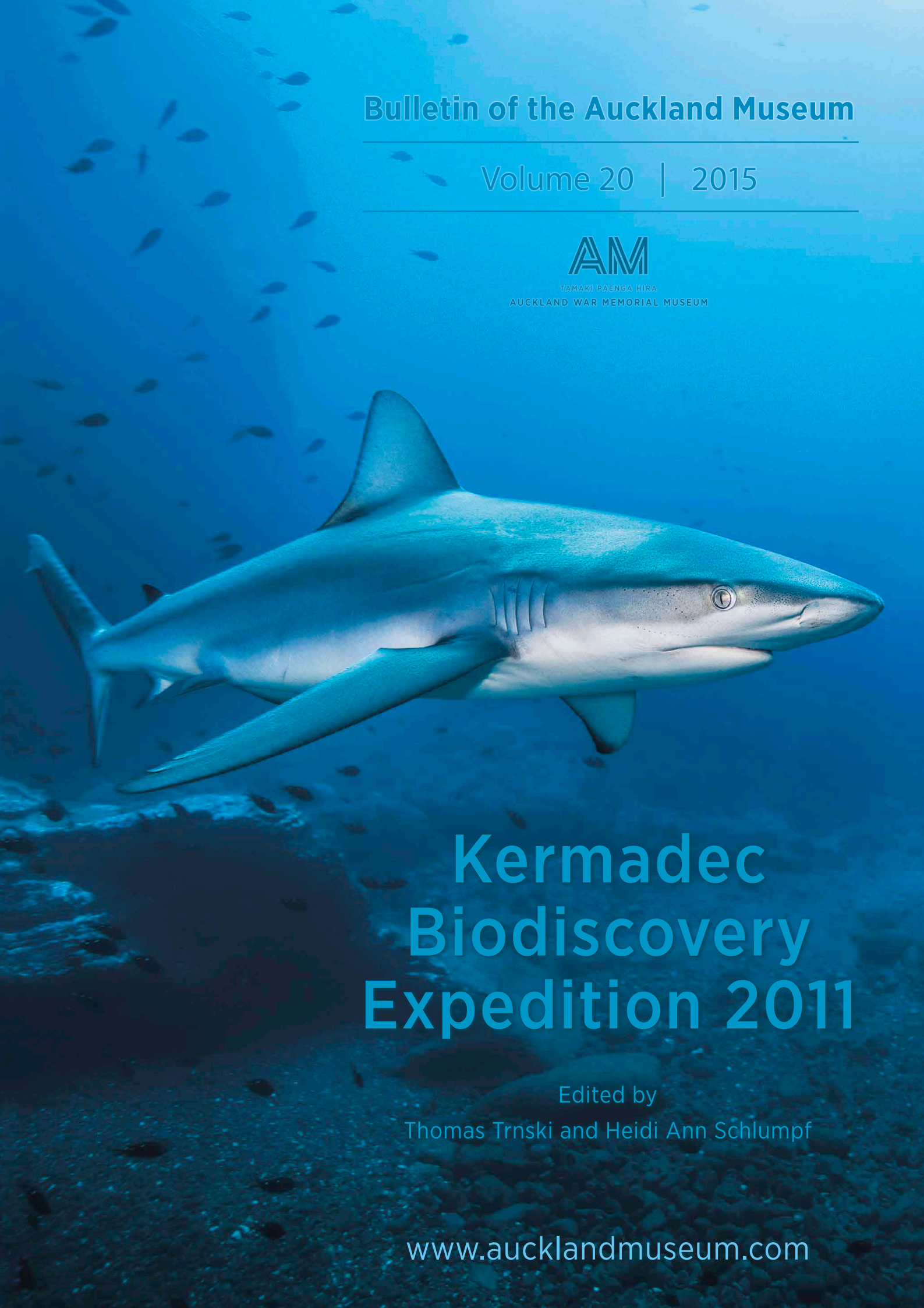
AUCKLAND WAR MEMORIAL MUSEUM



Kermadec Biodiscovery Expedition 2011

Edited by
Thomas Trnski and Heidi Ann Schlumpf

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Pittosporum rangitahua sp. nov., from Raoul Island, Kermadec Islands, northern New Zealand

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Abstract
The single species of *Pittosporum* (Pittosporaceae) on Raoul Island of the Kermadec Islands is here described as a new species—*P. rangitahua* named after Rangitahua (Raoul Island), the largest island in the group. Previously it had been referred to *P. crassifolium* A.Cunn. this being otherwise confined to coastal areas of the northern North Island of New Zealand. The distinctiveness of the Kermadec Islands plant has become increasingly obvious as a result of its recent increase in population owing to the elimination of goats and rats. A table of distinguishing features between *P. rangitahua*, *P. crassifolium* and *P. fairchildii* Cheeseman is given.

Keywords
Raoul Island (Rangitahua); new species; taxonomy; New Zealand flora

INTRODUCTION

Pittosporum Banks ex Gaertn. is a genus of some 200 species in the family Pittosporaceae, occurring in Africa, eastern Asia, Australia, New Zealand and Oceania, as evergreen trees and shrubs (Mabberley 2008). Twenty-one species of *Pittosporum* are recognised as endemic to New Zealand (de Lange & Rolfe 2010). The well-known shrub or small tree, *Pittosporum crassifolium* Banks & Sol. ex A.Cunn., karo (Māori and common name), occurs on the northern North Island coasts of New Zealand, including most offshore islands, extending southwards to Poverty Bay on the east coast and North Taranaki on the west coast (Allan 1961; Eagle 2006a). Records from further south represent escapes from cultivation as karo has been widely planted as an ornamental in coastal areas because it is hardy there and tolerates salt-laden wind.

The only other place where karo has been considered to grow naturally is Raoul Island (Rangitahua), once known as Sunday Island (2938 ha, 516 m a.s.l., 29º16'S, 177º52'W; c.1000 km NE of New Zealand's North Island), the largest island in the Kermadec Islands. Here it was first recorded in 1888 (Cheeseman 1888) as the sole *Pittosporum* species and was treated as *P. crassifolium* (Cheeseman 1888, 1906, 1925; Oliver 1910; Cooper 1956; Allan 1961; Sykes 1977; Sykes & West 1996). These authors, except for Allan, were personally familiar with it on Raoul Island. Cooper (1956: p.130–131) appears to be the first to have suspicions that it might be different when he noted "…markedly narrow leaves, strict erect fruiting pedicels clustered together, and smaller capsules… but in the absence of flowers…best left with *P. crassifolium*."

During our visit in 1994 we too concurred with Cooper and referred to it as *Pittosporum* aff. *crassifolium* which has been followed by other authors (e.g. Eagle 2006a, 2006b; de Lange *et al*. 2013). Seed was collected and plants cultivated in Auckland at the Regional Botanic Gardens and private gardens. Subsequently additional herbarium material has been collected from Raoul Island, especially flowering specimens in 1998 by Department of Conservation staff. All *Pittosporum* herbarium collections known to the authors from Raoul Island were critically compared with *Pittosporum crassifolium* and *P. fairchildii,* the two other species that are the most morphologically similar and geographically closest to the Kermadec Islands (Table 1). Cultivated material grown in Auckland from wild collected seed *ex* Raoul Island was included in the study, along with the authors' own collections and observations of the taxon on Raoul Island. There is now ample material and evidence to describe it formally as a new species *Pittosporum rangitahua* E.K.Cameron & Sykes.

TAXONOMY

Pittosporum Banks ex Gaertn. *nom. cons., Fruct. & Sem. Plantarum 1*: 286 (1788)
Lectotype: *P. tenuifolium* Gaertn. (Bullock 1960: p. 44).

Pittosporum rangitahua E.K.Cameron & Sykes, sp. nov.
Diagnosis Differs from *Pittosporum crassifolium* and *P. fairchildii* by the usually narrower leaf shape, wider angle of the secondary leaf veins, thinner and more erect branches, longer and narrower sepals, generally longer

Table 1. Distinguishing features of *Pittosporum crassifolium*, *P. fairchildii* and *P. rangitahua*.

	P. crassifolium	*P. fairchildii*	*P. rangitahua*
Habitat	Coastal forest and shrublands, including offshore islands – often in salt-spray zone	Coastal forest - but not in salt-spray zone	Coastal forest - but not in salt-spray zone
Growth form	Densely branched small tree, 4–10 m tall	Densely branched small tree, 3–5 m tall	Densely branched small tree, 3–8 m tall
Leaf blade shape (juvenile)	Obovate	Obovate-oblanceolate	Oblanceolate
Leaf blade shape and dimensions (adult) (mm)	Obovate to oblanceolate, 30–85 × 10–33	Obovate to broad-obovate and elliptic-obovate, 30–75 × 15–37	Narrow to broad oblanceolate, (30–)40–97 × 10–27
Angle of 2° leaf vein from midrib	30–56°	28–60°	48–77°
Abaxial leaf indumentum (adult)	Densely felted in fine white hairs, these becoming off-white with age	glabrate or sparsely hairy	Densely felted in fine white hairs
Abaxial 2° leaf veins	Not raised	Not raised	Slightly raised when fresh (Fig. 5)
Ratio of leaf length to width	2.1–4.0	1.6–2.8	2.7–5.7
Flowering time	Aug-Sep	Aug-Sep	May-Sep
Sepal size (mm)	(5–)6–8 × 2.0–3.5	5.0–6.5 × 2–3	6–11 × 1.0–2.5
Sepals	Become reflexed	Become spreading	Not reflexing
Petal size (mm)	12–15 × 2.5–3.0	10–14 × 2.5–3.0	12–17(–19) × 4–6
Capsules	Globose, 3-valved (rarely 2 or 4); 14–32 mm diam.; densely tomentose (buff or grey), thinner tomentum and valves blackish (rarely yellowish) when mature	Subglobose, 3-valved; 16–30 × (12–)15–21 mm; valves soon ±glabrous, yellowish when mature	Globose, 2 (rarely 3)-valved; 12–18 mm diam.; densely buff tomentose, when young and thinner tomentose when mature
Ripe capsules	Valves open <90°	Tardily dehiscent, valves never opening widely	Valves open to ≥90°
Number of seeds	20–36	10–20	22–30
Edges of seed (Fig. 9)	Obtuse to rounded, rarely subacute	Rounded, i.e. without obvious angles	Mainly acute and sharply-angled

and wider petals, 2-valved and smaller capsules, and sharp-angled seeds.

Holotype (Fig. 1): NEW ZEALAND, Kermadec Islands, Raoul Island, Hutchison Bluff Track, *E.K. Cameron 7935*, 25 Nov 1995, AK 225422.

Description A densely branched small tree 3–8 m tall. Primary branches erect, with secondary and tertiary branches erect to ascending. Branchlets are at first densely white-tomentose (all tomentum can be ferruginous in aged herbarium specimens), becoming grey-brown and sparsely tomentose with aging; bark smooth, grey-brown and glabrous. Leaf scars consistently have three vascular bundles. Leaves are crowded towards the ends of bare branches (Fig. 2).

Leaves (Fig. 3) are entire, alternate, coriaceous, oblanceolate, 40–97 × 10–27 mm, 3–6 times longer than broad; weakly revolute with the midrib slightly sunken; apex subacute to rounded; base cuneate; petioles 5–10 mm long; adaxial leaf surface initially covered in dense white tomentum, soon deciduous and revealing a bright green leaf surface, secondary veins (8–11) at wide angle from the midrib (>45°), bifurcating halfway between the midrib and leaf edge, becoming faint towards the margin, slightly sunken making the leaf appear slightly bullate when fresh (Fig. 4). Adaxial surface with dense white felted hairs which thin out as the leaf ages. Secondary

Figure 1. Holotype of *Pittosporum rangitahua* (AK 225422).

Figure 2. Small tree of *Pittopsorum rangitahua* just east of Fishing Rock, Raoul Island. Note the erect branching. *Photo: 27 Nov 1994.*

veins are prominent when fresh (Fig. 5, 6). Seedling leaves are alternate, entire, leaf lamina with fringe of marginal hairs, and few-many hairs along the midrib (especially on the abaxial side), otherwise glabrous; petiole sparsely hairy. Cotyledons are four (Fig. 7), 13–17 × 4.0–5.5 mm; narrow elliptic to slightly ovate, shortly petiolate; apex apiculate.

Inflorescences are terminal umbels with (3–)6–14 flowers per umbel.

Subtending bracts are few, caducous, linear, 5–11 mm long, covered in off-white tomentum.

Pedicels are 10–25 mm long, covered in off-white tomentum.

Flowers are usually sweetly scented; appear bisexual but are functionally unisexual, with rudimentary organs. Sepals 5, unequal, 6–11 × 1.0–2.5 mm, narrow-triangular, acute-tipped; except for lower adaxial surface, covered in off-white tomentum, do not reflex (deciduous by fruiting stage). Petals red-purple (occasionally paler), free, 12–17(–19) × 4–6 mm, ± oblong-obovoid, upper third becoming reflexed, ± glabrous. Stamens 5, antisepalous, dorsifixed. Ovary superior, pilose, gynoecium of two fused carpels. Style unbranched.

Male flowers have pedicels 10–25mm long; flowers 10–14 mm long, stamens 7–10 mm long; filaments red-purple, tapering from apex to base (1.0–1.5 × 0.75 mm); anthers yellow, 2–3 mm long, exserted when shedding pollen (petals then reflexed); ovary ovoid, 3.0–3.5 × 1.5–2.0 mm; style 3.5–4.5 mm long, stigma not capitate (Fig. 4).

Female flowers (based on small sample size) have pedicels c.10 mm long; flowers c.10 mm long, stamens c.5.5 mm long; filaments red-purple, tapering from apex to base (1.0 –1.5 × 0.5 mm), anthers c.1.2 mm and not exserted; ovary ovoid, c.4.5 × 3.0 mm; style c.2.5 mm long, stigma prominently capitate (Fig. 5).

Capsule is 2 (rarely 3) -valved, globose (Fig. 8), 12–18 mm diam., opening to ≥90° (Fig. 6); valves whitish tomentose outside, pale brown and rugose inside, becoming woody at dehiscence; peduncles erect to spreading.

Seeds are 20–30/capsule (only a few capsules counted), viscid, lustrous black, irregular, 4.0–5.5 mm long, and many flat faces meeting along ± sharp edges (Fig. 9) – a result of being crowded in the capsule.

Notes *Pittosporum rangitahua* being an apparent tetracotyledon is not unique in the genus with seven of the New Zealand species previously recorded with 3–4 cotyledons, including *P. crassifolium* (Stebbins 1974), and *P. fairchildii*, *P. ralphii* and *P. virgatum* all being recorded with four cotyledons (Scott 1983). The male and female flowers of *P. rangitahua* are almost identical in proportions to *Pittosporum ralphii* Kirk illustrated by Godley (1979: fig. 3). Webb & Simpson (2001) recorded that the seeds of the Kermadec Islands plants are similar to *P. crassifolium* but differ in being more sharply angular, and Cayzer *et al*. (2000) emphasise the importance of seeds as a taxonomic difference for the Pittosporaceae. *Pittosporum ralphii* in tomentum and capsule size is superficially similar to *P. rangitahua* – its 3-valved capsules, wider leaves, and globose seeds with roundish edges readily separates it. The branchlet leaf scars *P. rangitahua* illustrated by Eagle (2006a) and said to be "distinctive" (Eagle 2006b: p.15) we found to be in the same morphological range as those of *P. crassifolium*. Because Norfolk Island, located some 1320 km to the west of Raoul Island, and the Kermadecs have many vascular plant species in common we also compared the sole native *Pittosporum* to Norfolk Island, *P. bracteolatum* Endl., with *P. rangitahua* – its glabrous leaves, cream flowers and 3-valved capsules easily separates it. Using DNA sequence data Chandler *et al*. (2007) confirmed a very close concordance between morphological and molecular data in the Pittosporaceae. From a molecular study using nrITS from all of the *Pittosporum* species from New Zealand and Norfolk Island, and most of the New Caledonian species, *P. rangitahua* is genetically distinct from other species and is sister to *P. fairchildii* (Chrissen Gemmill pers. comm., April 2012).

Representative specimens We studied all 39 specimens lodged in AK, CHR, K and WELT herbaria (acronyms follow Thiers 2011):

NEW ZEALAND: KERMADEC ISLANDS: RAOUL (RANGITAHUA, SUNDAY) ISLAND: *T.F. Cheeseman s.n.*, [Aug 1887], AK 4670 (fruit); *T.F. Cheeseman s.n.*,

Figure 3. A range of mature leaves showing the abaxial surface from herbarium specimens of *Pittosporum crassifolium* (top row), *P. fairchildii* (middle row) and *P. rangitahua* (bottom row).

Figure 4. Flowering (male) specimen of *Pittopsorum rangitahua*; cultivated, seed ex Raoul Island. Note the exerted anthers. *Photo: 30 Jul 1998.*

Figure 5. Flowering (female) specimen of *Pittopsorum rangitahua*; cultivated, seed ex Raoul Island. Note the capitate stigma. *Photo: 11 May 2008.*

Figure 6. Specimen with open capsules, Hutchison Bluff Track, Raoul Island (holotype AK 225422). *Photo: 25 November 1994.*

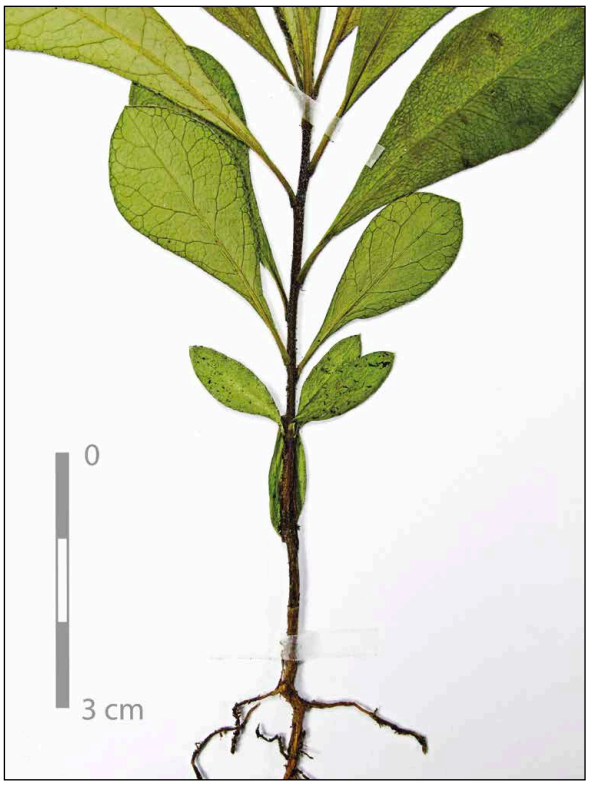

Figure 7. Cultivated seedling showing the whorl of 4 cotyledons with the first true leaves above them, seed ex Raoul Island. *(AK 301188)*

Figure 8. Specimen with a green capsule of *Pittopsorum rangitahua*; cultivated, seed *ex* Raoul Island. *Photo: 9 Dec. 2000*

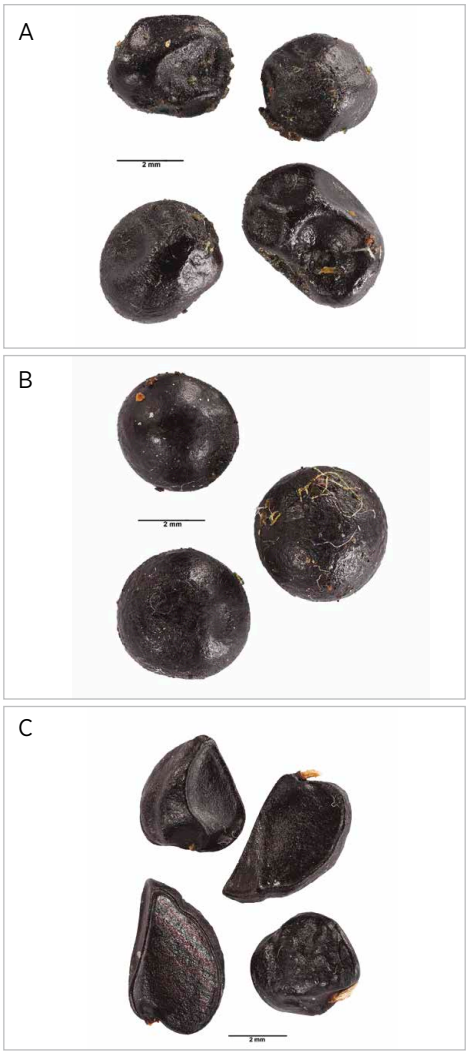

Figure 9. Comparison of the seeds of: ***A*** somewhat compressed seeds of *Pittosporum crassifolium* (from AK 221122); ***B*** spherical seeds of *P. fairchildii* (from AK 173043); and ***C*** highly compressed seeds of *P. rangitahua* (from AK 225422).

May 1889 [Aug 1887], K 000591697 (fruit); *W.R.B. Oliver s.n.*, 20 Apr 1908, WELT SP35631 (fruit and male fls); Boat Cove, *W.R. Sykes 341/K*, 5 Dec 1966, CHR 175953 (fruit); Wilson Point, *W.R. Sykes 605/K*, 14 Jan 1967, CHR 175955 (fruit); near Western Springs, 23 Nov 1994, *W.R. Sykes 1792/K*, CHR 500287 (1 fruit); Hutchison Bluff Track, *E.K. Cameron 7935*, 25 Nov 1994, AK 225422 (fruit); Hutchison Bluff Ridge, 25 Nov 1994, *W.R. Sykes 1810/K*, CHR 500335 (fruit); Hutchison Bluff Ridge, 25 Nov 1994, *W.R. Sykes 1811/K*, CHR 500336 (fruit); *C. Wickes s.n.*, 14 Jul 1998, AK 237813 (male fls); D'Arcy Point, *R. Dudfield s.n.*, Nov 1998, AK 242547 (fruit); *R.J. Stanley s.n.*, 3 Nov 1997, AK 234371 (seedling). CULTIVATED in Auckland seed *ex* Raoul Island: *E.K. Cameron 15050*, 10 May 2008, AK 302528 (female fls); *Y. Etherington s.n.*, 22 Nov 2007, AK 301188 (seedlings with cotyledons).

Etymology Named after the only known locality of the species, from the Māori name for Raoul Island (Anderson 1980) – Rangitahua translates as 'fire in the sky' indicating evidence of its volcanic eruptions (Harris 2001).

Distribution and Habitats In 1856 the naturalists W. Milne and J. MacGillivray on the *HMS Herald* collected some 41 vascular plant species on Raoul Island but that did not include the *Pittosporum* (Hooker 1856). *Pittosporum rangitahua* has only ever been recorded on Raoul Island and since its first collection in 1887 it has been rare and restricted to more or less vertical cliffs faces on the island (Sykes 1977) until recently. In the 1990s it was known only from the steep coastal forest on Raoul Island, where it is widely distributed, but generally local, specifically: Hutchison Bluff ridge (by far the largest population we saw in 1994 was over a hundred plants here to 7 m tall), near Western Springs, just east of Smith Bluff, and D'Arcy Point-Sunshine–Boat Cove–Wilson Point coastline. However, the closest plants to the coast were observed at 50-60 m asl near Boat Cove and on the track to Western Springs, and the largest population along Hutchison Bluff ridge was at c.400 m asl. It is mainly a canopy tree in low forest or scrub, in association with Kermadec pōhutukawa (*Metrosideros kermadecensis* W.R.B.Oliv.), Kermadec ngaio (*Myoporum rapense* subsp. *kermadecense* (W.R.Sykes) Chinnock) and *Myrsine kermadecensis* Cheeseman, or in more open areas between taller Kermadec pōhutukawa.

Populations have been severely impacted by feral goats (*Capra hircus*) (Sykes 1969) until their eradication in 1985 (Parkes 1990). Pacific rat (*Rattus exulans*) is known to severely impact on the regeneration of the closely related species, *Pittosporum crassifolium*, by eating the seed and seedlings (Campbell & Atkinson 1999, 2002). The eradication of Pacific rat and Norway rat (*R. norvegicus*) on Raoul Island in 2002 (Broome 2009), appears to have further assisted the regeneration and the dispersal of *P. rangitahua* on Raoul. A year after the eradication of rats, wild seedlings were observed on Raoul Island near Western Springs and D'Arcy Point (J. Boow pers. comm.), and in 2011 wild seedlings were observed well away from the known adult trees, e.g. in Sunshine Valley (Peter de Lange pers. comm.). The eradication of the goats, rats and cats (*Felis catus*), the latter were eradicated in 2004 (Broome 2009), has also dramatically increased the numbers of birds present on Raoul Island (Veitch *et al*. 2011) which should aid the dispersal of *P. rangitahua* seed which presumably is bird-dispersed.

Phenology The main flowering period is May-September, and fruit are present until at least January. Oliver (1910) states flowers "throughout most of the year", and on one of his collections (WELT SP35631) dated 20 April 1908, there is a flowering and a separate fruiting shoot – these flowering and fruiting months are not supported by any other collections or observations.

Chromosome number $2n = 24$ (de Lange & Murray 2002).

Illustrations (Fig. 2–5, 8): Eagle (2006a: p.213) colour plate as *Pittosporum* aff. *crassifolium* – including [male] flowers.

Cultivation The seed we brought back in 1994 appears to be the first introduced to cultivation. The resulting seedlings grew quickly and flowered for the first time in July 1998 (just over 4 years old). However, most plants were short-lived, possibly suffering from a fungal soil-borne disease as most died suddenly. The longest-lived cultivated plant known to us survived 13.5 years and reached 8 m tall (AK 301836). Remote islands may lack some aggressive root pathogens present on the New Zealand mainland, e.g., *Phytophthora cinnamomi* (Wright 1983; Beever 1984), and the presence on the mainland of such a pathogen maybe the reason for the fairly quick demise of *P. rangitahua* in cultivation.

Conservation Status Listed by de Lange *et al*. (2013) as *Pittosporum* aff. *crassifolium* (AK 253259; Raoul Island) and classified as Taxonomically Indeterminate with a rating of At Risk/Recovering and qualifiers of Conservation Dependent, Island Endemic and One Location. The natural population is heading towards >1000 mature individuals but no recent count has been carried out (Peter de Lange and David Havell pers. comm.). Therefore conservatively we support leaving its status as above for now, but if present trends continue it will soon qualify at the lower status of At Risk/Naturally Uncommon, i.e. >1000 mature individuals. Post-1994 *Pittosporum rangitahua* has been used in restoration plantings on Raoul Island by Department of Conservation staff in the highly modified areas around the Met Station and nearby at Low Flat (David Havell pers. comm.).

DISCUSSION

The Kermadecs represent the summits of volcanic mountains arising from the deep ocean Kermadec Trench; they are all very young, the oldest rocks on Raoul Island are probably of early Quaternary age, with Raoul Island one of the oldest islands, it had no land above sea level until the last half million years (Lloyd & Nathan 1981; Latter *et al*. 1992). The recognition of this closely related *Pittosporum* species to the northern North Island red-flowering species

Table 2. Kermadec Islands endemic vascular plant taxa.

Endemic taxa	Family
Ascarina lucida var. *lanceolata* (Hook.f.) Allan (1961)	Chloranthaceae
Blechnum kermadecense Perrie & Brownsey (2014)	Blechnaceae
Carex kermadecensis Petrie (1915)	Cyperaceae
Coprosma acutifolia Hook.f. (1856)	Rubiaceae
Coprosma petiolata Hook.f. (1856)	Rubiaceae
Coriaria arborea var. *kermadecensis* W.R.B.Oliv. (1942)	Coriariaceae
Cyathea kermadecensis W.R.B.Oliv. (1910)	Cyatheaceae
Cyathea milnei Hook. ex Hook.f. (1864)	Cyatheaceae
Disphyma australe subsp. *stricticaule* Chinnock (1976)	Aizoaceae
Hebe breviracemosa (W.R.B.Oliv.) Andersen (1926)	Plantaginaceae
Homalanthus polyandrous (Müll.Arg.) Cheeseman (1906)	Euphorbiaceae
Imperata cheesemanii Hack. (1903)	Poaceae
Lastreopsis kermadecensis Perrie & Brownsey (2012)	Dryopteridaceae
Lepidium castellanum de Lange & Heenan (2013)	Brassicaceae
Metrosideros kermadecensis W.R.B.Oliv. (1928)	Myrtaceae
Myoporum rapense subsp. *kermadecensis* (Sykes) Chinnock (2007)	Scrophulariaceae
Myrsine kermadecensis Cheeseman (1892)	Myrsinaceae
Pittosporum rangitahua Cameron & Sykes (this paper)	Pittosporaceae
Poa polyphylla Hack. (1903)	Poaceae
Pseudopanax kermadecensis (W.R.B.Oliv.) Philipson (1965)	Araliaceae
Senecio esperensis (Sykes) de Lange (2015)	Asteraceae
Senecio kermadecensis Belcher (1956)	Asteraceae
Treated as endemic by Sykes (1977) but now no longer accepted as endemic (treatment article given for status change)	
Pouzolzia australis (Endl.) Friis & Wilmot-Dear (incl. *Boehmeria australis* var. *dealbata* (Cheeseman) Sykes); see Wilmot-Dear & Friis (2006)	Urticaceae
Rhopalostylis baueri (Seem.) H.Wendl. & Drude (incl. *R. baueri* var. *cheesemanii* (Becc.) Sykes); see de Lange et al. (2005)	Arecaceae
Scaevola gracilis Hook.f.; see Sykes (1998)	Goodeniaceae

(*P. crassifolium* and *P. fairchildii*) supports the statement by Sykes (1977: p. 37–38): "Because of the lack of suitable land for plant colonisation in the Kermadecs until recently, it is not surprising that the degree of endemism is limited. Thus, although 21 [it should actually be 22] taxa of vascular plants have been described as endemic all are closely related to taxa elsewhere…". In addition to the recent availability of land for plant colonisation a factor promoting change in taxa is the fact that the Kermadecs are several degrees of latitude different from where most of the arrivals originated, meaning that different day lengths and amounts of insolation are experienced. Most came from New Zealand to the south but in a few cases the taxa came from the tropics to the north. Interestingly two taxa on the Kermadecs and Norfolk Island (which are almost at the same latitude) that were once thought to be distinct, but taxonomically closely related, are now considered taxonomically the same (*Pouzolzia australis* and *Rhopalostylis baueri*, see Table 2). Twenty-two vascular plant taxa are still considered endemic to the Kermadecs, however, three are no longer considered endemic, three are additional taxa (*Disphyma australe* subsp. *stricticaule, Lepidium castellanum*, *Pittosporum rangitahua*) to Sykes (1977)) and one has been raised from variety to species level (*Senecio esperensis*) (Table 2).

Pittosporum seed is bird dispersed (Gleadow 1982; Burrows 1994; Anderson *et al*. 2006; Kelly *et al*. 2010). The current bird species present on Raoul Island potentially capable of dispersing *Pittosporum* seed, though not all have been confirmed to feed on them, include the New Zealand endemic tui (*Prosthemadera novaeseelandiae*), the relatively recent native silvereye (*Zosterops lateralis*), as well as the introduced blackbird (*Turdus merula*) and starling (*Sturnus vulgaris*); though the silvereye is only present in low numbers (Veitch *et al*. 2011). *Pittosporum rangitahua* is surprisingly absent from all of the adjacent eight smaller islands within 0.7–3.7 km of the Raoul Island coast which all support woody vegetation and have never had goats or rats. The two largest and closest of these islands, Meyer Islands (except for the slightly closer Milne Islets), even support karaka (*Corynocarpus laevigatus*) and māhoe (*Melicytus ramiflorus*), but not *P. rangitahua* – even though starlings are known to use the Meyer Islands as a roost (Veitch *et al*. 2011). *Pittosporum crassifolium* on small islands off the north-eastern North Island coast of New

Zealand is often one of the closest woody species to the salt spray. The possible explanation for the absence of *P. rangitahua* from these adjacent islands as well as the Raoul Island foreshore is that it may not be as hardy and/or salt-tolerant as *P. crassifolium*. Since the mammalian pest eradications *P. rangitahua* has been increasing in numbers and distribution and only time will tell what its future distribution and preferred habitats will be.

ACKNOWLEDGEMENTS

We thank Chrissen Gemmill (University of Waikato) for her referee comments and preliminary results of her *Pittosporum* sequencing data; Carol West for referee comments; Department of Conservation (DoC) staff Karen Baird, Jonathan Boow, Ruth Dudfield, Peter de Lange, David Havell, Bec Stanley and Chrissy Wickes for seed, pressed specimens and/or recent observations of the *Pittosporum* on Raoul Island; Steve Benham, Geoff Davidson and Yvonne Etherington for cultivating seed brought back from Raoul Island; Rhys Gardner and Peter Heenan for critical comments on an earlier draft of this paper; Kanchi Gandhi (International Plant Names Index) for clarifying the authority of *Pittosporum*; assistance by the Auckland Botanical Society (ABS) members, crew of the *R.V. Acheron*, and the Raoul Island DoC staff during the ABS visit to Raoul Island (21–27 Nov 1994); Peter Quin for Fig. 9; Dhahara Rangitunga for Fig. 1, 3 and 7; and the assistance of the relevant staff at CHR, K and WELT herbaria for access to and/or the loan of specimens.

REFERENCES

Allan, H.H. 1961. *Flora of New Zealand. Vol. 1*. Government Printer. Wellington. 1085pp.

Anderson, A. 1980. The archaeology of Raoul Island (Kermadecs) and its place in the settlement history of Polynesia. *Archaeology and Physical Anthropology in Oceania* 15: 131–141.

Anderson, S.H., D. Kelly, A.W. Robertson, J.G. Ladley and J.G. Innes 2006. Birds as pollinators and dispersers: a case study from New Zealand. *Acta Zoologica Sinica* 52 *(Supplement)*: 112–115.

Beever, R.E. 1984. Observations on puka (*Meryta sinclairii*) on the Chicken Islands, with an assessment of the hypothesis that it was transferred there by the Maori. *Tane* 30: 77–92.

Broome, K.G. 2009. Beyond Kapiti – a decade of invasive rodent eradication from New Zealand islands. *Biodiversity* 10: 7–17.

Bullock, A.A. 1960. Nomenclatural notes: XII. The types of some generic names. *Kew Bulletin* 14: 40–45.

Burrows, C.J. 1994. Fruit types and seed dispersal modes of woody plants in Ahuriri Summit Bush, Port Hills, western Banks Peninsula, Canterbury, New Zealand. *New Zealand Journal of Botany* 32: 169–181.

Campbell, D.J. and I.A.E. Atkinson 1999. Effects of kiore (*Rattus exulans* Peale) on recruitment of indigenous coastal trees on northern offshore islands of New Zealand. *Journal of the Royal Society of New Zealand* 29: 265–290.

Campbell, D.J. and I.A.E. Atkinson 2002. Depression of tree recruitment by the Pacific rat (*Rattus exulans* Peale) on New Zealand's northern offshore islands. *Biological Conservation* 107: 19–35.

Cayzer, L.W., M.D. Crisp and I.R.H. Telford 2000. Revision of *Pittosporum* (Pittosporaceae) in Australia. *Australian Systematic Botany* 13: 845–902.

Chandler, G.T., G.M. Plunkett, S.M. Pinney, L.W. Cayzer and E.C. Gemmill 2007. Molecular and morphological agreement in Pittosporaceae: phylogenetic analysis with nuclear ITS and plastid *trn*L – *trn*F sequence data. *Australian Systematic Botany* 20: 390–401.

Cheeseman, T.F. 1888. On the flora of the Kermadec Islands. *Transactions of the New Zealand Institute* 20: 151–181.

Cheeseman, T.F. 1906. *Manual of the New Zealand Flora*. Government Printer. Wellington. 1199 pp.

Cheeseman, T.F. 1925. *Manual of the New Zealand Flora*. 2nd ed. Government Printer. Wellington.

Cooper, R.C. 1956. The Australian and New Zealand species of *Pittosporum*. *Annals of the Missouri Botanical Garden* 43: 87–188.

de Lange P.J. and B.G. Murray 2002. Contributions to a chromosome atlas of the New Zealand flora – 37. Miscellaneous families. *New Zealand Journal of Botany* 40: 1–24.

de Lange, P.J., R.O. Gardner, W.R. Sykes, G.M. Crowcroft, E.K. Cameron, F. Stalker, M.L. Christian and J.E. Braggins 2005. Vascular Flora of Norfolk Island: some additions and taxonomic notes. *New Zealand Journal of Botany* 43: 563–596.

de Lange, P.J. and J.R. Rolfe 2010. New Zealand indigenous vascular checklist. New Zealand Plant Conservation Network. Wellington. 131 pp.

de Lange, P.J., J.R. Rolfe, P.D. Champion, S.P. Courtney, P.B. Heenan, J.W. Barkla, E.K. Cameron, D.A. Norton and R.A. Hitchmough 2013. Conservation status of New Zealand vascular plants, 2012. New Zealand threat classification series 3. Department of Conservation, Wellington. 70 pp.

Eagle, A. 2006a. *Eagle's complete trees and shrubs of New Zealand*. Te Papa Press, Wellington. 1114pp.

Eagle, A. 2006b. Supplement to Eagle's complete trees and shrubs of New Zealand – additional notes. Botanical Society of Otago, Dunedin. 114 pp.

Gleadow, R.M. 1982. Invasion by *Pittosporum undulatum* of the forests of Central Victoria. 11. Dispersal, Germination and Establishment. *Australian Journal of Botany* 30: 185–198.

Godley, E.J. 1979. Flower biology in New Zealand. *New Zealand Journal of Botany* 17: 441–466.

Harris, W. 2001. Horticultural and conservation significance of genetic variation of cabbage trees (*Cordyline* spp.), pp. 87–91 *in*: Oats, M.R. (ed.). New Zealand plants and their story. Proceedings of the Royal New Zealand Institute of Horticulture Conference 1-3rd October 1999. Royal New Zealand Institute of Horticulture, Canterbury.

Hooker, J.D. 1856. On the Botany of Raoul Island, one of the Kermadec group in the South Pacific Ocean. *Journal of the Proceedings of the Linnean Society of London* 1: 125–129.

Kelly, D., J.J. Ladley, A.W. Robertson, S.H. Anderson, D.M. Wotton and S.K. Wiser 2010. Mutualisms with the wreckage of an avifauna: the status of bird pollination and fruit-dispersal in New Zealand. *New Zealand Journal of Ecology* 34: 66–85.

Latter, J.H., E.F. Lloyd, I.E.M. Smith and S. Nathan 1992. *Volcanic hazards in the Kermadec Islands, and at the Submarine Volcanoes between southern Tonga and New Zealand*. Ministry of Civil Defence. Volcanic Hazards Information Series no. 4. 44 pp.

Lloyd, E.F. and S. Nathan 1981. *Geology and tephrochronology of Raoul Island, Kermadec Group, New Zealand*. D.S.I.R. Bulletin 95.

Mabberley, D.J. 2008. *Mabberley's Plant-Book (3rd ed.)*. Cambridge University Press, Cambridge. 1021 pp.

Oliver, W.R.B. 1910. The Vegetation of the Kermadec Islands. *Transactions of the New Zealand Institute* 42: 118–175.

Parkes, J.P. 1990. Eradication of feral goats on islands and habitat islands. *Journal of the Royal Society of New Zealand* 20: 297–304.

Scott, L. 1983. Is *Pittosporum fairchildii* a tetracot? *Auckland Botanical Society Newsletter* 38: 25–26.

Stebbins, G.L. 1974. *Flowering plants. Evolution above the species level*. Cambridge, Massachusetts, Belknap Press of Harvard University Press. 399 pp.

Sykes, W.R. 1969. The effects of goats on vegetation of the Kermadec Islands. *Proceedings New Zealand Ecological Society* 16: 13–16.

Sykes, W.R. 1977. *Kermadec Island Flora – an annotated checklist*. DSIR Bulletin 219. 216 pp.

Sykes, W.R. 1998. *Scaevola gracilis* (Goodeniaceae) in the Kermadec Islands and Tonga. *New Zealand Journal of Botany* 36: 671–674.

Sykes, W.R. and C.J West 1996. New records and other information on the vascular flora of the Kermadec Islands. *New Zealand Journal of Botany* 34: 447–462.

Thiers, B. 2011. Index Herbariorum: a global directory of public herbaria and associated staff. New York Botanical garden's Virtual Herbarium. http: sweetgum.nybg.org/ih/ (accessed 3 April 2012).

Webb, C.J. and M.J.A. Simpson 2001. *Seeds of New Zealand gymnosperms and dicotyledons*. Christchurch, Manuka Press. 428 pp.

Veitch, C.R., C. Gaskin, K. Baird and S.M.H. Ismar 2011. Changes in bird numbers on Raoul Island, Kermadec Islands, New Zealand, following the eradication of goats, rats, and cats. Pp. 372–376 *in*: Veitch, C.R., M.N. Clout and D.R. Towns (eds). Island invasives: eradication and management IUCN, Gland, Switzerland.

Wilmot-Dear, C.M. and I. Friis 2006. The Old World species of *Pouzolzia* (Urticaceae, tribus Boehmerieae): a taxonomic revision. *Nordic Journal of Botany* 24: 5–114.

Wright, A.E. 1983. Conservation status of the Three Kings Islands endemic flora in 1982. *Records of the Auckland Institute and Museum* 20: 175–184.

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Article submitted: April 2012; revised and accepted: August 2012.