

CARTER ET AL.: PITTOSPORUM ROIMATA OF THE POOR KNIGHTS ISLANDS

A New Species of *Pittosporum* Described from the Poor Knights Islands, Northland,
Aotearoa/New Zealand

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Abstract—Here we describe *Pittosporum roimata* Gemmill & S.N. Carter, the only vascular plant endemic to the Poor Knights Islands, Northland, Aotearoa/New Zealand. This new species has previously been referred to as a distinct yellow-flowered variant of *Pittosporum cornifolium* (tāwhiri karo, wharewhareatua), a morphologically similar epiphytic shrub known from both main islands of New Zealand as well as other off shore islands. We have segregated this new species from *P. cornifolium* based on morphology, DNA sequence variation, as well as distribution. *Pittosporum roimata* is distinguished from *P. cornifolium* by flowers with yellow petals, larger inflorescences, and producing several terminal fruits per stem. Herbarium specimens of *P. roimata* statistically have larger leaves and shorter petioles than specimens of *P. cornifolium*. *Pittosporum roimata* is locally common on the islands of Tawhiti Rahi, Aorangi, and Aorangaia, growing on rocky substrates associated with *Xeronema callistemon* (raupo taranga) and *Metrosideros excelsa* (pōhutukawa). Using the current New Zealand Threat Classification System, we suggest a preliminary classification of this new species as ‘at risk/naturally uncommon’ qualified data poor [DP], one location [OL].

Keywords—Island endemic, linear discriminant analysis, New Zealand flora, Pittosporaceae, *Pittosporum roimata*, *Pittosporum cornifolium*.

The family Pittosporaceae R.Br. (Apiales) is comprised of nine genera and has its center of diversity in Australia (Putterlick 1839; Chandler et al. 2007). *Pittosporum* Banks ex Sol. in Gaertn. (1788) is the largest genus with about 200 species (Chandler et al. 2007) and is the only genus found widely outside of Australia (Brown 1814; Pax 1891; Cooper 1956). *Pittosporum* has a wide paleotropical distribution from the Canary Islands, Africa, Madagascar, to India and Asia, and throughout the eastern Pacific from the Hawaiian Islands in the north to the Pitcairn Islands in the south. Many species of *Pittosporum* are localized endemics and the majority of the species found in the Pacific region are only found on either a single island or island group (Haas 1977; Gemmill et al. 2002; Chandler et al. 2007). All 24 currently recognized native species in New Zealand (Breitwieser et al. 2010–2017; Schönberger et al. 2017) are endemic and exhibit a wide morphological and ecological range inhabiting lowland forests to sub-alpine regions (Cooper 1956, Allan 1961), including two species endemic to outlying islands, *Pittosporum fairchildii* Cheeseman of the Three Kings (55km N of the North Island) and *Pittosporum rangitahua* E.K. Cameron & Sykes of Raoul Island, Kermadec Islands Nature Reserve (1000km NE of the North Island). Two somewhat specialized species are most often found as epiphytic shrubs, *P. cornifolium* A. Cunn. (tāwhiri karo, wharewhareatua) and *P. kirkii* Hook.f. ex Kirk (thick-leaved kohukohu).

Pittosporum are evergreen shrubs and small trees, many with striking whorled architecture (Kirk 1872). While most *Pittosporum* appear to have bisexual flowers, closer inspection reveals the flowers to

be sexually dimorphic (Godley 1979) with many species having functionally male and female flowers, and hence are dioecious (Kirk 1872). Corolla colors include white, pink, dark red, purple, and yellow (Cooper 1956). Flowers are typically sweetly scented, especially at night (Wardle 1991). The genus is readily identified by the woody capsules that have yellow to bright vermilion interior linings that contrast with their dark red to black seeds. The seeds are immersed in a sticky resin which likely aids in long distance dispersal via birds; in fact, the name *Pittosporum* means “to besmear with pitch” (Cunningham 1832).

Pittosporum cornifolium (Fig. 1) was the focus of previous work by Clarkson (2011; Clarkson et al. 2012). During this work, it became clear that the plants from the Poor Knights Islands (Fig. 2) were morphologically distinct from *P. cornifolium* s.l. The Poor Knights Islands plants can be identified by their larger habit, larger, thicker leaves and bright yellow flowers. Furthermore, the inflorescences have more flowers and bear three or more fruits per infructescence. Genetic studies supported these observations. Population-level genetic variation was estimated by inter-simple sequence repeats markers (ISSRs) and the Poor Knights Islands samples were genetically distinct, had less genetic variability (16.8% of loci polymorphic) and many more unique alleles (n=18) relative to *P. cornifolium*. Additionally, the Poor Knights Islands samples had a single unique mutation in the nuclear ribosomal internal transcribed spacer (ITS) relative to *P. cornifolium*.

The aim of the study was to further evaluate the status of the yellow-flowered *Pittosporum* from the Poor Knights Islands. To this end we conducted traditional herbarium studies combined with statistical analyses of vegetative characters easily observable on herbarium sheets, as well as ITS sequences of vouchered specimens. Together these data support the segregation of the Poor Knights *Pittosporum* from *P. cornifolium*. We formally recognize the Poor Knights *Pittosporum* as a morphologically, genetically and geographically distinct species, *Pittosporum roimata*.

MATERIALS AND METHODS

We studied 55 herbarium specimens from New Zealand herbaria (AK, WELT and CHR; acronyms follow Thiers 2017) representing the entire geographic range for *P. cornifolium* s.l. (Appendix 1) including the North Island (22 specimens), islands off shore of the North Island (13 specimens), Poor Knights Islands (16 specimens), and the South Island (4 specimens). Of these, 39 retained the identification of *P. cornifolium*, and 16 were designated as *P. roimata*. We supplemented this work with study of materials collected from eight *ex situ* individuals in a common garden on the campus of the University of Waikato, Hamilton, North Island, New Zealand. Here, plants of *P. cornifolium* from the North Island are growing side by side with plants from the Poor Knights islands (hereafter referred to as *P. roimata*), facilitating comparison throughout the year. Herbarium vouchers have been lodged at the

University of Waikato Herbarium, Te Pā Whakahaumia o Te Whare Wānanga o Waikato (WAIK),
Hamilton, North Island, New Zealand.

Morphological Analyses—Given that the majority of herbarium specimens lack flowers and fruits, we tested the utility of readily observable vegetative characters. We analyzed five randomly selected leaves per specimen for 55 specimens, and averaged measurements across these five leaves. The variables we analyzed were leaf length, leaf width and petiole length, each measured in millimeters.

We tested for significant differences in means of leaf length, width, length to width ratio, and petiole length using Welch's t-tests, which does not assume homogeneity of variance, for the two species. We produced empirical density plots for each species across the four variables using a Gaussian smoothing kernel. The advantage of density functions is that they show the entire distribution, and unlike box-plots, reveal if multiple peaks exist. Finally, we performed Linear Discriminant Analysis with the `lda()` function from the MASS package for R (Venables and Ripley 2013), using all four variables described above, and taking the prior probability for each species to be equal.

Molecular identification—Leaf samples were collected from nursery plants, botanic gardens, and field-collected herbarium specimens (Appendix 2). Based on our ongoing phylogenetic studies of the genus (Gemmill et al. In Prep) we focused our study on *P. roimata*, *P. cornifolium* and the morphologically similar but much smaller *P. pimeleoides* (*P. pimeleoides* subsp. *pimeleoides* A. Cunn. ex Put. and *P. pimeleoides* subsp. *majus* (Cheeseman) R.C. Cooper). Total genomic DNA was extracted from

50–100 mg of dried leaf tissue using an Isolate Plant DNA mini kit (Bioline, London) according to the manufacturer's instructions, with a lysis period of 3 hours. The ITS region of 18S-26S nuclear ribosomal DNA was chosen for this study for its ability to resolve species-level phylogenetic relationships in *Pittosporum* (Hathaway 2001; Gemmill et al. 2002; Chandler et al. 2007). The universal eukaryote primer ITS-4 (White et al. 1990) and the higher-plant primer ITS-5 HP (Gemmill et al. 2002) were used to amplify the entire ITS region. The PCR was performed in a total reaction volume of 20 μ L consisting of: 12.6 μ L MilliQ water, 0.25 μ M of each primer, 1.25 units MyTaq™ red reaction buffer (Bioline), 0.1% bovine serum albumin (BSA), 0.05U of MyTaq™ polymerase (Bioline), and 1.0 μ L unquantified total genomic DNA. Reactions were run on an Eppendorf Mastercycler® pro thermal cycler (Hamburg) with an initial denaturation of 94°C for 5 min, followed by 36 cycles of 94°C for 30 s, 54°C for 30 s, and 72°C for 1 min, with a final extension of 72°C for 10 min. To verify amplification, 3 μ L of PCR product was loaded into a 1% 0.5 \times TBE agarose gel containing 0.005% volume of RedSafe™ nucleic acid staining solution (iNtRON Biotechnology, Inc., Seongnam-Si) and run for 40 min at 44 V. The gel was then visualized under UV light and photographed using an Alphalmager™ (Innotech, San Jose, California). A 100 bp DNA Ladder (Invitrogen™, Waltham, Massachusetts) was used as a size standard. Products that produced a strong, single band of around 700 bp were prepared for sequencing. PCR products were purified of excess primers and unincorporated nucleotides using exonuclease I (Exo, Global Science, Auckland) and shrimp alkaline phosphatase (SAP, Global Science). A reaction mixture of 10U of Exo, 2U of SAP, and 5 μ L of PCR

product was prepared and incubated at 37°C for 15 min, followed by 80°C for 15 min using an Eppendorf Mastercycler® pro thermal cycler.

Sanger sequencing was performed by the Waikato DNA Sequencing Facility using a BigDye® Terminator v3.1 cycle sequencing Kit (Applied Biosystems®, Waltham) and the 3130xl Genetic Analyzer (Applied Biosystems®). Initial sequence alignment and editing was performed using Sequencher version 5.3 (GeneCodes, Ann Arbor, Michigan). Sequences were confirmed as target DNA through sequence comparison using the NCBI database BLASTn search algorithm (Altschul et al. 1990) and to our own library of *Pittosporum* DNA sequences.

RESULTS

Morphological Analyses—Comparison of *P. roimata* and *P. cornifolium* provides a number of key differences in character states of vegetative characters (Table 1). Our statistical analyses support these observations. Leaves of *P. roimata* are longer and wider, with shorter petioles than *P. cornifolium* (Fig. 3A–D). The mean leaf length of *P. roimata* is significantly longer than that of *P. cornifolium* (Fig. 3A; $t = 4.040$, $df = 22.9$, $p < 0.001$), and with 95% confidence the mean leaf length of *P. roimata* is between 5.7–17.7 mm longer than that of *P. cornifolium*. The mean leaf width of *P. roimata* is significantly wider than the mean leaf width of *P. cornifolium* (Fig. 3B; $t = 4.213$, $df = 21.6$, $p < 0.001$), and with 95% confidence the mean leaf width of *P. roimata* is between 3.7–10.8 mm wider than that of *P. cornifolium*. The mean

petiole length of *P. roimata* is significantly shorter than that of *P. cornifolium* (Fig. 3C; $t = -4.252$, $df = 40.7$, $p < 0.001$), and with 95% confidence the mean petiole length of *P. roimata* is between 1.7–2.4 mm shorter than that of *P. cornifolium*. The mean ratio of leaf length to leaf width for *P. roimata* is significantly smaller than the same for *P. cornifolium* (Fig 3.D; $t = -3.866$, $df = 48.1$, $p < 0.001$), and with 95% confidence the mean ratio for *P. roimata* is between 0.15–0.47 units smaller than that for *P. cornifolium*.

Discrimination was between specimens identified as *P. roimata*, found only on the Poor Knights Islands, and specimens identified as *P. cornifolium*, found at all other locations (off shore, mainland (North and South Islands), producing a single linear discriminant (Fig. 4). This discriminant correctly ascribed 15 of the 16 Poor Knights Islands specimens to *P. roimata*, and 33 of the 39 specimens from other locations to *P. cornifolium*, resulting in a misclassification rate of 12.7%. Applying leave-one-out cross-validation with this model resulted in the same misclassification rate. Together these analyses suggest that the vegetative characters alone did a very good job in correctly identifying specimens of *P. roimata* and *P. cornifolium*.

Molecular identification—A single point mutation at base 36 in a truncated aligned matrix in the ITS region reliably provides identification *P. roimata* with base G from *P. cornifolium* and both subspecies of *P. pimeleoides* with base A, the latter three are identical in sequence. While a single mutation may not seem significant, to put this into context, all 11 morphologically distinct species of

Hawaiian *Pittosporum* have identical ITS sequences (Gemmill et al. 2002). Phylogenetic analysis of the ITS region (Gemmill et al. In Prep) places *P. roimata* as sister to the clade of *P. cornifolium* and *P. pimeleoides*. This lineage appears to be derived from New Caledonia and is not closely related to the other New Zealand species of *Pittosporum*.

TAXONOMIC TREATMENT

Pittosporum roimata Gemmill & S.N. Carter, sp. nov. –TYPE: NEW ZEALAND, North Island, Poor Knights Islands, Tawhiti Rahi. Beneath pōhutakawa forest on summit plateau. Terrestrial, flowers yellow. 9 Sept. 1980 A. E. Wright 3951 (holotype: AK 155344!). Fig. 5.

Pittosporum roimata is most similar to *P. cornifolium*, but is distinguished by its larger stature, larger (longer and wider), thicker leaves, often with ciliate margins, and bright yellow flowers (Figs. 1 and 2). Furthermore, *P. roimata* inflorescences have more flowers, longer pedicels, a greater number of fruits, and have many more seeds that are strikingly angular than does *P. cornifolium*. *Pittosporum crassifolium* Banks & Sol. ex A. Cunn (karo), with heavily tomentose leaves and red flowers also occurs on the Poor Knights Islands but cannot be confused with *P. roimata*. *Pittosporum roimata* shares thick coriaceous leaves and yellow flowers with *Pittosporum kirkii* Hook.f. ex Kirk but *P. roimata* differs by having leaves that are short-petiolate, wide oblanceolate-ovate to obovate to rhombic leaves, and relatively small dark fruits with bright orange interiors. *Pittosporum kirkii*, like *P. cornifolium*, is an

epiphytic shrub that is also sometimes found terrestrially or rupestrally. *Pittosporum kirkii* is found on the North Island and some offshore islands, but is not known via herbarium specimens or the literature from the Poor Knights Islands. de Lange and Cameron (1999) report that *Pittosporum umbellatum* Banks & Sol. ex Gaertn. (haekaro) was collected from Tawhiti Rahi by Wright s.n. (AK201708, AK201709). These two specimens were collected from a sapling and are the sole record of this species for the islands.

Pittosporum umbellatum is easily distinguished from *P. roimata* by having brown tomentum on young branches, petioles to 2 cm, umbels of [red] pink [cream] flowers and distinctive 4-lobed fruits.

Plant a shrub to ca. 4 m, cut stems and crushed leaves have fresh, resinous smell characteristic of the genus. **Stems** monoblastic. **Bark** reddish brown, thin, splitting vertically producing a diamond lattice-like pattern with light brown lenticels <2 mm long, long axis parallel to axis of stem. **Young stems** terete, appear whorled due to short internodes, flexible, reddish, with simple, unbranched multicellular white hairs, bearing caducous bracts with simple, low order dichotomous branching of veins and ciliate margins. **Leaf scars** obvious, elliptical, with three vein traces. **Axillary buds** green to reddish, numerous. **Bracts** protect new vegetative and floral shoots, imbricate, ranging from small, sessile, broad based scales progressively becoming more leaf-like, with differentiated basal portion, apiculate, pale yellowish when young, can be reddish at upper margins, turning brown before falling off. **Petioles** 0–3mm, short, somewhat expanded at base with broad attachment to stem, truncate, reddish in colour. **Leaves** 4–9.5 cm long and 1.3–4.7 cm wide, simple, exstipulate, thick and coriaceous, oblanceolate-obovate to

rhombic, apex rounded, and very shortly acuminate or obtuse, base cuneate to obtuse, can be slightly concave, alternate but appear whorled at tips of branches due to short internodes, usually 5–6 leaves per “whorl” and often with a single isolated leaf a few cm below the whorl. Leaf margin entire, often slightly revolute on dried specimens, red to yellow, occasional long uniseriate white hairs, especially prominent on young leaves. Adult leaves adaxially dark green, abaxially pale green and young leaves bright green and glossy, some mature leaves may remain on the stem, turning yellow then brown.

Venation pinnate, primary vein reddish brown basally fading to yellow-green, obvious particularly on young leaves, secondary veins somewhat raised, giving impression of pinnate venation, venation to the third order especially obvious when held to light, quaternary veinlets ending freely within islets, branched. **Inflorescences** terminal, umbellate, subtended by concave bracts with ciliate margins, persistent through flowering. Peduncle stout, with ca. 4 bracts and 1-few minute bracts. **Flowers** actinomorphic, 5-merous, appearing complete but slightly dimorphic and functionally unisexual, smell lightly of honey. Flower buds ca. 7mm, in combinations of maroon, yellow or green, imbricate, pointed, becoming increasingly bright yellow, very rarely pink, mature petals lighter externally, deeper yellow internally. **Pedicels** with long, erect white uniseriate hairs, with up to 3 spherical terminal glandular cells, sometimes also with very long, non-glandular hairs immediately below the flowers, ♂ 18(–25) mm long, ♀ ca. 13.5 cm, erect, becoming woody. **Calyx** 8mm, lanceolate, light green, glabrous, equal to petals in

bud but about half the length of mature petals, long-lasting especially noticeable in old male flowers.

Corolla fused somewhat at least basally. In ♂ flowers, limb reflexes arching fully backwards, sometimes twisting, in ♀ flowers limb reflexes to the horizontal. **Stamens** in ♂ 6.7 , in ♀ 5.2mm, alternate with petals. **Filaments** fine, pale yellow. **Anthers** dorsifixed, introrse, opening by slits, in ♂ exerted, exceeding stigma, in ♀ short rudimentary, sterile. **Pollen** yellow. **Gynoecium** syncarpous. **Ovary** superior, unilocular, green with scattered white hairs, five basal glands completely covered in hairs, in ♂ thin, reduced apparently sterile, in ♀ large and plump. **Carpels** 2. **Placentation** parietal, funicles long, robust, bright vermillion, turning brown. **Ovules**, numerous, in two rows, unitegmic. **Style** one, straight, persistent. **Stigma** capitate, glossy. **Fruit** dehiscent, 2-valved loculicidal woody capsule. Young fruit bright green, oval, surface smooth with scattered white hairs, ring of white hairs around the base of the fruit. Mature fruit with inner surface of valves bright vermillion, fading to brown. **Seeds** up to ca. 20, 3.5 x 5.5 mm, compressed, irregular and highly angular, with sharp thin edges, initially shiny, immersed in viscid pulp.

Distribution and Habitat– *Pittosporum roimata* is known only from the Poor Knights Islands located ca. 35°28' S, 174°44' E, 22km off the east coast off Northland, North Island, New Zealand (Fig. 6). The island group is comprised of two main islands, Tawhiti Rahi (151.5 ha, 204m) and Aorangi (101 ha,

216m), the two smaller islands of Archway and Aorangaia, as well as numerous smaller islets and rock stacks (Hayward 1993). Together these islands form the Poor Knights Islands Nature Reserve, and are surrounded by the Poor Knights Islands Marine Reserve. *Pittosporum roimata* is locally abundant and known from Tawhiti Rahi, Aorangi, and Aorangaia islands.

These islands are the remnant of a rhyolitic volcano which became inactive nine mya (Hayward 1991) and have been isolated from the mainland for at least the last two million years since the last glaciation, however, the channel between Northland and the Poor Knights Islands narrowed to five to eight km during the last glacial period 18–20,000 years ago (Hayward 1991). Today the islands are characterized by high, sheer rocky cliffs. The flora and fauna are distinctive and these islands have been designated as the Tawhitirahi Ecological Region, Aotearoa/New Zealand (McEwan 1987). Sea birds are abundant and many species are represented (Buddle 1941, 1946), as well as the iconic tuatara (*Sphenodon punctatus*). The vascular flora of these islands comprises just over 300 species (de Lange and Cameron 1999; Cameron 2002) and while there are a number of near endemics, *P. roimata* is currently the sole endemic vascular plant species (cf. de Lange and Cameron 1999).

Conservation Status –According to the New Zealand Conservation Threat classification we suggest that this species be classified as at risk/naturally uncommon (Townsend et al. 2008; de Lange et al. 2013), and further qualified as data poor [DP], one location [OL] (Peter de Lange, pers. comm. 10 July 2017). The population's area of occurrence (AOO) is < 100 ha and while the population is assumed to be

stable, no assessment has been undertaken. Furthermore, because the islands are in such close proximity, there is an increased risk of decline or extirpation across all islands. Future projections are optimistic as a program of sustained control of weed species is ongoing (West 1999). Additionally, the islands are an off-limits Nature Reserve and mammalian pests have been extirpated. More research is needed on most aspects of *in situ* populations as our knowledge is currently inadequate.

Ecology—*Pittosporum roimata* grows rupestrally in open, flat areas as well as on cliff faces (Fig. 7). Common associates include *Xeronema callistemon* W.R.B.Oliv. (raupo taranga), *Leptospermum scoparium* J.R.Forst. & G.Forst. (mānuka), *Myrsine aquilonia* de Lange & Heenan (Poor Knights matipo), *Chionochloa bromoides* and *Metrosideros excelsa* Sol. ex Gaertn. (pōhutukawa) (Cockayne 1906; Oliver 1925; de Lange and Cameron 1999). At Tatua Peak (Aorangi Island) and particularly on Tawhiti Rahi plants also have been observed growing epiphytically on *M. excelsa* (pers. comm. Peter de Lange).

Although these islands are geologically and geographically isolated they are not pristine. The Poor Knights Islands were settled by Māori well before European arrival (Fraser 1925; Ritchie et al. 1979). During this time, large areas were cleared, fortifications built (pā), and crops cultivated in terraces (Cranwell 1937). European pigs were introduced to Aorangi in early 1793 (Poaka 1972 as cited in Hayward, 1993), which eventually led to the extirpation of native biota such as the large land snail (*Placostylus hongii*, pupuharakeke; Oliver 1925; Buddle 1941, 1946;). The islands were eventually abandoned by Māori ca. 1822 following a massacre, and the islands were designated wāhi tapū (Fraser

1925; pers. comm. Marie Tautari and David Peters, Te Whakapiko te hapū). The pigs were left to roam the island for >100 years and were finally eradicated from Aorangi in 1936 (Buddle 1941). Today the islands remain free of introduced mammals including rodents (Ritchie et al. 1979), facilitating the recovery of the native biota. The islands were classified as a Scenic Reserve in 1922 and since 2009 the islands are an off-limits Nature Reserve, reserved for the preservation of flora and fauna. Access to the islands by the general public is prohibited and the Department of Conservation has strict quarantine measures for any approved visits to prevent further introductions.

Reproduction—Kirk (1872) and Godley (1979) recognized that many species of *Pittosporum* are functionally dioecious, and hence are predominantly outcrossing. Petrie (1921) observed floral dimorphism in *P. cornifolium* where male plants had more flowers (6–8 [10]) than female plants (1 to very few). We observed this as well in *P. roimata* and found that male plants have more flowers per inflorescence, longer pedicels, and longer stamens, yet much thinner ovaries compared to female flowers. We also observed that male flowers produce >95% viable pollen while female flowers produce essentially no viable pollen (Agulló Brotons and Gemmill, unpublished data). One *ex situ* male plant of *P. roimata* has been observed to produce 1–2 fruit per season (Gemmill, pers. obs.), suggesting that this functionally dioecious species may have a very low frequency of “inconstant males” (Lloyd 1975) with female flowers. These rare functionally female flowers on male plants appear to be produced in the last flowering flush and produce no viable pollen.

A diverse range of insects have been observed on the unspecialized flowers and are the presumed pollinators. In the wild, beetles (soft-winged flower beetle, Melyridae; true weevils, Curculionidae (Tribe Storeini) have been observed on the flowers. On *ex situ* plants, we have observed steelblue ladybird (*Halmus chalybeus*) on the leaves, honeybees (*Apis mellifera*) and beetles (*Litargus vestitus*, Mycetophagidae) on the flowers, and thrips (Thysanoptera) and springtails (Subclass *Collembola*) within mature fruits. Active dispersal is presumed to be via birds (Oliver, 1930; Burrows, 1994), externally and possibly internally. The native wattlebird kōkako (*Callaeas cinerea wilsoni*) is known to eat seeds of *P. cornifolium* (Powlesland 1987). Native kākārīki (*Cyanoramphus novaezealandiae*), korimako (*Anthornis melanura*), and tieke (*Philesturnus refusater*) have all been observed in the vicinity of plants on Aorangi Island (D. van Winkel, pers. comm.).

Chromosome Counts—*Pittosporum roimata* has a count of $2n=24$ (pers. comm. Peter de Lange). Close relatives *P. cornifolium* and *P. pimeleoides* have $2n=24$ (de Lange et al. 2004), in fact all *Pittosporum* assessed so far have this same number.

Phenology—Observations for flowering of *P. roimata* in the wild are limited. Flowers have been collected and observed *in situ* (Dylan van Winkel, pers. comm) in September. Clarkson (2011) reported that *ex situ* plants of *P. roimata* flowered mid-August to late October, while *P. cornifolium* flowered earlier in July to early Sept. Fruit has been observed on herbarium specimens of *P. roimata* collected in

April, March and October. Immature green and mature open fruits can be observed on the same plant and may be present year-round.

We suggest that *P. roimata* is reproductively isolated from other species of *Pittosporum* due to its geographical isolation and differences in flowering times. The likelihood of hybridization with other species of *Pittosporum* is currently unknown. Hence, we recommend that this species not be used in restoration projects on the mainland or other offshore islands to prevent genetic contamination and introgression.

Historical Botanical Notes—The first European botanist to visit the islands was Cockayne (1906), who noted *P. crassifolium*, followed by Oliver (1925) and Moore and Cranwell (Cranwell, 1937). The earliest *P. roimata* herbarium specimen that we could locate was collected in 1933 from Tunnel Island by Moore and Cranwell (AK) and then from Tawhiti Rahi and Aorangi in 1937. Subsequent collections did not occur until 1978, 1980, 1988, 1991, with the last in 1994.

Cooper (1956) described the flowers of *P. cornifolium* as yellow instead of reddish. We suggest that Cooper mistakenly confused it with the *P. kirkii*. Cooper placed both of these epiphytes in the same couplet in his key. Additionally, no specimens collected before 1956 mention yellow flowers. The first specimen from the Poor Knights to record yellow flowers was collected 9 September 1980 by A.E. Wright (AK155344) from the summit plateau of Tawhiti Rahi. Wright also collected a pink flowered specimen (AK 155369) on the same date from the same site; this is the only documented occurrence of

pink flowers. de Lange and Cameron (1999) mentioned that *P. cornifolium* of the Poor Knights Islands has larger thicker leaves and ciliate margins, but did not mention flower color. The “yellow flowered form” of *P. cornifolium* was first mentioned within a horticultural magazine by Smith (2004). Clarkson (2011; Clarkson et al. 2012) likely included the first published photos of the yellow-flowered Poor Knights *Pittosporum*.

Cultivation– Young, non-woody cuttings of this species strike easily (Gemmill., pers. obs.). This plant was brought into cultivation about 20 years ago and has been commercially available as “*Pittosporum* Poor Knights” (Hobbs 2011).

Etymology–The Māori specific epithet ‘roimata’ was chosen through consultation with Te Whakapiko te hapū o Ngati Manaia te iwi, Whananaki, Aotearoa. We quote the kaumatua Marie Tautari and David Peters here: “According to oral tradition after the massacre took place on the Poor Knights two canoe loads of the dead were taken to the mainland at Whananaki and buried at a place called Roimata. Tawhitirahi and Aorangi were subsequently deemed by those connected to the islands as wāhi tapū and therefore unsuitable for occupation. Roimata, which means tears [in te reo Māori], symbolises the connection between the people who lost their lives, their final resting place at Whananaki and the ongoing respect accorded to Tawhitirahi and Aorangi for the action that took place.” We are pleased to be able to bring this species to light and to give it a name with such deep meaning for the indigenous people of Aotearoa.

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APPENDIX 1. Specimens Examined

Pittosporum roimata

NEW ZEALAND. North Island: Poor Knights Ecological Region and District, Poor Knights Islands, 1/02/1937, *L.M. Cranwell s.n.* (AK102379); North Island: Poor Knights Ecological Region and District, Poor Knights Islands, 1/02/1937, *L.M. Cranwell s.n.* (AK102390); North Island: Poor Knights Ecological Region and District, Poor Knights Islands, Aorangi Island, Tatua Peak, 27/10/1988, *E.K. Cameron 5080a* (AK208662); North Island: Poor Knights Ecological Region and District, Poor Knights Islands, Aorangi Island, Tatua Peak, 28/10/1988, *E.K. Cameron 5080b* (AK208661); North Island: Poor Knights Ecological Region and District, Poor Knights Islands, Southern Island (southern island as in Aorangi?), 13/02/1937, *L.M. Cranwell s.n.* (AK102364); North Island: Poor Knights Ecological Region and District, Poor Knights Islands, Tawhiti Rahi Island, 26/04/1991, *A.E. Wright 11485* (AK201814); North Island: Poor Knights Ecological Region and District, Poor Knights Islands, Tawhiti Rahi Island, 26/04/1991, *A.E. Wright 11485* (AK201736); North Island: Poor Knights Ecological Region and District, Poor Knights Islands, Tawhiti Rahi Island, beneath the pōhutakawa forest on summit plateau, 9/09/1980, *A.E. Wright 3952* (AK155343); North Island: Poor Knights Ecological Region and District, Poor Knights Islands, Tawhiti Rahi Island, beneath the pōhutakawa forest on summit plateau, 9/09/1980, *A.E. Wright 3965* (AK155369); North Island: Poor Knights Ecological Region and District, Poor Knights Islands, Tawhiti Rahi Island, northern Islet, 1/02/1937, *L.B. Moore & L.M. Cranwell s.n.* (AK102375); North Island: Poor Knights Ecological

Region and District, Poor Knights Islands, Tawhiti Rahi, beneath pohutakawa forest on summit plateau, 9/09/1980, *A.E. Wright 3951* (AK155344); North Island: Poor Knights Ecological Region and District, Poor Knights Islands, Tawhiti Rahi, Maraetea Point, 17/03/1994, *P.J. de Lange 2533* (AK214230); North Island: Poor Knights Ecological Region and District, Poor Knights Islands, Tunnel Island [Aorangaia], 19/11/1933, *L.B. Moore & L.M. Cranwell s.n.* (AK102365); North Island: Poor Knights Ecological Region and District, Poor Knights Islands, Tunnel Island [Aorangaia], 20/11/1933, *L.B. Moore & L.M. Cranwell s.n.* (AK102367); North Island: Poor Knights Ecological Region and District, Poor Knights Islands, 14/2/1937 *L.M. Cranwell s.n.* (CHR21645); North Island: Poor Knights Ecological Region and District, Poor Knights Islands, Aorangi Island, Tatua Peak, 3/1/1978, *G.N. Park s.n.* (WELT 77738)

Pittosporum cornifolium

NEW ZEALAND. North Island: Auckland Ecological Region, Hunua Ecological District, Hunua Range, Mangatangi, road to kauri area, 18/08/1973, *A.J. Dakin s.n.* (AK211483); North Island: Auckland Ecological Region, Inner Gulf Islands Ecological District, Kawau Island, 16/06/1920, *H.B. Matthews s.n.* (AK102369); North Island: Auckland Ecological Region, Inner Gulf Islands Ecological District, Kawau Island, 16/06/1920, *H.B. Matthews s.n.* (AK102381); North Island: Auckland Ecological Region, Inner Gulf Islands Ecological District, Kawau Island, 15-16-Jun-1920, *H.B. Matthews s.n.* (AK102382); North Island: Auckland Ecological Region, Inner Gulf Islands Ecological District, Waiheke Island, Awaawaroa Bay,

Awaawaroa Road, Awaawaroa River, 16/02/2010, *P.J. de Lange 8753* (AK310100); North Island: Auckland Ecological Region, Inner Gulf Islands Ecological District, Waiheke Island, Enclosed Bay, 1/09/1993, *P.J. de Lange 2225* (AK231818); North Island: Auckland Ecological Region, Rodney Ecological District, Mount Auckland, 6/10/1974, *D.J. Court 531* (AK181986); North Island: Auckland Ecological Region, Waitakere Ecological District, Spraggs Bush, 14/12/1966, *B.S. Parris s.n.* (AK128893); North Island: Auckland Ecological Region, Waitakere Ecological District, Titirangi, August - 1884, *T.F. Cheeseman s.n.* (AK224839); North Island: Auckland Ecological Region, Waitakere Ecological District, Titirangi, August - 1884, *T.F. Cheeseman s.n.* (AK224837); North Island: Auckland Ecological Region, Waitakere Ecological District, Waitakere Ranges, Dreamland Road, 21/09/1968, *P. Hynes s.n.* (AK120169); North Island: Coromandel Ecological Region, Colville Ecological District, Te Moehau, 20/05/1933, *L.B. Moore & L.M. Cranwell s.n.* (AK102374); North Island: Coromandel Ecological Region, Great Barrier Ecological District, Rangiwheake Bay, 4/01/1983, *A.E. Wright 5427* (AK160937); North Island: Coromandel Ecological Region, Great Barrier Ecological District, Rangiwheake Bay, 10-18-Feb-1965, *J. Frater, R.S. Cooper & A.B. Stephenson s.n.* (AK122308); North Island: Coromandel Ecological Region, Little Barrier Ecological District, Little Barrier Island, 1897-1910, *E.M. Smith s.n.* (AK110080); North Island: Coromandel Ecological Region, Little Barrier Ecological District, Little Barrier Island, 1900-1902, *F. Shakespear s.n.* (AK127628); North Island: Eastern Northland Ecological Region, Eastern Northland & Islands Ecological District, Russell, 1/05/1953, *J.L. Edwards s.n.* (AK31866); North Island:

Eastern Northland Ecological Region, Eastern Northland & Islands Ecological District, Whangaruru North, 28/08/1967, *R.C. Cooper s.n.* (AK224833); North Island: Eastern Northland Ecological Region, Taranga Ecological District, Hen (Taranga) Island, 17/11/1933, *L.B. Moore & L.M. Cranwell s.n.* (AK102376); North Island: Eastern Northland Ecological Region, Taranga Ecological District, Hen (Taranga) Island, 17/11/1933, *L.B. Moore & L.M. Cranwell s.n.* (AK224832); North Island: Eastern Northland Ecological Region, Taranga Ecological District, Hen (Taranga) Island, 17/11/1933, *L.B. Moore & L.M. Cranwell s.n.* (AK102377); North Island: Eastern Northland Ecological Region, Taranga Ecological District, Hen (Taranga) Island, 28/11/1934, *L.B. Moore & L.M. Cranwell s.n.* (AK102378); North Island: Eastern Northland Ecological Region, Taranga Ecological District, Hen (Taranga) Island, ridge from Pinnacles down to Pukanui Bay, 1/01/1991, *A.E. Wright 10939* (AK201207); North Island: Eastern Northland Ecological Region, Eastern Northland & Islands Ecological District, north Whangaroa Harbour, off track from Totara North to Lanes Cove, 24/09/1990, *A.E. Wright 10417* (AK226136); North Island: Manawatu Ecological Region, Manawatu Plains Ecological District, Turakina Valley, 10/10/1981, *M. Dickson s.n.* (AK244582); North Island: Northern Volcanic Plateau Ecological Region, Otanewainuku Ecological District, Ngawaro, 15/10/1965, *R.C. Cooper s.n.* (AK125750); North Island: Northern Volcanic Plateau Ecological Region, Otanewainuku Ecological District, Western Kaimai Ranges, Above Okauia Settlement, 27/08/1958, *J.L. Nicholls s.n.* (AK154324); North Island: Northern Volcanic Plateau Ecological Region, Rotorua Ecological District, Lake Rotoma, 10/01/1952, *K. Wood s.n.* (AK28060); North Island: Tainui Ecological Region,

Kawhia Ecological District, Kawhia Harbour, Te Uremaronui Rock, 20/08/1984, *P.J. de Lange s.n.* (AK170455); North Island: Tainui Ecological Region, Raglan Ecological District, Raglan Harbour, Marotaka Point, 15/03/1989, *P.J. de Lange s.n.* (AK185366); North Island: Urewera Ecological Region, Waikaremoana Ecological District, Lake Waikaremoana, April/March 1920, *G.O.K. Sainsbury 15* (AK224834); North Island: Western Northland Ecological Region, Maungataniwha Ecological District, Kaitaia, Fairburn, 1/09/1905, *H. Carse 206* (AK246968); North Island: Western Northland Ecological Region, Maungataniwha Ecological District, Kaitaia, Okahu, 17/08/1920, *H.B. Matthews s.n.* (AK102386); North Island: Whakatane Ecological Region, Te Teko Ecological District, White Pine Bush, 23/10/1966, *P. Hynes s.n.* (AK110360); North Island: Hawks Bay, Akatarewa (?) Station, 01/11/1936?, *H. Bedggood? s.n.* (AK102373); South Island: North Westland Ecological Region, Punakaiki Ecological District, Barrytown Flats Mahers Swamp, 31/08/1991, *P.J. de Lange 981* (AK203233); South Island: North Westland Ecological Region, Punakaiki Ecological District, Tennyson inlet, Pelorus Sound, 1/03/1937, *E.P. Turner s.n.* (AK102388); South Island: North-West Nelson Ecological Region, Golden Bay Ecological District, Pohara Beach, 1/05/1953, *J. White s.n.* (AK219626).

APPENDIX 2. Samples sequenced for the internal transcribed spacer region in this study including species, sample ID, source information, accession number, and Genbank accession number. Sequences for samples without vouchers were not submitted to GenBank.

Pittosporum cornifolium A. Cunn, *Gemmill P1-4* cultivated Waikato University, WAIK17917, AF302030.1; *P. cornifolium*, A.E. Wright 10939, Eastern Northland Ecological Region, Taranga Ecological District, Hen (Taranga) Island, ridge from Pinnacles down to Pukanui Bay, AK201207, MG560836; *P. cornifolium*, *Gemmill s.n.*, Canterbury Agriculture and Science Centre, Lincoln, South Island, LC19369, MG560834; *P. cornifolium*, *Gemmill s.n.*, Otari Native Garden, Wellington, sourced from Waikanae, North Island, OBG9200494, MG560835; *P. cornifolium*, F.M. Clarkson R1, North Island, Tainui Ecological Region, Raglan Ecological District, Raglan Harbour, Marotaka Point, no voucher; *Pittosporum roimata* Gemmill & S.N. Carter, P.J. de Lange 2533, Poor Knights Ecological Region and District, Tawhiti Rahi, Maraetea point, AK214230, MG560839; *P. roimata*, F.M. Clarkson PK2, obtained from native plant nursery as *P. cornifolium* "Poor Knights", no voucher; *P. roimata*, F.M. Clarkson PK1, obtained from native plant nursery as *P. cornifolium* "Poor Knights", no voucher; *P. roimata*, F.M. Clarkson PK8, obtained from native plant nursery as *P. cornifolium* "Poor Knights", no voucher; *Pittosporum pimeleoides* subsp. *majus* (Cheeseman) R.C. Cooper, *Gemmill s.n.*, Canterbury Agriculture and Science Centre, Lincoln, South

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Island, sourced from North Cape, North Island, LC11564, MG560837; *Pittosporum pimeleoides* subsp. *pimeleoides* A. Cunn. ex Put., *Gemmill s.n.*, Canterbury Agriculture and Science Centre, Lincoln, South Island, sourced from Timaru Botanical Gardens, North Island, LC15/90 , MG560838.

TABLE 1. Comparison of key morphological features of *Pittosporum cornifolium* (Fig. 1) and *P. roimata* (Fig. 2) based on our observations of live plants.

Character	<i>P. cornifolium</i>	<i>P. roimata</i>
Habit	Epiphytic, occasionally terrestrial or rupestral; branches fine	Usually terrestrial, occasionally epiphytic; branches stout
Petiole	1-4mm in length, green	0-3mm in length, dark red
Leaves	Small, much longer than wide; horizontal; young leaves without hairs	Large, slightly longer than wide; held upright, cupping the terminal buds; young leaves with ciliate margins
Inflorescence	Bracts not persistent, no apparent peduncle	Subtended by persistent bud scales and stout peduncle
Young pedicels	Red/maroon, no bracts	Light green, can be tinged with red, can have linear bracts

Flowers/inflorescence	Few	Many
Calyx	Soon spreading to horizontal	Held upright, close to petals
Corolla	Usually red externally, paler, even yellow to cream, internally	Bright yellow, very rarely pink
Buds	Completely red	Red, with yellow and/or green
Fruits	Usually 1 capsule; High fruit retention >1 year	Many, up to 6 capsules per infrutescence; Low/no fruit retention
Seeds	4-8, compressed, slightly rounded	10-20, highly compressed and strikingly angular

FIG.1. Morphological features of *Pittosporum cornifolium*. A and B. Female inflorescence. C and D. Male inflorescence. E and F. Adaxial leaf. G and H. Abaxial leaf. I. Stem. J. Infrutescence with two immature fruits. K. Mature fruits with seeds. Photos by Phil Garnock- Jones.

FIG. 2. Morphological features of *Pittosporum roimata*. A. Female inflorescence. B and C. Female flower. D. Male inflorescence. E and F. Male flower. G and H. Adaxial leaf. I and J. Abaxial leaf. K. Stem. L. Bract. M. Infrutescence of multiple immature fruits. N. Mature fruit with seeds. Photos by Phil Garnock- Jones.

FIG. 3. Density plot functions of morphological data from *Pittosporum roimata* (black) and *P. cornifolium* (red). A. Leaf length. B. Leaf width. C. Petiole length. D. Leaf length to width ratio

FIG. 4. Linear discriminant analysis of morphological data from *Pittosporum roimata* (black) and *P. cornifolium* (red) for specimens from Poor Knights Islands (black circles), other offshore islands (red triangles) and mainland New Zealand (red squares).

FIG. 5: Holotype of *Pittosporum roimata* Gemmill & S.N. Carter (AK 155344). A.E. Wright 3951 on 9 September 1980 from Tawhiti Rahi Island, Poor Knights Islands, New Zealand. Photo by Barry O'Brien.

FIG. 6. Male *Pittosporum roimata* on Tatua Peak, Aorangi Island, Poor Knights Islands, Aotearoa/New Zealand, 27 September 2016. Photo by Dylan van Winkel.

FIG. 7. Map of the Poor Knights Islands relative to the North Island of Aotearoa/New Zealand. Drawn by Max Oulton.













