

## Additions to the liverwort flora of the Kermadec Islands, New Zealand Botanical Region

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### Abstract

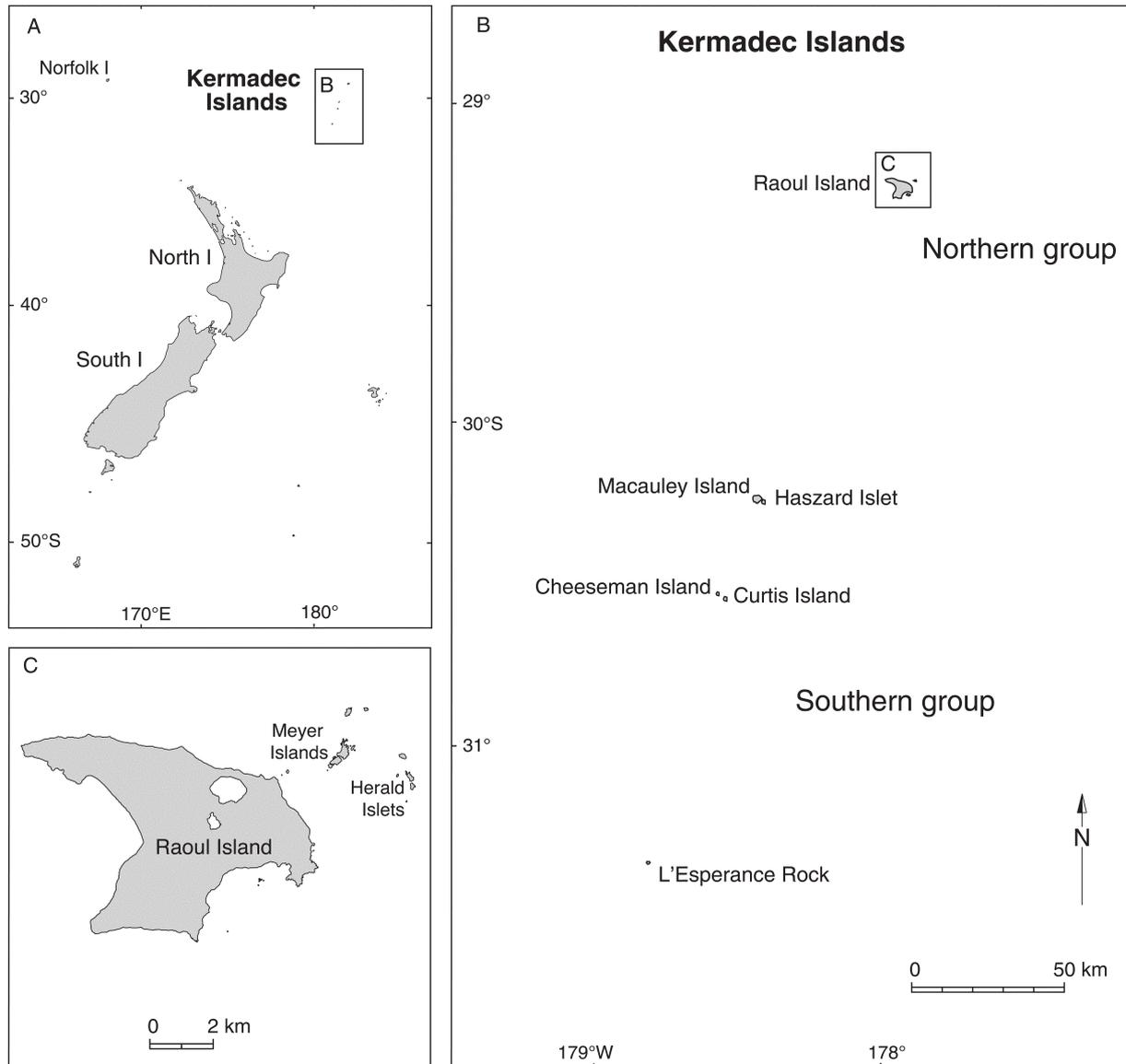
Five liverwort species are reported for the first time from the New Zealand Botanical Region, all from Raoul Island in the Kermadec Islands group: *Ceratolejeunea belangeriana*, *Notoscyphus lutescens* and *Lepidolejeunea integristipula* (new records for their respective genera in New Zealand), *Acrolejeunea pycnoclada* var. *pycnoclada* and *Cheilolejeunea ceylanica*. Keys to Australasian *Acrolejeunea* and vitate species of *Cheilolejeunea* subg. *Xenolejeunea* are provided.

### Introduction

The Kermadec Islands group (29° 15' – 31° 30' S, 177° 55' – 179° 00' W) (Fig. 1) is the northernmost extension of the New Zealand Botanical Region (*sensu* Allan 1961; Wardle 1991). Of the 29 or so islands, islets, rock stacks and emergent reefs that make up the group, Raoul Island at 2943 ha and elevations up to 518 m. a.s.l. is the largest, highest and only island supporting a dense cover of indigenous forest. Although the vascular flora of the Kermadec Islands are especially well documented (e.g. Sykes 1977; Sykes & West 1996) the bryophyte flora (particularly the hornwort and liverwort flora) remains poorly known. Campbell in Sykes (1977), based largely on gatherings from Raoul and Macauley Islands, listed 20 hornwort and liverwort taxa, and Beaver et al. (1996) accepted 52 mosses for the island group. Since then there have been only a few publications dealing with new bryophyte records for the island (Campbell 1997; Fife & de Lange 2009; Renner & de Lange 2011; Renner et al. 2013a), new endemic taxa (Engel & Merrill 1999; Renner 2005) and/or reinstatements of synonymised species (So 2001; Engel & Merrill 2010). Currently, there is one liverwort endemic to the Kermadec Islands, *Plagiochila pacifica* Mitt. which is known only from Raoul Island, (So 2001; Engel & Merrill 2010). A second species, *Radula erigens* (M.A.M.Renner & Braggins) M.A.M.Renner (Renner 2005; Renner et al. 2013b), described initially as an endemic subspecies of *R. cordiloba* Taylor (Renner 2005), is now regarded as synonymous with *R. javanica* Gottsche (Renner 2014). There are no known endemic mosses (de Lange & Beaver *in press*) or hornworts occurring in the Kermadec Islands.

In May 2011, the Auckland War Memorial Museum (AK) led the *Kermadec Biodiscovery Expedition* visiting all the main islands, islets and rock stacks, except for Curtis, Haszard, 'Haszardette', Milne and Dougal Rocks. As a result, five taxa new to the Kermadec Islands, as well as for the New Zealand Botanical Region, were identified:

*Acrolejeunea pycnoclada* (Taylor) Schiffner var. *pycnoclada*, *Ceratolejeunea belangeriana* (Gottsche) Steph., *Cheilelejeunea ceylanica* (Gottsche) R.M.Schust. & Kachroo, *Lepidolejeunea integristipula* (Jack & Steph.) R.M. Schust., and *Notoscyphus lutescens* (Lehm. & Lindenb.) Mitt. A description of the habitat of each of these taxa and their conservation status in the New Zealand Botanical Region are provided using the *New Zealand Threat Classification System* (Townsend et al. 2008).



**Fig. 1.** Location and spatial extent of the Kermadec Islands. A, General map showing position of the Kermadec Islands relative to Norfolk Island and the North and South Islands of New Zealand; B, Details of Kermadec Islands; C, Herald Islets, Meyer Islands, Raoul Island of the Kermadec Islands.

### New records for the New Zealand Botanical Region

*Acrolejeunea pycnoclada* (Taylor) Schiffner var. *pycnoclada*: Engl. & Prantl, *Natürlichen Pflanzenfamilien* I, 3(1): 128 (1893).

*Ptycanthus pycnocladius* Taylor *Journal of Botany* 5: 835 (1846).

*Lejeunea pycnocladius* (Taylor) Mitt. *Journal of the Proceedings of the Linnean Society, Botany* 5: 111 (1861).

*Ptychocoleus pycnocladius* (Taylor) Steph. *Species Hepaticarum* 5: 52 (1912).

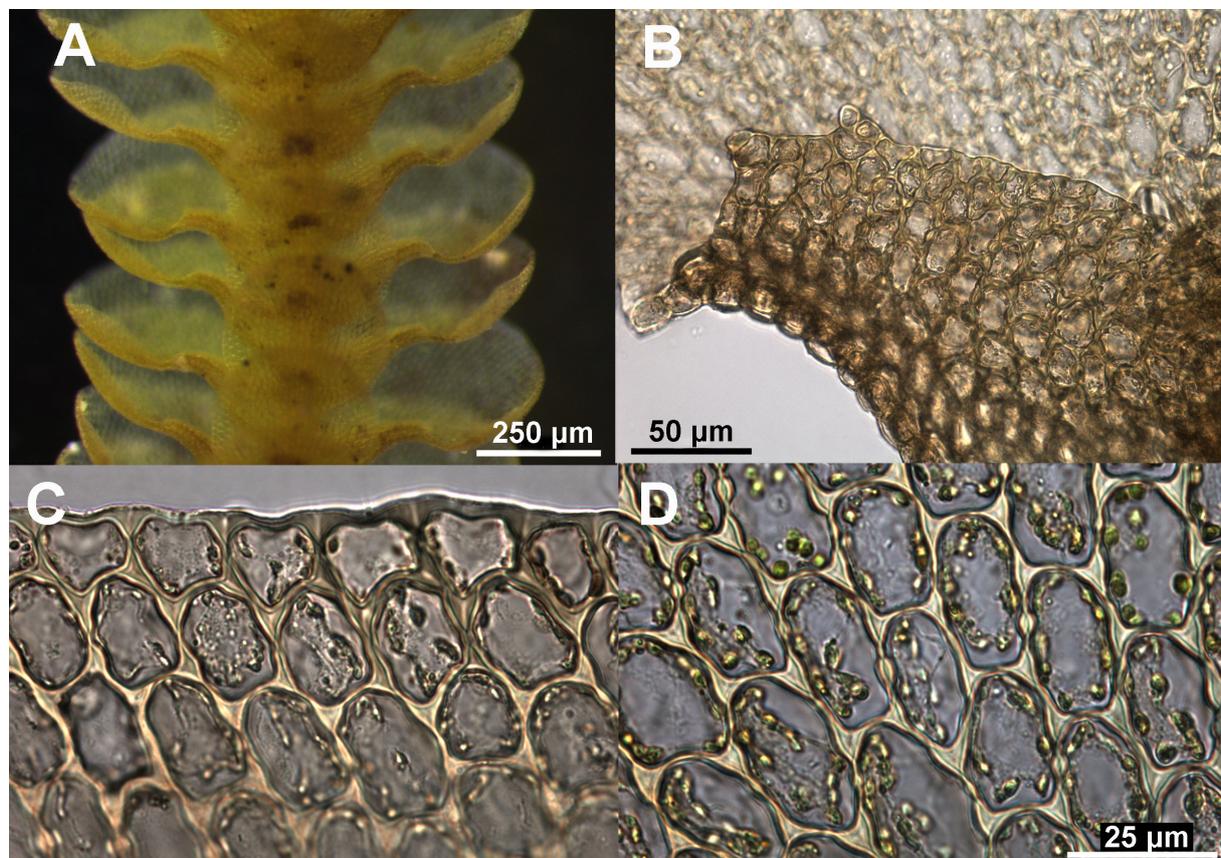
Type: MALAYSIA. Malacca, *Cantor s.n.* (holotype fide Gradstein, 1975: FH! Taylor Herbarium; isotypes: G! MANCH, NY, S, U, W).

Corticolous. Plant olive-green. Stems to at least 8 mm long, mostly shorter, appressed to bark. 0.3 mm (dry)–0.9 mm (wet) wide; 90–110  $\mu\text{m}$  diameter, ventral merophyte of 4 or 5 cells in width, Cortical cells subrectangular to irregular, 20–30  $\times$  12–22  $\mu\text{m}$  with c. 17 cortical cells surrounding c. 20 medullary cells. Branches mostly of *Lejeunea* type but occasionally *Frullania* type. Leaves imbricate when dry, spreading but not squarrose when wet. Lobe c. 540  $\times$  330  $\mu\text{m}$ , broad, shortly crescent-shaped with apex rounded, incurved. Dorsal base not auriculate. Ventral margin short and  $\pm$  recurved. Keel curved, not decurrent and cells not or weakly protuberant. Median leaf cells ovoid, 22  $\times$  15–16  $\mu\text{m}$ , base cells larger 29–31  $\times$  16–17  $\mu\text{m}$ , trigones medium-sized, Y-shaped (sides swollen), intermediate thickenings scattered to scarce. Oil-bodies not present. Lobule narrowly ovate-rectangular with apex slightly oblique, free margin almost straight. Teeth (2 or)3, each 1 or 2 cells long, erect, first cell at tip of free margin, hyaline papilla at base of second tooth (the ‘apical tooth’), lobule is about half length of lobe. Underleaf, slightly overlapping base of adjacent underleaf, broadly oval, c. 190  $\mu\text{m}$  long, c. 320 wide. Median cells ovoid, 15–18  $\times$  13–15  $\mu\text{m}$ , slightly larger at base, 22–25  $\times$  (9–)10(–13)  $\mu\text{m}$ . Rhizoid disc small. Sporophyte not seen. Fig. 2

**Specimen examined:** New Zealand, Kermadec Islands Nature Reserve, Raoul Island, Sunshine Valley, near Sunshine Bivy, 16 May 2011, *P.J. de Lange K688* (AK325478, F, NSW).

**Recognition:** The female bracts of *Acrolejeunea pycnoclada* are distinctive in being cucullate, and closely adpressed to one another. The lobule bears two small triangular teeth that are two cells broad at the base, and in this character differ from other Australian species. The lobule of *A. securifolia* has 3 or 4, 1–3-celled teeth that are usually clawed toward and behind the ventral surface of the lobule, and so are difficult to observe. The lobules of *A. mollis* Steph. have a single prominent, triangular tooth. *Acrolejeunea pycnoclada* from Raoul Island does not have the distinctly punctate surface ornamentation found in Australian plants (Renner 2013).

**Distribution:** *Acrolejeunea pycnoclada* var. *pycnoclada* is widespread through Africa, Indo-Malesia and the Pacific (Gradstein 1975), whereas in the New Zealand Botanical Region it is known only from the single gathering from Raoul Island in the Kermadec Islands.



**Fig. 2.** *Acrolejeunea pycnoclada* var. *pycnoclada* A: ventral view of shoot. B: lobule showing teeth. C: marginal leaf-lobe cells. D: medial leaf-lobe cells. All from AK325478.

**Habitat:** The gathering came from the branch of a *Metrosideros kermadecensis* W.R.B.Oliv. *Acrolejeunea pycnoclada* var. *pycnoclada* grew in association with the liverwort *Frullania rostrata* (Hook.f. & Taylor) Hook.f. & Taylor, moss *Calymperes tenerum* Müll.Hal., ferns *Pyrrhosia eleagnifolia* (Bory) Hovenkamp and *Asplenium* aff. *haurakiense* (Brownsey) Ogle, and a number of lichens including *Heterodermia obscurata* (Nyl.) Trevis., *Hypotrachyna costaricensis* (Nyl.) Hale, *Parmotrema reticulatum* (Taylor) M.Choisy, and *Pseudocyphellaria argyracea* (Delise) Vain.

**Conservation Status:** Although *A. pycnoclada* var. *pycnoclada* is widespread outside of New Zealand, it is known only from a single gathering from Raoul Island in the New Zealand Botanical Region, where it was abundant on *Metrosideros kermadecensis* in that locality. Therefore, the conservation status of this species is here regarded as Data Deficient, qualified OL [One Location] and SO [Secure Overseas].

### Key to Australasian *Acrolejeunea*

A key to all *Acrolejeunea* species currently known from Australia and New Zealand that builds on the key to Australian species in Renner (2013) is presented below.

- 1 Plants large, shoots to 1.5 mm wide, reddish brown; leaf lobe cells arranged in radiating rows; lobules narrowly pyriform, keel straight most its length, inclined at 30–45° to stem (measured on shoot apex side of angle), lobule bearing two teeth ..... 2
- 1 Plants medium to small, shoots 0.8–1.3 mm wide, mid-green, yellow-green or grey-green, never reddish; leaf lobe cells not arranged in radiating rows; lobules narrowly obpyriform to trapeziform, keel straight or arched, inclined at 60–80° to the stem, lobule bearing one, three or four teeth ..... 3
- 2 Dioicous; androecia intercalary on leading shoots; female bracts in two gyres, bract lobe apices obtuse-acute, bract lobes particularly those of inner gyre often reflexed; perianths exerted above bracts at maturity, underleaves ovoid to longitudinally oblong; lobule second tooth shorter or longer than lobule first tooth ..... *Acrolejeunea arcuata* (Nees) Grolle & Gradst. subsp. *arcuata*
- 2 Autoicous; androecia on short lateral branches; female bracts in one gyre, bract lobe apex rounded, bract lobes not reflexed; perianths immersed within bracts at maturity; underleaves longitudinally oblong c. 0.2× the shoot width; lobule second tooth longer than lobule first tooth ..... *Acrolejeunea arcuata* subsp. *gradsteinii* M.A.M.Renner
- 3 Lobule with one prominent tooth ..... 4
- 3 Lobule with 3 or 4 teeth ..... 5
- 4 Perianth not or only slightly emergent, plicate  $\frac{1}{4}$ – $\frac{1}{3}$  of length, beak 7–8 cells long, underleaf 0.5 mm wide ..... *Acrolejeunea mollis* (Hook.f. & Taylor) Schiffn.
- 4 Perianth emergent for  $\frac{1}{2}$  its length, plicate over  $\frac{1}{2}$ – $\frac{2}{3}$  its length, beak 3–4 cells long, Underleaf 0.6–0.8 mm wide ..... *Acrolejeunea allisonii* Gradst.
- 5 Lobule with four teeth, the first of one or two cells, the remainder unicellular, evenly distributed along the broadly rounded lobule free antical margin; underleaf weakly obovate; female bract margins entire ..... *Acrolejeunea aulacophora* (Mont.) Steph.
- 5 Lobule with three teeth, variously one to three celled, unevenly distributed along the lobule free antical margin; underleaf ovate or obovate; female bract margins scalloped or entire ..... 6
- 6 Lobule arch one or two cells, (first lobule tooth one or two cells from the junction of the lobe and lobule), first and/or second lobule tooth hooked, lobule carinal region broadly pyriform, keel curved; leaf lobe cells finely punctulate; female bracts cucullate, margins entire; perianth rostrum 8–12 cell tiers high ..... *Acrolejeunea pycnoclada* (Taylor) Schiffn. var. *pycnoclada*
- 6 Lobule arch 4 or 5 cells (first lobule tooth four or five cells from the junction of the lobe and lobule), lobule teeth not hooked, lobule carinal region narrowly pyriform, keel straight; leaf lobe cells unornamented; female bracts plane, margins scalloped; perianth rostrum 3–7 cell tiers high..... *Acrolejeunea securifolia* (Nees) Watts subsp. *securifolia*

*Ceratolejeunea belangeriana* (Gottsche) Steph. *Species Hepaticarum* 5: 396 (1913).

*Lejeunea belangeriana* Gottsche in Gottsche et al. *Synopsis Hepaticarum* 398 (1845).

Type: REUNION. Without more specific locality, *Belanger* ex herb. Steph. 'Original' (BM!).

*Ceratolejeunea oceanica* (Mitt.) Steph. in Reinecke *Botanische Jahrbücher* 23: 310 (1897).

*Lejeunea oceanica* Mitt. *Flora Vitiensis* 414 (1871 [1873]).

*Ceratolejeunea oceanica* (Steph.) Horik. *Acta Phytotaxonomica et Geobotanica* 13: 214. (1943) *nom. illeg.*

*Lopholejeunea oceanica* Steph. *Species Hepaticarum* 6: 378 (1923).

Type: SAMOA. Without more specific locality, *T. Powell* s.n. (NY).

*Ceratolejeunea renistipula* Steph. *Botanische Jahrbücher* 20: 236 (1895).

Type: TAHITI. Without more specific locality, *M. Vesco* 85 (G-11910!).

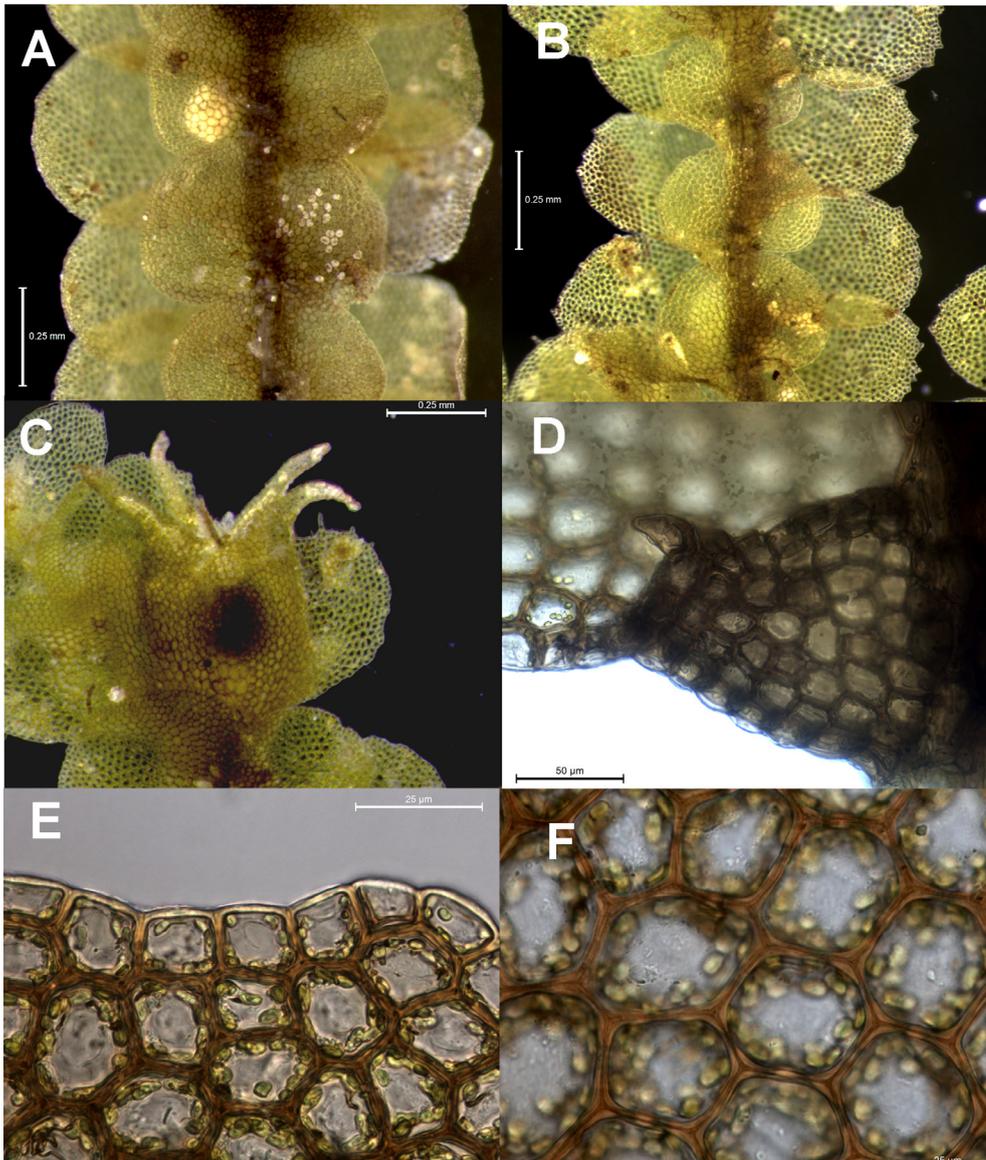
Forming loose patch of dispersed shoots mixed with and growing on other bryophytes. Shoots golden-brown to black (in dried material), medium-sized for genus, to 10 mm long and 0.8–1.3 mm wide, branching irregular, shoot system monomorphic. Stems with seven inflated cortical cells and up to 20 smaller medulla cells, cortical and medulla cell walls golden-brown to dark-brown pigmented, walls not heavily thickened, but with triangular trigones at cell junctions. Dorsal leaf-free strip absent. Leaf-lobes rotund to asymmetrically ovate with apex near postical lobe margin, 480–750  $\mu\text{m}$  long, 380–500  $\mu\text{m}$  wide, apex rounded on smaller to acute on larger lobes, margin with scattered triangular teeth comprised of 3–5 cells around apex, concave, imbricate, interior margin extending over stem to opposite stem margin and obscuring stem in dorsal view. Leaf lobes not vittate, but consistently with 2 or 3 scattered ocelli at leaf base, medial cells rounded to oblong, 20–28  $\mu\text{m}$  long and wide, walls with continuous secondary thickening more pronounced at junctions forming triangular trigones, medial thickenings occasional but obscure, cells becoming larger toward leaf-lobe base, marginal cells quadrate to oblong, 8–15  $\mu\text{m}$  long and wide, walls appearing to lack secondary thickening and occasionally also pigmentation in the free external wall. Oil-bodies not known. Lobules dimorphic, often explanate, when developed 120–150  $\mu\text{m}$  long and 90–120  $\mu\text{m}$  wide at base, approximately one twentieth the lobe area, pyriform, keel curved, carinal region strongly and continuously inflated along entire keel length and lobule width, lobule antical margin inrolled, not visible in ventral view, lobule arch 3 cells, lobe-lobule junction lying postical to the base of the first lobule tooth, first lobule tooth 1-celled, triangular with a sharp apex, long axis perpendicular to stem so as to point sideways and extend beyond the lobule exterior margin, lobule second tooth unicellular, more or less incorporated into lobule margin, lobule papilla attached to lobule margin immediately above the first tooth. Underleaves rotund, cordate, contiguous to imbricate, broadest near base, 300–500  $\mu\text{m}$  long, 500–750  $\mu\text{m}$  wide, bifid to 0.3 $\times$ , sinus V-shaped, narrow, c. 70  $\mu\text{m}$  deep, lobes acute, with a single cell at lobe apex. Underleaf insertion U-shaped across two ventral cortical cells, lateral basal cells of underleaf not inflated, underleaf base not cordate. Oil-bodies not known. Asexual reproduction absent. Paroicous. Androecia on modified, determinate, secondary shoots bearing 2–8 pairs of bracts. Gynoecia terminal on primary or secondary shoots, subtended by 2 subfloral innovations when located on primary shoots and 1 subfloral innovation when on secondary shoots, subfloral innovations always with Pycnolejeuneoid merophyte sequence, female bracts elliptic-ovate, acute, denticulate, bracteole narrowly elliptic, lobes acute, divided to 0.5 $\times$ , margin irregular to denticulate, perianths to 1 mm long, more or less immersed among bracts, 5-carinate, lateral and ventral carinae cornute so perianth bears 4 horns that project above bracts, stipa not developed in observed perianths. Sporophyte not seen. Fig. 3.

**Specimen examined:** New Zealand, Kermadec Ecological Region and District, Kermadec Islands Nature Reserve, Raoul Island, base of, Sunshine Valley Waterfall, 29° 17' 10.8" S 177° 55' 45.7" W, c. 53 m, 16 May 2011, *P.J. de Lange* K1147 (AK329755).

**Recognition:** *Ceratolejeunea belangeriana* is recognised by its dark brown to black colouration in combination with large, bifid underleaves whose base is cordate, the obscurely dentate leaf-lobe margin, and presence of ocelli at leaf-lobe base. This species is similar to many of the larger species of *Lopholejeunea* in its golden brown to black colour, but easily distinguished by its bifid underleaves. When fertile, the horn-bearing perianths are also characteristic of this species.

**Distribution:** *Ceratolejeunea belangeriana* is widely distributed throughout the Pacific and, in its current broadly accepted circumscription, extends as far west as South Africa.

**Habitat:** *Ceratolejeunea belangeriana* was collected at the base of Sunshine Valley Waterfall, where it grew as scattered shoots admixed with *Plagiochila stephensoniana* Mitt. among a large mat of *Radula javanica* that was carpeting a damp boulder directly below the ephemeral waterfall.



**Fig. 3.** *Ceratolejeunea belangeriana* A: ventral view of large shoot. B: ventral view of small shoot. C: Dorsal view of perianth. D: ventral view of lobule. E: marginal leaf-lobe cells. F: medial leaf-lobe cells. All from AK329755.

**Conservation status:** *Ceratolejeunea belangeriana* is known from the New Zealand Botanical Region from the single Raoul Island gathering. We assign this species a conservation status of Data Deficient, qualified OL and SO, for the New Zealand part of its range.

*Cheilolejeunea ceylanica* (Gottsche) R.M.Schust. & Kachroo *Journal of the Linnean Society, Botany* 56: 509 (1961).

*Pycnolejeunea ceylanica* (Gottsche) Schiffn. *Hepaticae ... aus Engler-Prantl, Die naturlichen Pflanzenfamilien* : 124 (1893).

*Pycnolejeunea ceylanica* (Gottsche) Steph. *Hedwigia* 28: 259 (1889), nom. inval.

*Lejeunea ceylanica* Gottsche *Synopsis Hepaticarum* 3: 359 (1845).

Type: CEYLON. "inter Rad. boryanum. mis. Hooker" (isotype: G-19377).

*Cheilolejeunea verdoornii* (G.Hoffm.) R.M.Schust. & Kachroo. *Journal of the Linnean Society, Botany* 56: 509 (1961).

*Pycnolejeunea verdoornii* G.Hoffm. *Annales Bryologici* 8: 118 (1935).

Type: INDONESIA. "Java orient., Res. Pasoewean, in mm. Tengger, in silvis primigen, in decliv. G. Ajek-Ajek," ca 2100 m, anno 1930, *Verdoorn s.n.* (holotype: JE, isotype: FH) syn. fide Thiers (1992).

*Euosmolejeunea setchellii* Pearson. *Publications of the Carnegie Institution of Washington* 20: 148 (1924).

Type: SAMOA. Tutuila Is., Aua-Aofono trail, Jun–Jul 1920, *Setchell 1161a/1277a* (holotype: MANCH) syn fide Thiers (1992).

*Lejeunea connivens* Gottsche ex Schiffn. *Forschungsreise S.M.S. "Gazelle"*. 4, Botanik: 32. (1889 [1890]).

Type: INDONESIA. Moluccas, Amboina Is. "in litore boreali-occidentali ...", leg. *Naumann*, 7 Jun. 1875. syn fide Soderström (unpublished data).

*Pycnolejeunea arietina* Tixier. *Bulletin de la Société d'Histoire Naturelle de l'Afrique du Nord* 63: 9 (1972).

Type: MALAYSIA. Kedah distr, Kedah Peak, 900 m, leg. Tixier 6069 (holotype: PC slide) syn. fide Grolle (1979).

Forming loose patches of dispersed shoots mixed with and growing on other bryophytes on tree trunks. Shoots brown-green (when fresh), light-brown (when dried), medium-sized for genus, to 10 mm long, 0.9–1.3 mm wide, branching infrequent and irregular, shoot system monomorphic. Stems with seven cortical cells and up to 15 smaller medulla cells, cortical and medulla cell walls with yellow-brown pigmentation, external free cortical cell wall, radial longitudinal cortical walls and inner tangential cortical walls continuously thickened, with bulging trigones at cell junctions, medulla cell walls with bulging trigones confluent across medial walls, constricting the cell lumen. Dorsal leaf-free strip present, dorsal cortical cell row not or only partly covered by leaf insertion lines. Lobes elliptic-oblong, slightly falcate and then almost reniform, 440–750 µm long, 360–430 µm wide, flat, imbricate, interior margin extending over stem to opposite stem margin and obscuring stem in dorsal view, lobe apex broadly rounded. Leaf lobes vittate, basal and medial cells oblong, 15–25 µm long, 10–20 µm wide, with concave trigones, medial thickenings common but obscure, transition to marginal cells gradual on all sides of vitta, marginal cells quadrate to oblong, 8–10 µm long and wide, walls continuously thickened, triangular trigones present. Oil-bodies not known. Lobules monomorphic, always well developed, 200–250 µm long, 65–115 µm wide, large lobules one seventh the lobe area, rectangular to falcate, keel straight to arched, carinal region weakly and continuously inflated along keel length, lobule antical margin not inrolled, visible in ventral view, lobule arch arched, 1–3 cells, lobe-lobule junction lying postical to base of first lobule tooth, first lobule tooth 1-celled, partially or completely incorporated into the exterior lobule margin, lobule second tooth multicellular, 3–5 cells, 2 cells wide at base, uniseriate for 2 or 3 cells, originating perpendicular to shoot axis, but curved backward, apex pointing toward postical lobe margin, overtopping first tooth, lobule papilla attached to lobule margin immediately above first tooth. Underleaves elliptic-rotund, remote, to contiguous, broadest at midpoint, 260–340 µm long, 220–280 µm wide, bifid to 0.4× on larger underleaves, sinus V-shaped, narrow, 70–120 µm deep, lobes obtuse, with a single cell at lobe apex. Underleaf insertion transverse across two ventral cortical cells, lateral basal cells of underleaf weakly inflated, underleaf base not cordate. Oil-bodies not known. Asexual reproduction not known. Dioicous (?). Androecia terminal on primary shoots or lateral on secondary branches. Gynoecia, perianths and sporophytes not seen. Fig. 4.

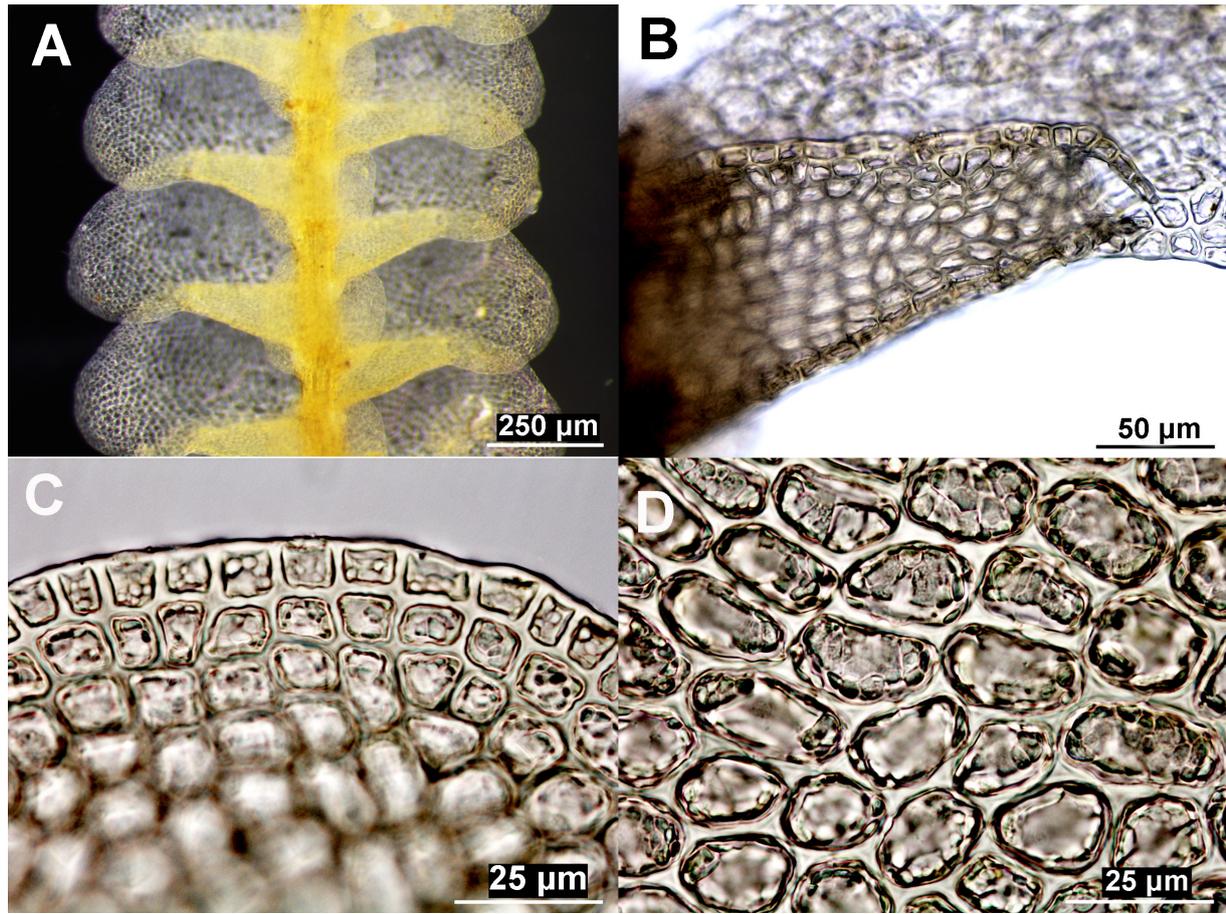
**Specimens examined:** New Zealand, Kermadec Islands Nature Reserve, Kermadec Islands northern group, Raoul Island, Smiths Bluff track just past Mahoe, 29° 17' 24" S 177° 56' 59" W, 330 m, 15 May 2011, *P.J. de Lange K731* (AK325641, NSW900223); Moumoukai-Prospect track (roughly half-way between Moumoukai and Prospect), 29° 16' 30" S 177° 55' 17" W, 15 May 2011, *P.J. de Lange K733* (AK325644, NSW851682). In both specimens *C. ceylanica* is scattered over and among *Radula javanica*.

**Recognition:** *Cheilolejeunea ceylanica* is readily recognised by the combination of long rectangular lobules with a more or less straight keel extending about two-thirds of the leaf-lobe width, the second lobule tooth 3–6 cells long (terminology follows Renner 2012), and the group of enlarged cells, 4 or 5 cells long, 3 or 4 cells wide, in the leaf-lobe base that are weakly differentiated from surrounding cells. The shape of the lobule places the species into subg. *Xenolejeunea*.

**Distribution:** *Cheilolejeunea ceylanica* has a paleotropical distribution, and has been reported from Japan, Thailand, the Philippines, and Indonesia (Mizutani 1980), the wet tropics of Queensland (Thiers 1992), and Fiji (Pócs et al. 2011). The record for the Kermadec Islands extends the distribution south and east, and, on the basis of this record, its occurrence throughout the Pacific should be anticipated.

**Habitat:** *Cheilolejeunea ceylanica* is an epiphyte that can inhabit all tree surfaces. It may form near-pure patches or occur in multi-species mats with other bryophytes. On Raoul Island *Cheilolejeunea ceylanica* is known from two gatherings in which it grew scattered with *Lejeunea gracilipes* and *Lepidolejeunea integrispula* as an epiphyte (or epipmuscicole) on the liverwort *Radula javanica*.

**Conservation Status:** *Cheilolejeunea ceylanica* is known from the New Zealand Botanical Region by two gatherings made on Raoul Island. We assign this species a conservation status of Data Deficient, with qualifiers OL and SO.



**Fig. 4.** *Cheilolejeunea ceylanica* A: ventral view of shoot. B: moniliform second lobule tooth pointing toward postical lobe margin. C: marginal leaf-lobe cells. D: basal leaf-lobe cells. All from AK325644.

#### Key to vittate and ocellate species of *Cheilolejeunea* subg. *Xenolejeunea*

The key to vittate and ocellate Australasian species of *Cheilolejeunea* subg. *Xenolejeunea* from Renner (2012) is reproduced below.

- 1 Enlarged cells grouped in the leaf base, not forming a line of cells down leaf and not also scattered elsewhere in the lobe, leaf lobe ovate-elliptic, apex rounded, reflexed or otherwise ..... 2
- 1 Enlarged cells forming a line of cells along leaf mid-line, and also scattered elsewhere in the leaf lobe, leaf lobe ovate-triangular, apex obtuse, reflexed .....  
..... *Cheilolejeunea falsinervis* (Sande Lac.) Kachroo & R.M.Schust.
- 2 Vittate cells markedly differentiated from surrounding cells, vitta zone up to 15 cells long and 10 cells wide ..... 3
- 2 Vittate cells weakly differentiated from surrounding cells, vitta zone 4 or 5 cells long, 3 or 4 cells wide .....  
..... *Cheilolejeunea ceylanica* (Gottsche) R.M.Schust. & Kachroo
- 3 Vittate cells round, with 2 or 3 distinct medial thickenings per wall, vitta zone extending beyond the lobule apex, second lobule tooth on largest lobules up to 5 cells long, lobule fused to lobe across a single cell, explanate lobules with one teeth, cladia absent.....  
..... *Cheilolejeunea vittata* (Steph. ex G.Hoffm.) R.M.Schust. & Kachroo
- 3 Vittate cells oblong, without distinct medial wall thickenings, vitta zone extending to two thirds the lobule length, second lobule tooth on largest lobules up to 3 cells long, lobule fused to lobe across 1 or 2 cells, explanate lobules with two teeth, cladia present .....  
..... *Cheilolejeunea oscilla* M.A.M.Renner

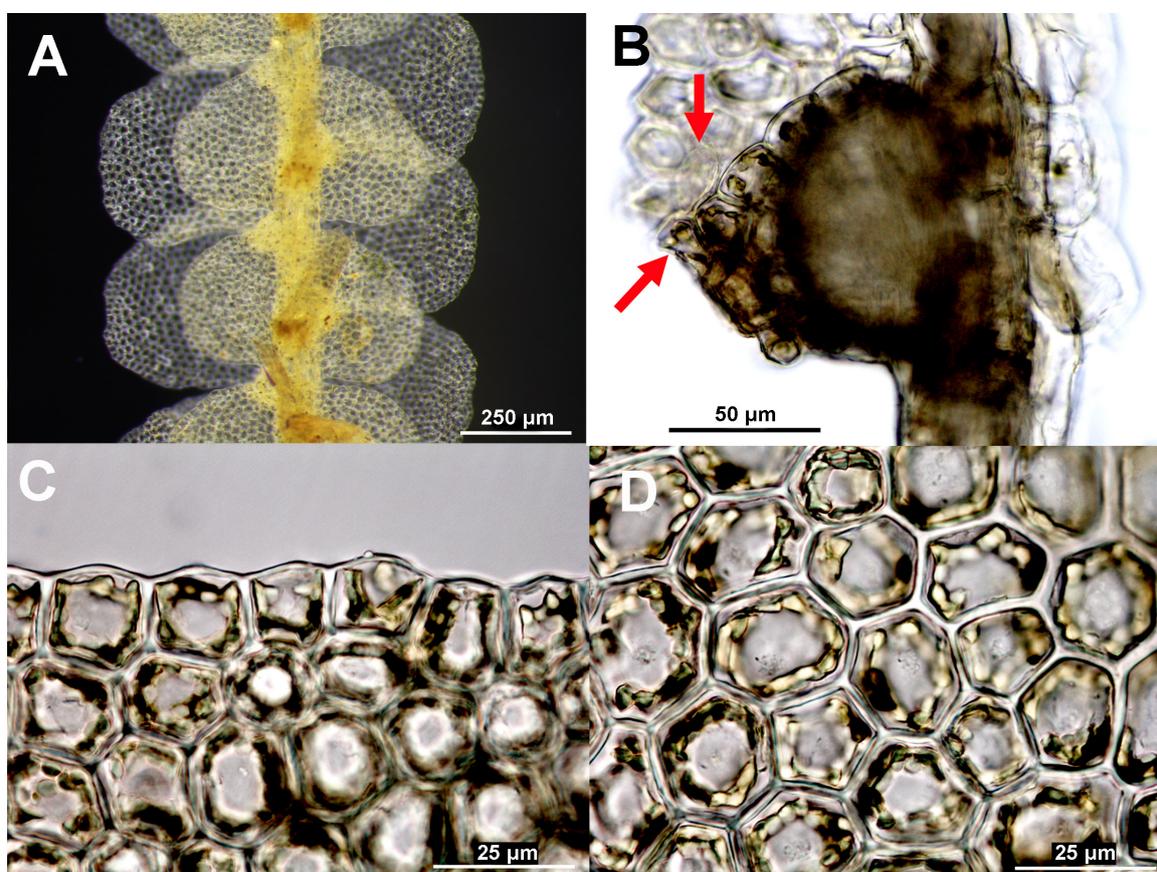
*Lepidolejeunea integristipula* (Jack & Steph.) R.M.Schust. *Phytologia* 45: 425 (1980).

*Pycnolejeunea integristipula* Jack & Steph. *Beihefte zum Botanischen Centralblatt* 60: 107 (1894).

Type: FIJI. Viti insulae, Ovalau, in monte Tana-lilai, anno 1864, *Graeffe* (holotype *fide* Piippo (1986): G-20388).

Known from a few shoots growing scattered through bryophytes epiphytic on *Radula javanica*, yellow-brown when dry, medium-sized for genus, to 15 mm long, 0.8–0.9 mm wide, branching infrequent and irregular, shoot system monomorphic. Stems with external and internal walls unthickened except for weak concave trigones of primary wall around cell wall junctions, 7 cortical cells and 5–10 smaller medullary cells. Dorsal leaf-free strip absent. Lobes rotund, 350–400  $\mu\text{m}$  long and wide, plane. Lobe apex rounded, postical margin straight toward keel, antical margin continuously curved, exceeding opposite stem margin. Basal and medial cells irregularly hexagonal, 15–25  $\mu\text{m}$  long, 9–18  $\mu\text{m}$  wide, thin-walled with weak concave trigones, medial thickenings absent, marginal cells quadrate, 12–18  $\mu\text{m}$  long and wide, thin-walled, external wall protruding, triangular in outline, lobe margin serrulate as a result. Lobules relatively tiny, 70–80  $\mu\text{m}$  long and wide, about one thirtieth the lobe area, almost sphaeroidal with inflation of carinal region, keel curved, mostly in outer half, base perpendicular to stem. Carinal region inflated, lobule antical margin inrolled, obscured in ventral view except for area in vicinity of first tooth; lobule arch straight, 2 cells, angle between arch and keel  $10^\circ$  at lobe-lobule juncture, lobe-lobule junction lying slightly postical to the base of the first lobule tooth. First lobule tooth 1-celled, triangular, oriented perpendicular to shoot axis or pointing outward. Lobule second tooth not or only weakly differentiated from adjacent marginal cells. Underleaves reniform, remote to contiguous, broadest at midpoint, 250–310  $\mu\text{m}$  long, 520–600  $\mu\text{m}$  wide, entire. Underleaf insertion transverse across 2 ventral cortical cells, lateral basal cells of underleaf inflated, underleaf base not cordate. Oil-bodies not known. Asexual reproduction absent. Sporophyte not seen. Fig. 5.

**Specimen examined:** New Zealand, Kermadec Islands Nature Reserve, Kermadec Islands northern group, Raoul Island, Moumoukai-Prospect track (c. half-way between Moumoukai and Prospect,  $29^\circ 16' 30''$  S  $177^\circ 55' 17''$  W, 15 May 2011, *P.J. de Lange* K733 (AK325644, NSW851682). Scattered over *Radula javanica* with *Cheilolejeunea ceylanica*.



**Fig. 5.** *Lepidolejeunea integristipula* A: ventral view of shoot. B: lobule showing lobule papilla (indicated by upper arrow) and sideways pointing, triangular first lobule tooth (indicated by lower arrow). C: marginal leaf-lobe cells. D: basal leaf-lobe cells. All from AK325644.

**Recognition:** Among species of Lejeuneaceae currently known from New Zealand, *Lepidolejeunea integristipula* is recognisable by the isolobous shoot systems having large, reniform, entire underleaves; the lobules with a prominent sideways pointing first lobule tooth; and the leaf-lobe cell walls lacking secondary pigmentation.

Entire underleaves are more commonly associated with species belonging to subfamily Ptychanthoideae, such as *Archilejeunea*, *Lopholejeunea* and *Thysananthus* in New Zealand. *Lepidolejeunea integristipula* can be separated from all New Zealand species of subfam. Ptychanthoideae by its lack of secondary pigmentation in the leaf-cell walls and by the crenulate-serrulate leaf-lobe margins where each minute tooth is formed by angular projecting cell lumen. The New Zealand plants of *L. integristipula* do not have obvious ocelli and, therefore, bear resemblance to *Lejeunea mimula*, a species distributed from Malaysia to Fiji. However, several micro-morphological characters separate these two species. In *Lejeunea mimula*: 1) the first lobule tooth is forward-pointing, and situated half-way between the lobe-lobe and the lobule-stem junction; 2) the leaf-lobe margin of *L. mimula* is entire; 3) the cell walls have discrete medial thickenings; and 4) the leaf-lobe cell surface bears punctate to finely granular ornamentation. In contrast in *Lepidolejeunea integristipula*: 1) the first lobule tooth is sideways pointing and is situated over the lobe-lobe junction; 2) the leaf-lobe margin is crenulate-serrulate; 3) the cell walls lack medial thickenings; 4) the leaf-lobe cell surface is smooth.

**Distribution:** *Lepidolejeunea integristipula* is distributed throughout the Asian-Oceanic regions from Borneo to Fiji and south to the Wet Tropics Bioregion of north-eastern Queensland (Australia) (Pócs et al. 2011; Pócs and Streimann 2006). The Kermadec Islands record represents a new global southern limit for this species.

**Habitat:** Throughout its wide geographic distribution *Lepidolejeunea integristipula* is typically a lowland plant, inhabiting a range of microsites within lowland mesophyll rainforest, including the surfaces of rotting logs, trunks of rainforest trees, and leaves of large-leaved trees and shrubs. It may form pure mats. When growing on branches, twigs and leaves, the species may become semi-pendulous and form near-pure wefts. On Raoul Island *L. integristipula* grows as scattered stems among a mat of larger bryophyte species dominated by *Radula javanica* and including *Cheilolejeunea ceylanica* and *Lejeunea gracilipes*.

**Conservation status:** *Lepidolejeunea integristipula* is known from the New Zealand Botanical Region by one gathering made on Raoul Island. We assign this species a conservation status Data Deficient, with qualifiers OL and SO.

*Notoscyphus lutescens* (Lehm. & Lindenb.) Mitt. *Flora Vitiensis* 407 (1871 [1973]).

*Acolea lutescens* (Lehm. & Lindenb.) Trevis. *Memorie del Reale Istituto Lombardode Scienze e Lettere. Serie 3, Classe di Scienze Matematiche e Naturali* 4: 395 (1877).

*Cesius lutescens* (Lehm. & Lindenb.) Kuntze. *Revisio Generum Plantarum* 2: 834 (1891).

*Gymnanthe lutescens* (Lehm. & Lindenb.) Mitt. *Journal of the Linnean Society, Botany* 5: 100 (1861).

*Gymnomitrium lutescens* (Lehm. & Lindenb.) Gottsche *Synopsis Hepaticarum* 1: 4 (1844).

*Nardia lutescens* (Lehm. & Lindenb.) Steph. *Bulletin de l'Herbier Boissier, séries* 1, 5: 81 (1897).

*Jungermannia lutescens* Lehm. & Lindenb. *Novarum et Minus Cognitarum Stirpium Pugillus* 4: 16 (1832).

Type: INDIA. Habitat in India orientali (BM, G, S, W).

Note: heterotypic synonyms not listed here.

Terricolous, forming a light green loose weft with individual shoots to 14 × 1.2–1.4 mm, anisophyllous. Branching infrequent, ventral-intercalary, stems slender, terete, 94–120 µm diameter, 7 cells high in transverse section; cortical cells thick walled in surface view variable in size and shape 37–59 × 19–26 µm; rhizoids 9–15 µm diam produced in groups at or near underleaf bases, occasionally scattered on stem. Leaves unlobed or slightly bilobed, alternate, succubous, nearly horizontal, flat when damp, dorsally assurgent when dry, contiguous, shortly oblong, 430–700 × 270–500 µm, margin entire; not inserted to stem midline dorsally leaving one row of cortical cells leaf-free, dorsal bases slightly decurrent; leaf cells are variable in size the median cells (31–)51–55 × 24–26(–31) µm, basal cells to 40–47 µm wide, trigones triangular, bulging slightly Y-shaped 9 × 7.5 µm, no intermediate thickening; cell surface with c. 20 low striae over entire surface. Underleaves small, bifid, with lobes lying parallel to stem, unequal one being shorter by 1 or 2 cells, 250–374 × 94–187 µm, with longest lobes 150–210 µm long, with 4–7 uniseriate cells based on 1 biseriate row; 1 or 2(or 3) single-celled (rarely 2-celled) lateral spurs variably developed on the disc, or lateral spur rarely absent; cell walls are thick (c. 4.4 µm) and swollen at corners, cells rectangular, length: width ratio 1.3–1.4:1, tip cell being narrower (length to width ratio c. 1.5:1). Oil bodies 2–4(–5) per cell ovoid to spherical, homogeneous, pale yellow-brown, variable in size, 9–13 µm diam. Sporophyte not seen. Fig. 6.

**Specimen examined:** New Zealand, Kermadec Islands Nature Reserve, Kermadec Islands northern group, Raoul Island, Prospect – Mahoe Hut Track (near Prospect Peak, eastern flank), 15 May 2011, *P.J. de Lange* K730 (AK325635, CHR, F).

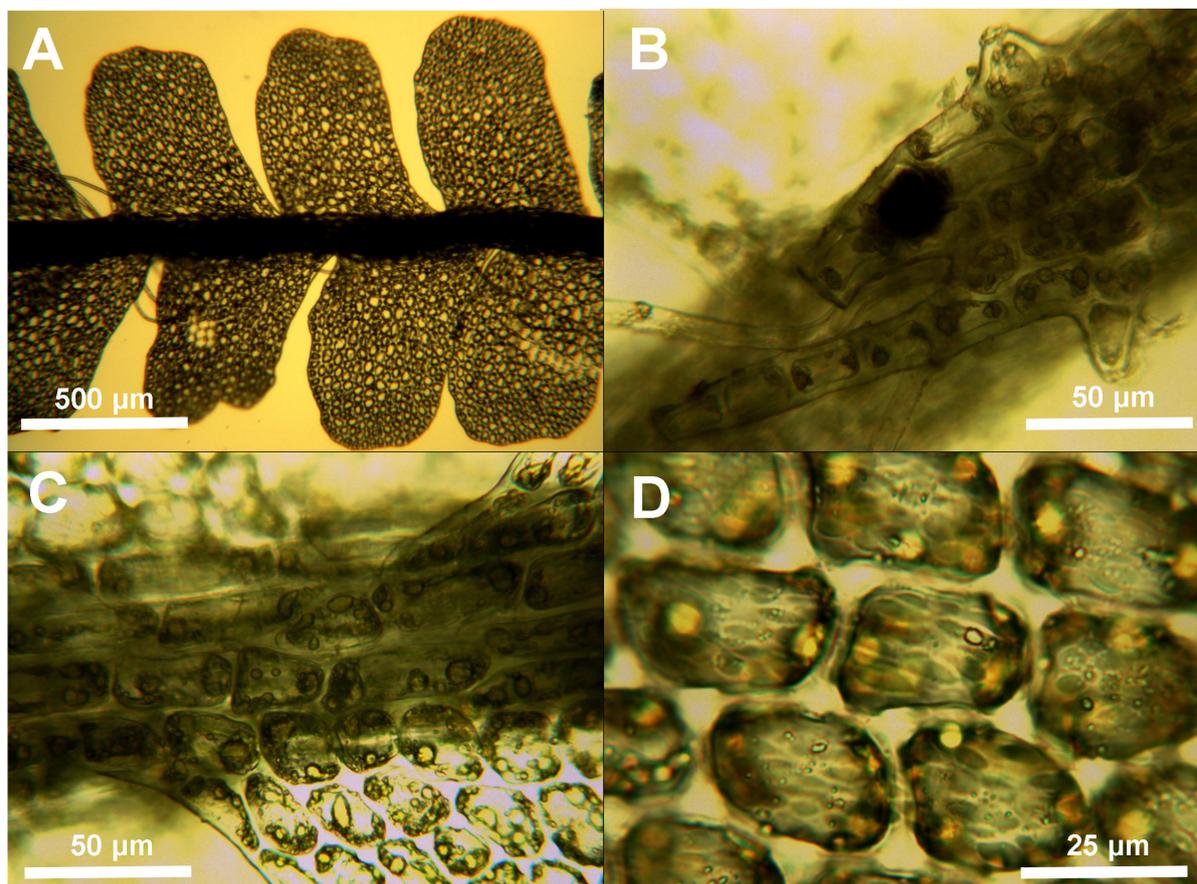
**Recognition:** The underleaves are either as wide as the stem or narrower than stem, with long setaceous lobes orientated parallel to stem, with 1 small tooth between base of lobe and insertion on each disc margin. The leaf-lobe is ornamented by up to c. 20, long, low striae that are orientated perpendicular to stem, on dorsal leaf-lobe surface only. Neither the underleaves nor the striate leaf surface ornamentation occur in combination in other phenetically similar genera, including *Chilocyphus* and *Saccogynidium*.

**Remarks:** Since the description of oil-bodies was taken from dried material, some degeneration may have occurred.

**Distribution:** *Notoscyphus lutescens* has been reported from South Africa, Madagascar, India, China, Japan, Philippines, Indonesia, Papua New Guinea, north-eastern Australia (Queensland), as well as New Caledonia, Hawai'i, Fiji and Samoa (Schuster 2002). Its presence on the Kermadec Islands is considered as being within the distribution given by Schuster (2002).

**Habitat:** *Notoscyphus* was collected from the south-eastern flank of Prospect Peak, growing in deep shade at the back of 'tree cave' made by a *Metrosideros kermadecensis*. There it grew by itself on damp peaty soil and grit festooned amongst *Metrosideros* and *Cyathea milnei* Hook. roots.

**Conservation status:** *Notoscyphus lutescens* is known from the New Zealand Botanical Region by a single gathering made on Raoul Island. We assign this species a conservation status of Data Deficient, with qualifiers OL and SO.



**Fig. 6.** *Notoscyphus lutescens* A: ventral view of shoot. B: underleaf. C: dorsal stem surface. D: leaf cell surface. All from AK325635.

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