

Camptochaete monolina sp. nov. and *Camptochaete subporotrichoides* (Bryophyta: Lembophyllaceae) from the Australian Wet Tropics

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Abstract

Camptochaete monolina sp. nov. is described from three collections in the Australian Wet Tropics bioregion. *Camptochaete subporotrichoides* (Broth. & Geh.) Broth. (Bryophyta: Lembophyllaceae), previously known from Indonesia, Papua New Guinea, Vanuatu, Solomon Islands and Fiji, is reported as new to Australia from several collections in the same bioregion.

Key words: Australian Wet Tropics, bryophytes, moss, taxonomy

Introduction

Camptochaete Reichardt is a small genus of pleurocarpous mosses with a largely Australasian distribution. Its range extends from Indonesia through Papua New Guinea into the Pacific as far east as French Polynesia, and south through eastern Australia to Tasmania and New Zealand (Tangney 1997). The revision of *Camptochaete* by Tangney (1997) recognised five species from Australia: *C. arbuscula* (Sm.) Reichardt, *C. curvata* Tangney, *C. deflexa* (Wilson ex Müll.Hal.) A.Jaeger, *C. excavata* (Taylor) A.Jaeger and *C. leichhardtii* (Hampe) Broth.

Several problematic specimens of *Camptochaete* collected recently from widely separated localities in the Australian Wet Tropics bioregion, as well as others collected previously by G.A.M. Scott and D.C. Cargill, do not match any of the reported Australian species. Specimens from Bellenden Ker represent an undescribed species, and other *Camptochaete* specimens from various locations in the Wet Tropics are entirely consistent with our concept of *C. subporotrichoides*. The following treatment is based on our Australian material.

Taxonomic treatment

***Camptochaete monolina* Meagher & Cairns sp. nov.**

Diagnosis: *Camptochaete* with julaceous stems and branches, leaves orbicular to suborbicular, deeply concave, costa strong and double, to 3/5 of leaf length, up to 10 cells wide at base and 3 cells thick in cross-section,

secondary stem with pigmented outer cortex of 2–3(–5) rows of cells, innermost perichaetial leaves with weakly serrulate margin and occasional teeth; other perichaetial leaves with entire margins.

Type: Australia: Queensland, Wooroonooran National Park, western ridge of Bellenden Ker, on rock, *Meagher & Cairns WT-1123*, 18 Aug. 2016 (BRI AQ1015686).

Plants bright green to brown-green, lithophytic in simple microphyll vine-fern thicket, consisting of a slender, creeping primary stem giving rise to erect secondary stems. *Primary stem* leafless, rhizoids reddish-brown, smooth, 10–12 µm in diameter. *Secondary stems* ± stipitate, ± frondose, to about 110 mm; branching ± irregularly pinnate to bipinnate, julaceous, to 95 mm. *Stipe* moderately developed, to about 12 mm long. Frond axis in cross-section with a pigmented outer cortex 2–3 cells wide. *Leaves* of lower stipe and lower frond axis patent, distant, ± orbicular, deeply concave, with acute apices, 0.8–1.2 mm long × 0.9–1.3 mm wide, lower margins entire, apical margins weakly serrulate. Leaves of upper stipe and frond axis imbricate, suborbicular, abruptly mucronate, 1.3–1.5 mm long × 1.7–1.9 mm wide, apical margins weakly serrulate. *Branch leaves* similar to frond axis leaves but narrower, to 1.3 × 1.15 mm, becoming smaller towards the branch apex. *Branches* usually tapering but not flagellate. Leaves little wrinkled when dry. *Stem* with an outer cortex of 2–3 rows of pigmented, isodiametric, thick-walled cells; inner cortex of larger, thinner-walled cells surrounding a central strand. *Costa* strong, distinctly darker green in fresh leaves (brownish and less distinct when dried) to about 3/5 of leaf length, unequally double, often positioned asymmetrically, in cross-section 9–10 cells wide at base and 3 cells thick, the cells distinctly thick-walled. *Cells* in mid-leaf elongate, somewhat sigmoid, weakly pitted, often prorate, 28–38 × 3.8–4.1 µm, shorter towards the apex, 9–18 × 3.5–5 µm. *Alar cells* indistinct, irregularly-shaped, ± elongate, pitted, 25–46 µm × 5.0–8.5 µm. *Axillary hairs* 53–126 µm, consisting of 2–3 brownish, quadrate basal cells and 2–3 hyaline, elongate uniseriate cells, 2–4(–6) hairs in axils of young leaves at branch apices. Pseudoparaphyllia persistent at branch bases, ovoid, 60–72 µm, apex weakly serrulate.

?*Dioicous*. Perichaetia (only immature seen) lateral on branches. Inner perichaetial leaves reflexed, with acuminate apices tapering from a broad sheathing base to 1.75 mm, ecostate, margins weakly serrulate from projecting cell ends, with occasional large, single-celled teeth in the upper half. Marginal cells with thickened outer walls. Outer perichaetial leaves shorter, to 1.35 mm × 0.85 mm, apex ± acute, margins ± entire. Gynoecia with ± 20 archegonia and numerous hyaline paraphyses. Androecia not seen.

Additional specimens examined: QUEENSLAND: Wooroonooran National Park, Bellenden Ker, chairlift track, Centre Peak, in montane rainforest, *G.A.M.Scott s.n.*, 3 Sep. 1986 (MELU 77); Wooroonooran National Park, Bellenden Ker summit ridge, in transition between elfin and montane forest, on rock, *D.C. Cargill 115*, 13 June 2001 (CANB 644598.1).

Etymology: The specific epithet *monolina* is the feminine form of classical Greek *monolinon*, a string of pearls, referring to the appearance of the plants, especially when wet. It is to be treated as a noun in apposition. The feminine form is required because *Camptochaete* is feminine.

***Camptochaete subporotrichoides* (Broth. & Geh.) Broth., *Nat. Pflanzenfam.* 1(3): 865 (1907)**

Basionym: *Thamniella subporotrichoides* Broth. & Geh. in Geh., *Biblioth. Bot.* 44: 22, fig. 18 (1898)

Type citation: Indonesia, Mt Arfak, ad hautam 5000–7000¢, Beccari 168, Julio 1875, c. fruct. perfect.

Type: Indonesia, Irian Jaya, Mt Arfak, *Beccari 168*, July 1875, holotype H-BR!

Plants green, growing in open colonies. *Primary stems* slender, creeping, monopodial, to about 10 cm, with erect, ± stipitate, ± frondose secondary stems to 50 mm, often shorter. *Rhizoids* intermittent in dense clumps or fascicles on primary stem and occasionally on stipe of secondary stem, dark reddish brown. *Fronde*s (secondary stem plus branches) ± bipinnate, loosely complanate, branches often flagellate. *Stipe* often poorly developed, to about 10 mm long. Secondary stems straight, more or less stipitate, irregularly pinnate to bipinnate, to 15 mm, often tapering to elongate flagellae. *Stipe leaves* weakly concave, ovate, acuminate or somewhat abruptly cuspidate, 1.0–1.1 mm × 0.7–0.8 mm, margins entire or weakly denticulate towards base. *Leaves* of rest of secondary stem more or less smooth when dry, distichous, ± patent, weakly concave, ovate to ovate-oblong, acuminate to somewhat abruptly cuspidate, entire or weakly denticulate to lower margin, (1.3–)1.5–1.7 × 0.9–1.1 mm. *Branches* also commonly tapering to elongate flagellae, leaves similar to secondary stem leaves but smaller and narrower, 1.0–1.3 × 0.6–0.7 mm. *Costa* double, failing below midleaf, often weak or absent. Cells in mid-leaf linear, slightly vermicular, 29–50 × 4–5 µm, becoming weakly pitted in the base, forming a weak basal band. *Alar cells* not strongly differentiated, forming a small triangular group of rectangular cells, 4–5 cells high. *Axillary hairs* 70–110 µm, consisting of 3–4 uniseriate cells. *Dioicous*. Gynoecia and androecia not seen in Australian specimens. See Tangney (1997) for a description of perichaetial leaves, sporophytes and spores.

Specimens examined: AUSTRALIA: Queensland: Malanda Falls Conservation Park, near Malanda, on base of sapling, *Meagher & Cairns WT-048B*, 17 Sep. 2012 (BRI-AQ1015683); Lake Barrine Circuit Track, Crater Lakes National Park, Atherton Tableland, epiphytic on tree trunk, *Meagher & Cairns WT-379*, 9 May 2014 (BRI-1015684); Lake Barrine Circuit Track, Crater Lakes National Park, Atherton Tableland, on tree trunk and on bases of other trees in the same area, *Meagher & Cairns WT-497*, 20 Nov. 2014 (BRI-1015685). PAPUA NEW GUINEA: Morobe Province: Herzog Mountains, 15 km WSW of Lae, 760 m, *Streimann 10898*, 13 Jan. 1981, CBG-8102883; Nawata Banda, 9 km S of Bulolo, 1400 m, *Streimann 19527*, 11 May 1982, CBG-8210843.

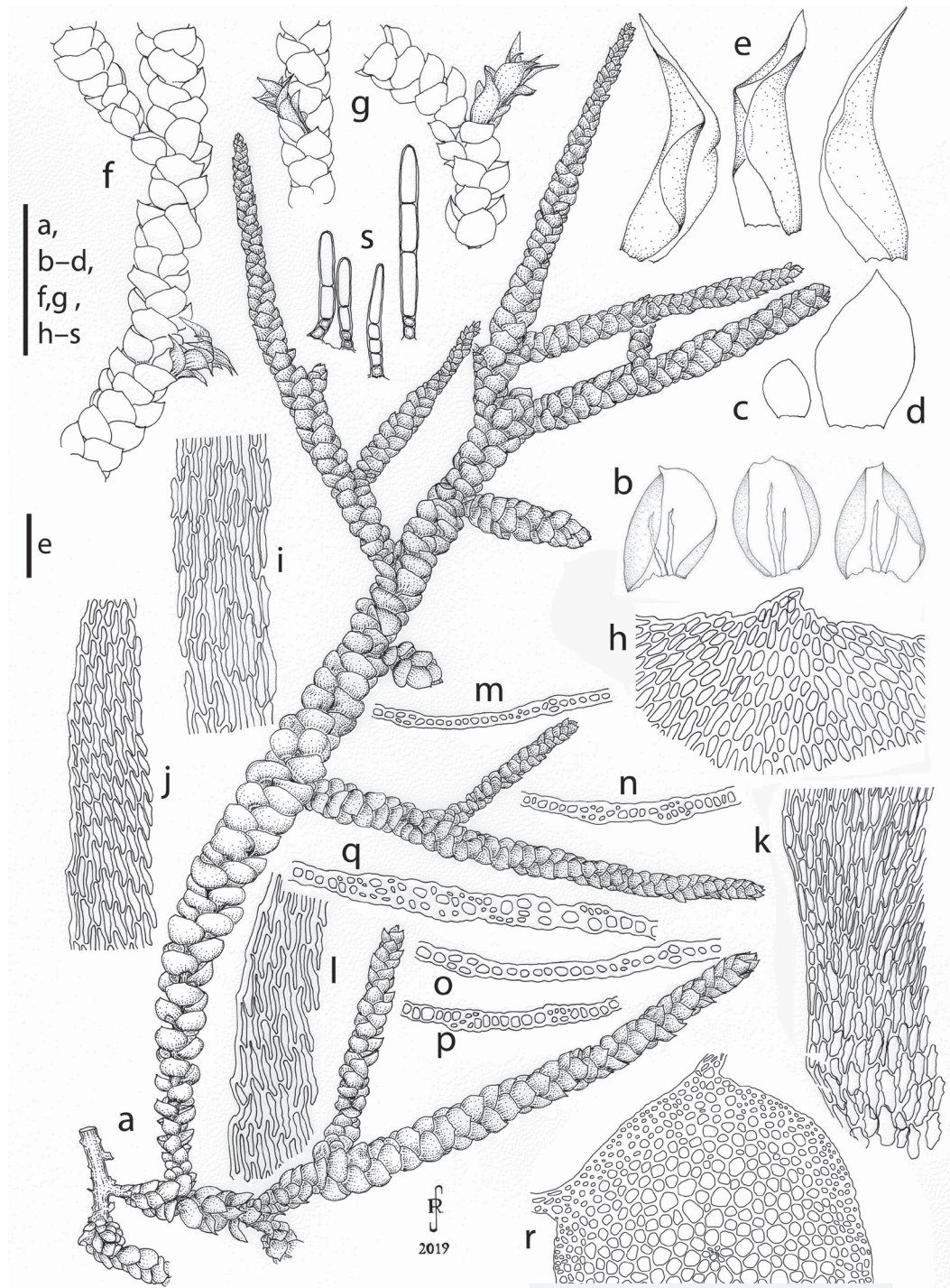


Fig. 1. *Camptochaete monolina*: **a** part of plant when moist; **b** branch leaves; **c–e** perichaetial bracts; **f, g** stem sectors with perichaeta; **h** cells at apex of branch leaf; **i** mid-lamina cells of branch leaf; **j** mid-lamina marginal cells, branch leaf; **k** cells of basal angle of branch leaf showing indistinct alar cells; **m–q** Sections of basal part of leaf showing double costa (**q** at leaf insertion); **r** partial stem cross-section; **s** axillary hairs with 1–2 brownish basal cells. Scale bars: **a** = 5.0 mm; **b–d** = 1.0 mm; **e** = 1.0 mm; **f, g** = 2.0 mm; **h–s** = 100 μ m. Drawn from *Meagher & Cairns WT-1123* and *Scott s.n.* by R.D. Seppelt.

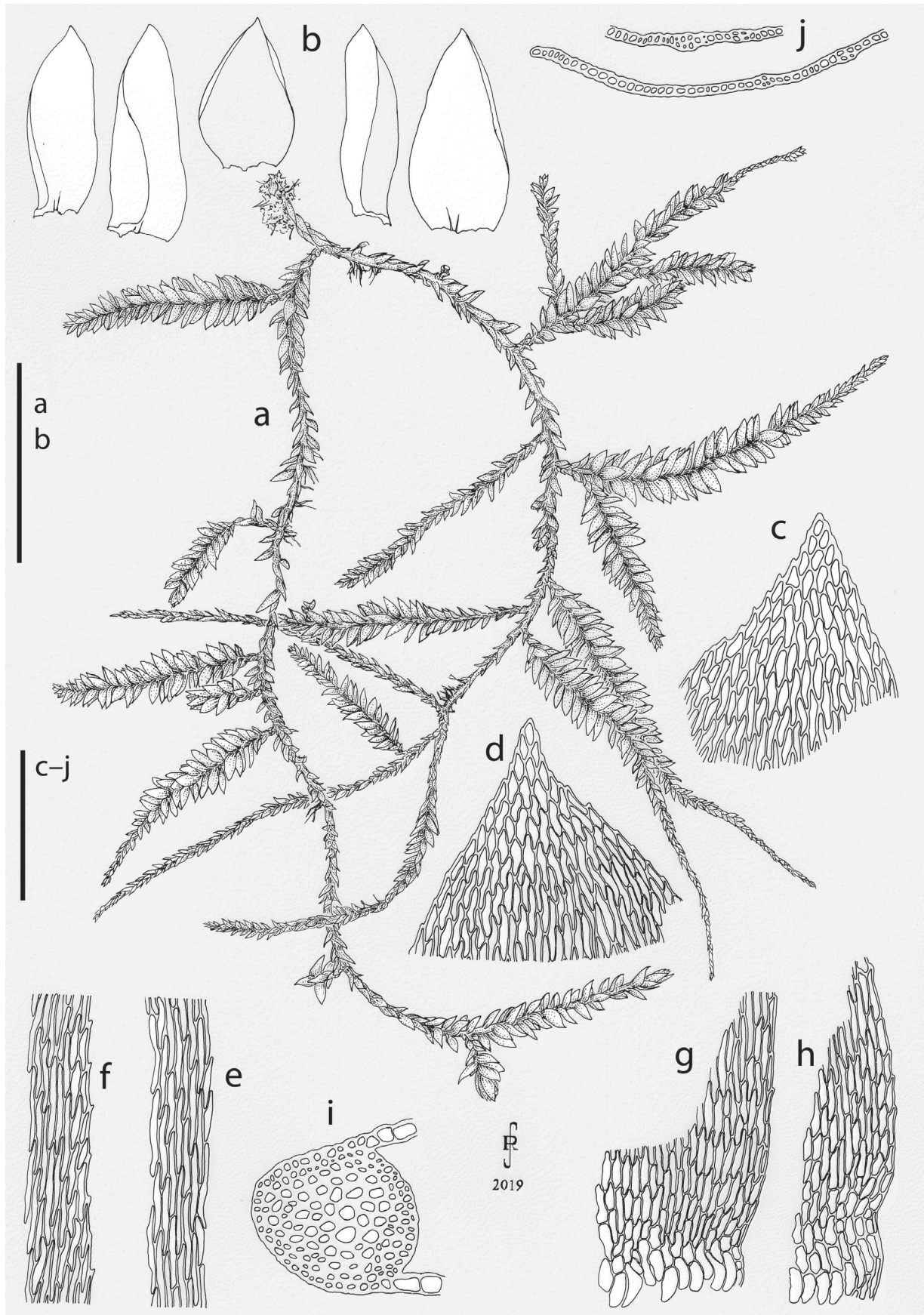


Fig. 2. *Camptochaete subporotrichoides*: **a** whole plant when moist; **b** frond axis and branch leaves; **c, d** frond axis leaf apex; **e** cells in upper part of stem leaf; **f** cells at margin of stem leaf; **g, h** basal area of stem leaf, showing the denticulate margin and indistinct alar cells; **i** stem cross-section. Scale bars: **a** = 5.0 mm; **b** = 1.0 mm; **c–j** = 100 μ m. Drawn from Meagher & Cairns WT-497 by R.D. Seppelt.



Fig. 3. *Camptochaete subporotrichoides* (Meagher & Cairns WT-379), showing flattened leaves on all stem sectors. Scale bar: 10 mm.



Fig. 4. *Camptochaete excavata* (Meagher & Cairns WT-205), showing the mostly strongly concave leaves, slightly flattened in some stem sectors. Scale bar: 10 mm.

Discussion

Camptochaete monolina

Brotherus (1909, 1925) divided *Camptochaete* into sections *Thamniella* and *Camptochaete*, based on operculum and leaf shape. Operculum shape is a reliable character: rostrate in Sect. *Thamniella*, blunt or apiculate in sect. *Camptochaete*. However, Tangney (1997) found leaf shape to be an unreliable character, and therefore separated Sect. *Thamniella* from Sect. *Camptochaete* by the arrangement of stipe leaves (patent and distant in Sect. *Thamniella*, appressed and imbricate in Sect. *Camptochaete*).

Tangney (1997) found the sections to be biogeographically distinct for most of their range, with overlap between the two in eastern Australia and Vanuatu. He determined that species within Section *Thamniella* tend to have a subtropical to tropical distribution, occurring in Indonesia (Flores), Papua New Guinea, the Solomon Islands, Vanuatu, New Caledonia, Lord Howe Island and eastern Australia, whereas species in sect. *Camptochaete* are known from subtropical to cool-temperate regions of eastern Australia (southern Queensland to Tasmania), Vanuatu, New Zealand, and possibly Hawaii.

The stipe leaves of *Camptochaete monolina* are patent and distant, which suggests that *C. monolina* belongs to sect. *Thamniella*, but this cannot be confirmed until a sporophyte with an intact operculum is found. As male plants of *C. monolina* have not been found, it is assumed (but not confirmed) to be dioicous.

Comparison with other *Camptochaete* sect. *Thamniella* species

We compared *C. monolina* to the other members of *Camptochaete* Sect. *Thamniella* — *C. excavata*, *C. porotrichoides*, *C. subporotrichoides*, *C. curvata* and *C. papuana*. *Camptochaete monolina* is most similar to *C. excavata*, sharing tumid branches and orbicular leaves, which are deeply concave and apiculate. However, *C. monolina* is a much larger plant, with longer branches and more open branching, and lacks the compactly pinnate fronds than occur in *C. excavata*.

Comparison of the critical features that distinguish *C. monolina* is presented in Table 1.

Table 1. Comparison of the stipe and leaves, stem outer cortex width (from the lower stipe), costa characters, and known distribution in *Camptochaete* section *Thamniella*. Data from Tangney (1997) except for *C. monolina*.

Species	Stipe and leaves	Outer cortex width	Costa*	Known distribution
<i>C. curvata</i>	well-developed; leaves strongly concave	8–10 cells	double, faint, failing below midleaf	Australia: eastern Qld, NSW
<i>C. excavata</i>	weakly to moderately developed; leaves strongly concave	5–8 cells	double, faint, failing below midleaf, 3–5 cells wide, 2 cells thick	Australia: eastern Qld, eastern NSW, eastern Vic, ACT
<i>C. monolina</i>	moderately developed; leaves strongly concave	2–3 cells	double, strong, to 3/5 leaf length 9–10 cells wide, 3 cells thick	Australia: north-eastern Qld
<i>C. papuana</i>	well-developed; leaves weakly concave	10–12 cells	double, faint, failing below midleaf	Papua New Guinea
<i>C. porotrichoides</i>	well-developed; leaves weakly concave	5–7 cells	double, faint, failing below midleaf	New Caledonia
<i>C. subporotrichoides</i>	well-developed; leaves weakly concave	7–10 cells	double, faint, failing below midleaf	Indonesia, Papua New Guinea, Solomon Is, Fiji, Vanuatu, Australia: north-eastern Qld

A stem (lower stipe) outer cortex of small, isodiametric, pigmented, thick-walled cells is typical of the genus (Tangney 1997). However, the outer cortex in *C. monolina* is a narrow band, only 2–3 cells thick, whereas the outer cortex of other *Camptochaete* species is wider, for example, 5–8 cells in *C. excavata*, 10–12 cells in *C. papuana* (Sect. *Thamniella*) and 6–8 in *C. arbuscula* (Sect. *Camptochaete*) (Tangney 1997, Fig. 5).

Tangney (1997) describes the costa of *Camptochaete* species as ‘short and double, usually faint, and often absent...sometimes longer and irregularly single’. For example, the costa of *C. excavata* is double, failing below mid-leaf, faint and often absent, having little differentiation in cross-section, being only 3–5 cells wide and 2 cells thick. In contrast, the costa of *C. monolina* is double, strong, to 3/5 leaf length, 9–10 cells wide at base and 3 cells thick. It is possible that some other collections of *Camptochaete excavata* from north-eastern Queensland are *C. monolina*.

There are some similarities with *C. arbuscula* var. *tumida* (sect. *Camptochaete*), described by Tangney (1997) as having ‘stems and branches swollen and loosely julaceous’... ‘with leaves that are widely ovate to round, deeply concave, and abruptly and distinctly mucronate’. However, *C. arbuscula* var. *tumida* has stipe leaves that are closely appressed, aligning it to section *Camptochaete*, and leaves arranged in neat, catenulate spirals, i.e. resembling a chain.

Camptochaete monolina is unique within genus *Camptochaete*.

It is evident from this discussion that a molecular study of *Camptochaete* is needed to confirm phylogenetic relationships between the species and sections as proposed in the taxonomic revision by Tangney (1997).

Camptochaete subporotrichoides

Camptochaete subporotrichoides may have been confused in the past with *C. excavata* and *C. curvata*. The stipitate and frondose form that is typical of *Camptochaete* in general is less obvious in Australian *C. subporotrichoides* plants. Klazenga and Milne (2012) noted that, in the field, *C. excavata*, ‘could be overlooked as a *Thamnobryum* species because of the complanate fronds and commonly flagellate branches.’ This suggests that they included *C. subporotrichoides* in their circumscription of *C. excavata*.

Camptochaete excavata is distinguished from *C. subporotrichoides* by its very concave leaves with short, abruptly pointed apices (Fig. 4). The concave leaves are imbricate and give the stems an inflated, bubble-like appearance. *C. excavata* may have \pm complanate leaves as in *C. subporotrichoides*, but secondary stem leaves are mostly, if not entirely, of the deeply concave and rounded type seen in typical *C. excavata*.

Camptochaete curvata also has concave leaves, but they are more oblong in shape, with the widest part of the leaf at mid-lamina or above, rather than at the base as in *C. subporotrichoides* and *C. porotrichoides*.

C. leichhardtii has the leaves erect, pointing towards the shoot apex, and most stem and branch leaves are appressed. In *C. subporotrichoides* the leaves are appressed only in the lower parts of stems. *C. leichhardtii* tends to form soft, pendent masses on the twigs of shrubs, rather than on the lower trunks of trees and saplings. The leaves in *C. leichhardtii* are also neatly distichous-complanate with short, sharply recurved apices, and the cells are longer. As far as we know, *C. leichhardtii* does not occur in tropical Australia.

Camptochaete porotrichoides, which is known only from New Caledonia, has the leaves typically more irregularly spreading, and the leaf length to width ratio is less than 1.6, compared to more than 1.8 in *C. subporotrichoides*.

Camptochaete subporotrichoides varies considerably in the overall size and colour of plants. Specimens we have seen from New Guinea are much more robust than Australian specimens, which are typically small, wiry, and green to olive green. It is therefore possible that *C. subporotrichoides* is actually a species complex. A thorough molecular analysis would be very useful in delimiting the boundaries of the various species in the region.

We have not had a chance to review all specimens of *Camptochaete* collected in the Australian Wet Tropics. Some undetermined specimens might turn out to be *C. subporotrichoides*, as may some currently identified as *C. excavata*, *C. curvata* or *Thamnobryum*.

Keys

Camptochaete monolina would not key out to the genus in the current printed and online keys to the genera of Australian mosses (Buck and Vitt 2006, 2016). The second option in couplet 63, ‘Costa ending below mid-leaf or absent’, applies to all previously known Australian *Camptochaete* species but not *C. monolina*, which has a costa ending around 3/5 of the leaf length. We suggest the following amendment to account for this:

- 63 Costa extending more than half of the leaf length (61:) 63A
 63: Costa ending below mid-leaf or absent 64
 63A Leaves \pm orbicular to suborbicular, deeply concave; stem in cross-section lacking a
 hyaloderm (63:) *Camptochaete*
 63A: Leaves oblong-ovate, not deeply concave; stem in cross-section with a well-developed
 hyaloderm *Thamniopsis*

Camptochaete subporotrichoides keys out satisfactorily to the genus. However, in the current treatment of *Camptochaete* for the *Flora of Australia* (Klazenga and Milne 2012) it would key out to *C. excavata* or *C. curvata*. The following amended key is suggested.

Key to Australian *Camptochaete*

- 1 Stipe leaves patent and distant; operculum rostrate (sect. *Thamniella*) 2
 Stipe leaves appressed and overlapping; operculum blunt or apiculate (sect. *Camptochaete*) 5
- 2 Frond axes and branches mostly terete-foliate and turgid; leaves broadly ovate to suborbicular; leaf apices abruptly mucronate 3
 Frond axes and branches mostly subdistichous to complanate; leaves ovate to oblong, apices obtuse to widely acute, acuminate, or abruptly cuspidate..... 4
- 3 Costa weak and double, failing below mid-leaf, often absent, in cross-section 3–5 cells wide and 2 cells thick at base; stem (lower stipe) in cross-section with an outer cortex 5–8 cells wide; margin of inner perichaetial leaves entire *C. excavata*
 Costa strong and double, to about 3/5 of leaf length, in cross-section to 10 cells wide and 3 cells thick at base; stem (lower stipe) in cross-section with an outer cortex 2–3 cells wide; margin of inner perichaetial leaves serrulate–dentate *C. monolina*
- 4 Frond axis leaves oblong, leaf apices obtuse with a short acute reflexed point; branches curved when dry *C. curvata*
 Frond axis leaves ovate, leaf apices acuminate or somewhat abruptly cuspidate, not reflexed; branches straight when dry..... *C. subporotrichoides*
- 5 Frond axes and branches subdistichous; leaf apices recurved *C. leichhardtii*
 Frond axes and branches complanate to terete-foliate, occasionally turgid; leaf apices straight..... 6
- 6 Plants pale light green to yellowish green; leaves collapsed-wrinkled when dry, strongly concave and cochleariform, broadly ovate to suborbicular, obtuse or with a short point..... *C. arbuscula* var. *arbuscula*
 Plants dark green or brownish green; leaves not markedly altered when dry (then occasionally striate-wrinkled), moderately concave, ovate to broadly ovate, acute to acuminate *C. deflexa*

Acknowledgements

We acknowledge the Jirrbal people and Mamu people, Traditional Owners of land on which our collections were made, and recognise their elders past, present and emerging. Our gratitude goes to Darren Crayn, Stuart Worboys and other members of the Australian Tropical Herbarium Mountain Flora Surveys team for arranging access to the Bellenden Ker Range.

We especially thank Dr Rod Seppelt for preparing the illustrations, and the Queensland Department of Environment and Science for permission to collect bryophytes in the Australian Wet Tropics. We also thank Dr Christine Cargill and Judith Curnow (National Herbarium, Canberra) for useful discussions on *Camptochaete monolina*, and Dr Niels Klazenga (Royal Botanic Gardens, Melbourne) for his original discussion on *C. subporotrichoides* specimens from Queensland. We also thank the two reviewers of the manuscript for several useful suggestions that we have incorporated. The authors declare no conflict of interest in relation to this paper. The field work and preparation of this paper were undertaken in the authors' own time and at their own expense.

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