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Chiastocaulon raetzelii (Marchantiophyta, Plagiochilaceae), a new species from New Caledonia

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Abstract

The new liverwort species *Chiastocaulon raetzelii* is described from New Caledonia. *Chiastocaulon raetzelii* is characterized by very fragile, caducous leaves, stems therefore often becoming completely denuded of leaves; only bract leaves of the androecia are permanent and often the only ones remaining on the stem. Plants are minute with leafy shoots to 1 mm wide. Leaves on leafy shoots are arranged in opposing pairs, they are obovate-truncate to spathulate, with 3–7 teeth per leaf, teeth are filiform, consisting of long rectangular cells, and occupy about 1/3 to 1/4 of the entire leaf length. The species is compared to *C. oppositum* and *C. geminifolium*, which are the most similar morphologically.

Key words: *Chiastocaulon*, liverworts, New Caledonia, Pacific Islands, Plagiochilaceae

Introduction

The genus *Chiastocaulon* Carl (1931: 58) was originally established to accommodate *C. dendroides* (Nees 1830: 77) Carl (1931: 59), a species with alternating leaves first described as *Plagiochila* that produced ventral-intercalary branches within leafy shoot sectors. Phylogenetic analyses of the Plagiochilaceae by Patzak *et al.* (2016) prompted a broader circumscription of *Chiastocaulon* incorporating species previously attributed to *Acrochila* Schuster (1963: 285) and *Plagiochilion* Hattori (1947: 7). All of the members of the genus *Chiastocaulon* in this new, broadened sense are plagiochiloid species which frequently or exclusively produce ventral-intercalary vegetative branches. The genus *Plagiochilion* was proposed by Hattori (1947) for species of *Plagiochila* possessing leaves in opposing pairs, previously placed in *Plagiochila* sect. *Oppositae* Schiffner (1900: 106). Inoue (1964), in his monograph of *Plagiochilion* recognised 11 species worldwide. One of these, the SE Asian and Australasian *Chiastocaulon oppositum* (Reinwardt *et al.* 1824: 236) Patzak *et al.* (2016: 492) was characterized by Inoue (1964) [as *Plagiochilion oppositum* (Reinwardt *et al* 1824: 236) Hattori (1947: 7)] as an extremely variable species to which he synonymized several names, e. g. *Plagiochila geminifolia* Mitten (1871: 408) and *P. samoana* Stephani (1910: 197). Broadly, *C. oppositum* is circumscribed by its monomorphic leafy shoots, more or less rotund leaves in opposing pairs, toothed leaf margin, and plane perianth mouth (Renner *et al.* 2016). Whether *Chiastocaulon oppositum* is indeed a widespread variable species or is a complex of two or more morphologically diagnosable species was a question addressed by the study of Renner *et al.* (2016). The authors recognized at least two species, *C. oppositum* and *C. geminifolium* (Mitten 1871: 408) Renner (2016: 382) in Renner *et al.* (2016) within what was previously known as *C. oppositum*. The latter species, originally synonymized with *Plagichilion oppositum* (=*Chiastocaulon oppositum*) by Inoue (1964) was reinstated as morphologically and genetically distinct from *C. oppositum*.

So far, in New Caledonia, the genus *Chiastocaulon* includes *C. dendroides* (Nees 1830: 77) Carl (1931: 59), *C. caledonicum* (Stephani 1908: 32) Patzak *et al.* (2016: 491) (with the type locality in New Caledonia), *C. braunianum* (Nees 1830: 80) Patzak *et al.* (2016: 491), *C. theriotianum* (Stephani 1924: 228) Patzak *et al.* (2016: 492) (with the type locality in New Caledonia) and *C. oppositum* (Thouvenot *et al.* 2011).

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In New Caledonia we have found a very slender *Chiastocaulon* species with opposite leaves extremely caducous which neither belongs to *C. oppositum* nor to *C. geminifolium* and is hereby described as a new species of the *C. oppositum* complex.

The new species

Chiastocaulon raetzelii Frank Müll., ***sp. nov.*** Figs. 1–2

Diagnosis: The species is characterized by very fragile, caducous leaves; on most parts of stem, leaves have fallen off; persisting only on basal parts of stem; bract leaves of androecia are permanent and often the only ones remaining on the stem. Plants minute, leafy shoots to 1 mm wide, stem diameter 85–170 µm, leaves 0.5–0.9 mm long, 0.3–0.8 mm wide. Leaves on leafy shoots in opposing pairs, obovate-truncate to spathulate, teeth 3–7 per leaf, filiform, with long rectangular cells, teeth occupying about 1/3 to 1/4 the entire leaf length. Both antical (dorsal) and postical (ventral) margin of leaves are straight to shallowly arched towards base, the postical margin reaching ventral stem midline. Cortical stem cells light brown. Antheridial bracts in 6–10 pairs.

Holotype:—NEW CALEDONIA. South Province, Nouméa 45 km N, Mont Humboldt, ascend from the south to the mountain hut below the summit, epiphytic in mossy forest, ca. 1200 m, 21°54'S, 166°24'E, 30 August 2003, *F.Müller NC811* (DR).

Description: Plants with shoots weakly differentiated into a creeping or erect leafy sector and a creeping stolon, both sections irregularly and frequently branched, stolons bearing reduced leaves; plants forming loose, diffuse turfs, yellowish brown; leafy shoots erect-ascending, up to 25 mm long and 1 mm wide, monomorphic, flagellae absent. Branching exclusively ventral-intercalary, with or without a subsidiary ventral-intercalary branch producing a positively geotropic stolon at the base of the primary. Stems reddish-brown to brown, 85–170 µm diameter, surface smooth, in cross section transversely elliptic, cortical layer 1 or 2 cell tiers deep, cortical cells slightly smaller than the medullar, with heavily thickened and light brown walls that constrict the cell lumen, walls evenly thickened, medulla 3–4 cells high, number of medullar cells 9–15, lumen clearly wider than in cortical cells, the cell walls less thickened, only cell corners more thickened. Rhizoids mainly on the stolons, arising in loose fascicles from the base of the leaves, also scattered on ventral and lateral stem surfaces. Leaves extremely caducous; on most parts of the stems, usually remaining only on basal part of stems, otherwise male bracts more persistent, all surrounding vegetative leaves absent. Leaves on leafy shoots in opposing pairs, remote to contiguous, transversely orientated and widely spreading; leaves obovate-truncate to spathulate, 0.5–0.9 mm long, 0.3–0.8 mm wide, usually as wide as long or indistinctly longer than wide; on dorsal side leaves standing close together or more often dorsal leaf bases connate dorsally, antical (dorsal) margin straight to shallowly arched, very slightly decurrent, postical (ventral) margin straight to gently arched towards base, oriented parallel to the stem, attaining the dorsal stem midline; apex truncate to spathulate, not lobed, apical margins and partly ventral margins with 3–7 very prominent filiform teeth, dorsal margins in general entire, seldom with one tooth, teeth to 320 µm long, at base 2–6 cells wide, the longer teeth with uniseriate tip of 3–6 cells, these cells long rectangular, 24–56 µm long, 10–21 µm wide, filiform teeth occupying 1/3 to 1/4 the leaf length; cells of leaf margin quadrate to rectangular, mostly wider than long, 13–23 µm long, 18–30 µm wide, walls evenly thickened; cells in mid-leaf variably sized and shaped, subquadrate to elliptic, 25–38 µm long, 19–28 µm wide, cell walls evenly thickened with indistinct to distinct bulging trigones; cells in leaf base longer, quadrate to rectangular, unequally sized, 32–50 µm long, 15–32 µm wide, arranged in loose tiers, with coarse cordate to bulging trigones and less thickened intermediate walls, grading into surrounding mid-leaf cells; cell surfaces smooth and unornamented. Oil-bodies unknown. Underleaves lacking. Dioicous. Androecia spike-like, solitary, intercalary on shoots that continue vegetative growth, male bracts closely imbricate, toothed like vegetative leaves, saccate, in 6–10 pairs. Gynoecia not seen. Sporophytes not seen.

Additional material seen (paratypes): NEW CALEDONIA. South Province, Dumbéa, along the hiking trail from Auberge du Mont Koghi to Mont Bouo, epiphytic in montane rainforest, ca. 800 m, 22°10'S, 166°31'E, 09 September 2001, *F. Müller NC97* (DR); Païta, summit of Mt Mou, 1219 m, amongst bryophytes on twig in dwarf cloud forest, 17 September 2016, *Thouvenot NC1975* (Thouvenot private herbarium).

Etymology: The species is named in honour of Stefan Rätzel, an enthusiastic German botanist, specialist of a wide range of plant groups. He accompanied the senior author on his second visit to New Caledonia and pointed out in the field some easily overlooked bryophytes.

FIGURE 1. *Chiastocaulon raetzelii*. **A–B.** Habit of male plants. **C.** Habit of male plants with defoliated vegetative parts. **D.** Plants with persistant vegetative leaves only on basal parts. **E–F, I.** Shoots in dorsal view. **G–H.** Shoots in ventral view. A–C, E–H from the holotype, D, I from *Müller NC97*.

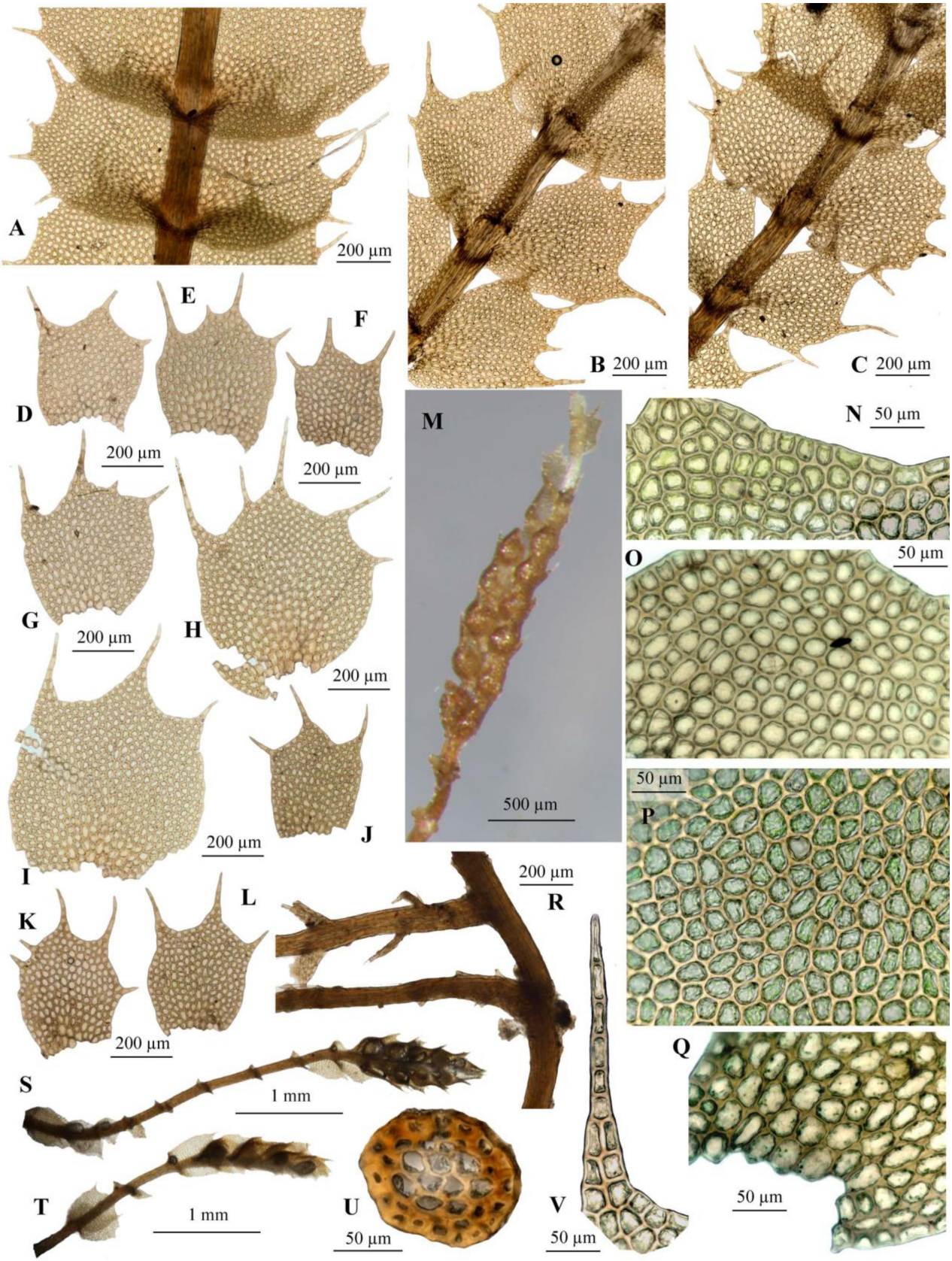

FIGURE 2. *Chiastocaulon raetzelii*. **A.** Shoot portion, dorsal view. **B–C.** Shoot portion, ventral view. **D–L.** Leaves. **M.** Androecium. **N.** Marginal cells of leaf. **O.** Cells in upper part of leaf. **P.** Median cells of leaf. **Q.** Basal cells of leaf. **R.** Ventral intercalary branching. **S–T.** Upper part of male shoots lacking caducous vegetative leaves below androecia. **U.** Transverse section of stem. **V.** Marginal teeth of leaf. A–E, H–N, P, R–V from the holotype. F–G, O, Q from *Müller NC97*.

Distribution and ecology: Known only from New Caledonia, reportedly limited to the South Province, where it was found in montane rainforests on ultrabasic substrates at elevations from 800 to 1200 m. On Mont Humboldt it was found growing together with *Dicnemon cuspidatum* Bescherelle (1873: 191), *Drepanolejeunea* sp., *Heteroscyphus* sp., *Bazzania francana* (Stephani 1924: 463) Kitagawa (1972: 446), and *Radula amentulosa* Mitten (1861: 367), on Mont Bouo with *Pleurozia articulata* (Lindberg 1869: 78) Lindberg & Lackström (1874: 5) and *Heteroscyphus aselliformis* (Reinwardt *et al.* 1824: 412) Schiffner (1910: 172), and on Mont Mou it was growing mixed with *Solenostoma hirticalyx* (Stephani 1924: 87) Schuster ex Váňa *et al.* (2010: 137), *Metalejeunea cucullata* (Reinwardt *et al.* 1824: 227) Grolle (1995: 100), *Frullania chevalieri* (Schuster 1970: 289) Schuster (1992: 34) and others.

Discussion

The new species belongs to the species complex of *C. oppositum* and is morphologically similar to *C. oppositum* and *C. geminifolium*. Differences from *C. oppositum* and *C. geminifolium* are summarized in Table 1.

TABLE 1. Differences of *Chiastocaulon raetzelii*, *C. oppositum* and *C. geminifolium.*

	C. raetzelii	*C. oppositum*	*C. geminifolium*
asexual reproduction	by caducous leaves	absent	absent
leafy shoot width	< 1 mm	1–2 mm	0.9–1.8 mm
stem diameter	85–170 µm	150–350 µm	110–200 µm
number of medullary cells in stem cross section	8–15	> 20	ca. 20
colour of cortical cells in stem cross section	light brown	dark red-brown	yellow-brown
leaf shape	obovate-truncate to spathulate	ovate to subreniform	obovate when small to rotund to broadly transverse-elliptic when mature
length and width of leaves	0.5–0.9 mm long, 0.3–0.8 mm wide	0.7–1.3 mm long, 0.7–1.3 mm wide	1.1–1.3 mm long, 0.9–1.3 mm wide
number of teeth per leaf	3–6(–7)	5–13	10–17
length of teeth in relation to total leaf length	1/3–1/4	<1/4	<1/4
cell shape of filiform teeth	long rectangular	isodiametric to short rectangular	isodiametric to quadrate
postical margin (ventral) of leaves at insertion	straight to gently arched towards base	curved towards base (arcuate)	straight towards base
antical margin (dorsal) of leaves at insertion	straight to shallowly curved	curved (arcuate)	straight to shallowly curved
number of pairs of antheridial bracts	6–10	8–10	2–4

Chiastocaulon raetzelii differs from both species by its very fragile, caducous leaves, which are assumed to be asexual reproductive devices. On most parts of the stems, the leaves have fallen off and partly remain only on the basal parts. Bract leaves of the androecia are permanent and often the only ones remaining on the stem. In *C. oppositum* and *C. geminifolium* such asexual reproduction is lacking (Renner *et al.* 2016). However, caducous leaves are known in other *Chiastocaulon* species, such as *C. pachycephalum* (De Notaris 1874: 14) Herzog (1950: 286) (Renner & Worboys 2018).

Further differences are its minuteness, which is seen in the width of the leafy shoots, the leaf dimensions and the thickness of the stem. Furthermore, *C. raetzelii* has a different leaf shape, being obovate-truncate to spathulate. The teeth, which are usually only present in small numbers (3–7), are particularly characteristic, in *C. raetzelii* they are long filiform and occupy about 1/3 to 1/4 the entire leaf length; the ciliform end of the teeth is made up of long rectangular cells.

Further differences from *C. oppositum* include the postical margin (ventral) of the leaves that are straight to gently arched towards base and reaching the ventral stem midline, whereas *C. oppositum* has leaves with postical margin curved towards base (arcuate) and not attaining the ventral stem midline, leaving one cortical cell row leaf-free. The cortical stem cells are light brown in *C. raetzelii* vs. dark red brown in *C. oppositum*.

Further differences from *C. geminifolium* are the long rectangular cells of the teeth (vs. isodiametric to quadrate throughout in *C. geminifolium*) and the number of antheridial bracts (6–10 pairs vs. 2–4 pairs in *C. geminifolium*).

Chiastocaulon theriotianus is a much more robust plant (plants 2.5–3.5 mm wide), the leaves are asymmetrically obovate, the teeth are triangular, and the leaf cells have large, nodulose trigones (Inoue 1964, Renner *et al.* 2016). *Chiastocaulon pachycephalum* shares with *C. raetzelii* the caducous leaves but differs by the leaves being distinctly longer than wide, deeply trifid to approximately half-way into acute lobes and leaf cells with bulging trigones (Inoue 1964, Renner & Worboys 2018).

Chiastocaulon oppositum was cited from New Caledonia by Dugas (1928, 1929), based on a specimen collected by Franc in 1909, and Paris (1910), based on a specimen collected on Me Areinbo by Le Rat 1909. In order to clarify whether these records are related to *C. oppositum* s. str. or possibly to *C. raetzelii* we tried to obtain herbarium material of these for investigation. We were able to investigate a duplicate of the Le Rat collection deposited in herbarium L (New Caledonia, Mt. Dzumac, 1425 m, July 1909, *Le Rat* s. n. [L *0108846*]) and could confirm its identity as *C. oppositum* s. str.

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