

***Macromitrium humboldtense*
(Orthotrichaceae, Bryophyta),
a new species from New Caledonia**

Louis THOUVENOT^{a*} & Frank MÜLLER^b

^a11 rue Saint Léon, 66000 Perpignan, France

^bTechnische Universität Dresden, Institut für Botanik,
Mommsenstr. 13, 01062 Dresden, Germany

Abstract – The genus *Macromitrium* is one of the richest genera of mosses in New Caledonia, although unrevised to date, with 44 names currently accepted. A new species, *Macromitrium humboldtense*, is described and illustrated here. It is characterized by 1) a soft and shaggy habit, when dry with the leaves irregularly individually twisted and loosely spirally arranged, with their thin points unevenly oriented; 2) branches relatively short and crowded; 3) branch leaves large (> 3.6 mm), narrowly lanceolate, regularly tapering from basal 1/8 of the leaf, long acuminate, ending in a piliform apex; 4) upper cells papillose, basal cells mainly smooth; 5) setae long (> 15 mm), calyptrae glabrous. Comparison with piliferous species of *Macromitrium* in neighbouring countries is given. Ecological and geographical features for the three long cuspidate *Macromitrium* in New Caledonia are discussed.

Musci / New Caledonia / Orthotrichaceae / Pacific region

Résumé – Le genre *Macromitrium* est l'un des plus riches parmi les mousses de Nouvelle-Calédonie, bien qu'il n'ait pas encore été révisé, avec 44 noms actuellement valides. Une nouvelle espèce, *Macromitrium humboldtense*, est décrite et illustrée. Elle est caractérisée par 1) un aspect mou et hirsute, avec à sec des feuilles individuellement torsadées de façon irrégulière, lâchement disposées en spirale, leurs fines pointes orientées en tous sens ; 2) des branches assez courtes et denses ; 3) des feuilles raméales longues (> 3.6 mm), étroitement lancéolées, régulièrement décroissantes dès le 1/8^e de la longueur de la feuille à partir de la base, longuement acuminées, finissant en apex piliforme ; 4) des cellules supérieures papilleuses, les basales essentiellement lisses ; 5) des soies longues (> 15 mm) et des coiffes glabres. Elle est comparée aux autres espèces pilifères des régions environnantes. Les caractéristiques écologiques et géographiques des trois espèces de *Macromitrium* à longues pointes, présentes en Nouvelle-Calédonie, sont discutées.

Mousse / Nouvelle-Calédonie / Orthotrichaceae / Région Pacifique

INTRODUCTION

New Caledonia has a relatively well known bryophyte flora with more than a thousand taxa hitherto accepted, including 546 mosses and 495 liverworts and

* Corresponding author: thouloup@club-internet.fr

hornworts (updated data from Thouvenot & Bardat, 2010; Thouvenot *et al.*, 2011; Müller, 2011, 2012, 2013; Zhu & Müller, 2012; Thouvenot & Bardat, 2013; Müller & Tan, 2013; Thouvenot & Reeb, 2014; Thouvenot, 2015; Thouvenot *et al.*, 2015; Thouvenot & Yong, 2015; Müller *et al.*, 2016). *Macromitrium* Brid. is one of the richest genera of mosses in New Caledonia with 44 names currently accepted at specific or infraspecific level (Thouvenot & Bardat, 2010; Thouvenot & Yong, 2015). Since the genus has not been revised for this French territory, the number is likely to be over-stated. For example, the number of *Macromitrium* taxa in New Zealand decreased from 47 to 15 following the revision by Vitt (1983). For Australia, 21 species and one subspecies are currently recognized (Vitt & Ramsay 1985, 2006); for Papua New Guinea 29 species of *Macromitrium* are reported (Vitt *et al.*, 1995) and Whittier (1976) included 8 species in the regional flora of the Society Islands. During two field trips to New Caledonia in 2001 and 2003, a substantial collection of *Macromitrium* was made by the second author and included in studies for the revision of the genus in the territory. Twelve species were identified by the first author from these collections: *M. cardotii* Thér., *M. francii* Thér., *M. involutifolium* (Hook. *et* Grev.) Schwaegr. subsp. *involutifolium*, *M. larrainii* Thouvenot *et* K.T.Yong, *M. leratii* Broth. *et* Paris, *M. ligulaefolium* Broth., *M. microstomum* (Hook. *et* Grev.) Schwaegr., *M. pilosum* Thér., *M. pulchrum* Besch., *M. renauldii* Thér., *M. subvillosum* Broth. *et* Paris and *M. tongense* Sull. An additional specimen was distinct from any species already described or mentioned in New Caledonia and neighbouring countries and proved to be a new species in the genus.

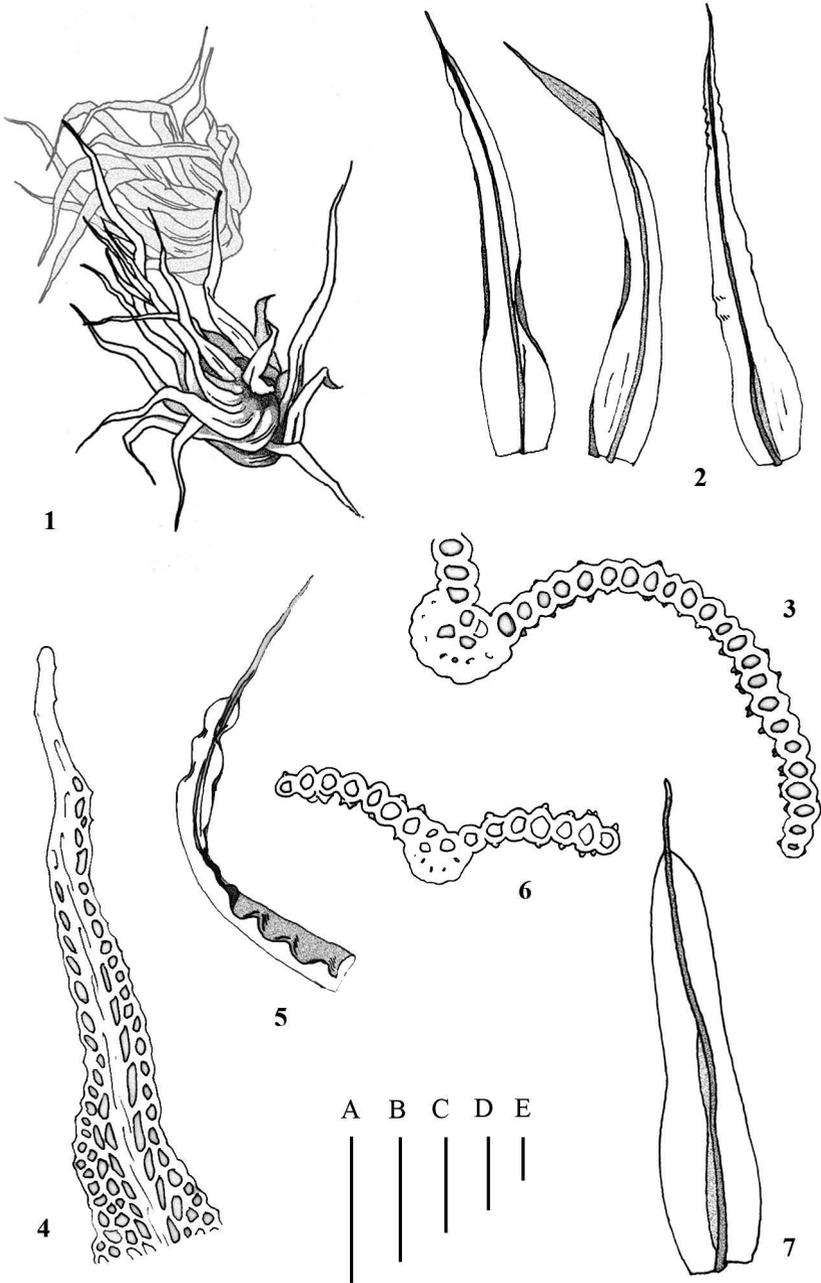
DESCRIPTION

Macromitrium humboldtense Thouvenot & Frank Müll., *sp. nov.* Figs 1-6, 8-16

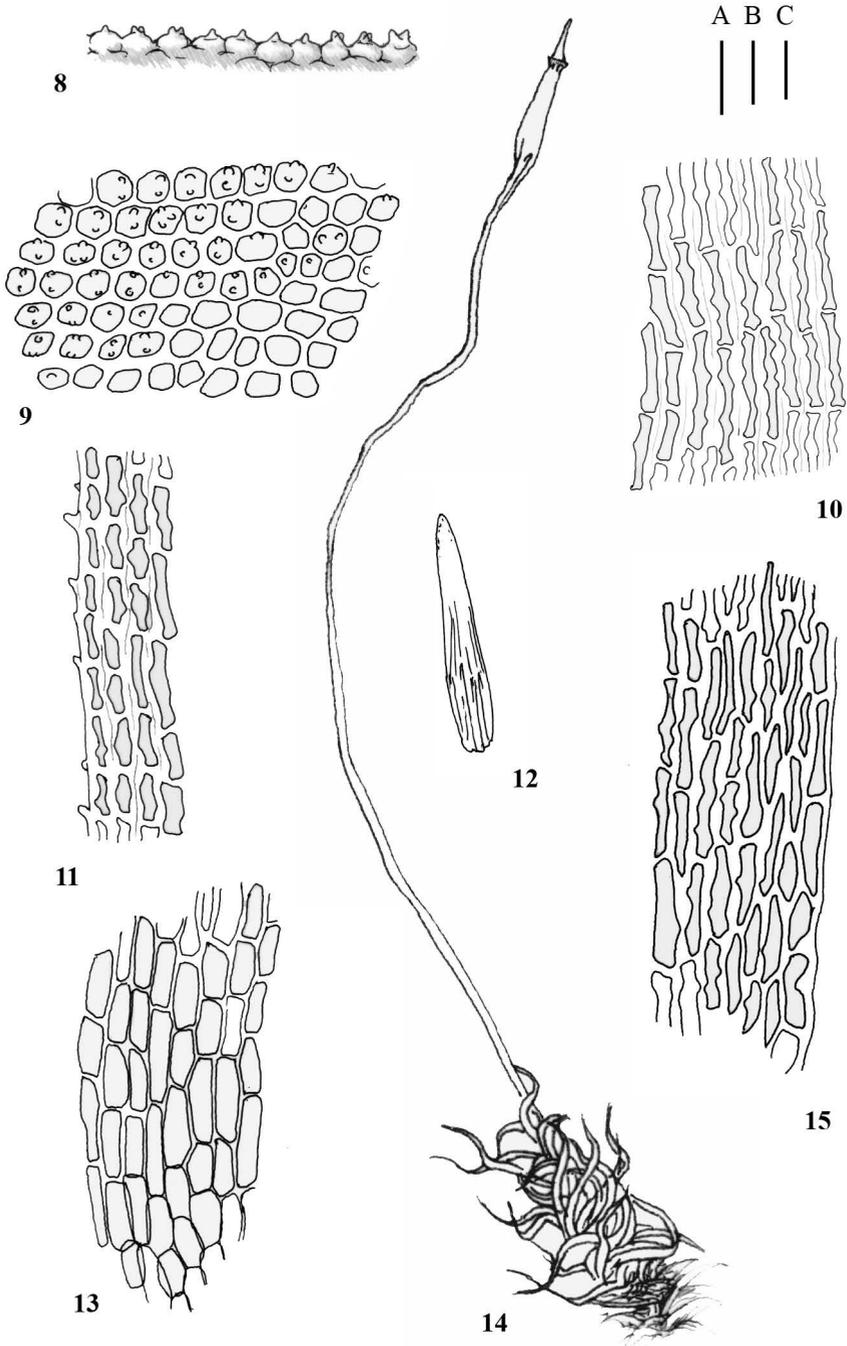
Diagnosis: Plants medium-sized with large slender branch leaves >3.6 mm long; leaves narrowly lanceolate to narrowly triangular, widest near the base, long acuminate, gradually tapering in a long arista almost entirely filled by the costa, concolorous or tinged red-brown, the apex sparsely and acutely toothed, often undulate; leaf cells papillose throughout but smooth in a short basal part; the seta long, >15 mm, flexuose, the calyptra hairless.

Type: NEW CALEDONIA, Province Sud, Mt Humboldt, Aufstieg von der Berghütte uh. vom Gipfel bis zum Gipfel; 21°53' S, 166°25' E; auf Gestein; ca 1600 m; 31 Aug. 2003; *F. Müller* NC763 (holotype: DR; isotypes: PC0723602, L. Thouvenot private herbarium NC1716).

Plants medium-sized, in the upper parts light green or often red-tinged, in the older parts brown. **Stems** creeping, with crowded erect branches, **branches** 3-7 mm long, 4 mm wide when moist, branch leaves when dry erecto-patent, twisted, very loosely spirally arranged with the leaf apices turned in all directions (Fig. 1), leaves spreading when moist, sideways-curved in a spiral configuration and with the upper lamina often tightly wavy. **Branch leaves** narrowly lanceolate to narrowly triangular, 3.6-4.6 mm long, 0.5-0.8 mm wide at 1/8 length from the base, 0.14-0.25 mm at 1/4 length from the top, soft, slightly carinate and somewhat plicate below, widest at 1/8 length from the base, gradually tapering, long acuminate, the lamina ending in a narrow band, one cell wide, on both side of the more or less excurrent costa; leaf margin crenulate-papillose to sharply toothed at the apex; costa



Figs 1-7. 1-6. *Macromitrium humboldtense*. 1. Branches habit. 2. Vegetative leaves. 3 & 6. Transverse sections in upper half of vegetative leaves. 4 & 5. Leaf apex of vegetative leaves. 7. *Macromitrium rufipilum*, vegetative leaf. (Scale bars. A: 100 μ m for 4; B: 1 mm for 2 & 7; C: 1 mm for 1; D: 200 μ m for 5; E: 20 μ m for 3 & 6. All drawn from the type specimen.)



Figs 8-15. *Macromitrium humboldtense*. **8.** Upper cells of vegetative leaf, side view. **9.** Upper cells of vegetative leaf, front view. **10.** Basal cells of vegetative leaf. **11.** Margin at the transitional part of vegetative leaf. **12.** Calyptra. **13.** Basal cells of perichaetial leaf. **14.** Fertile branch. **15.** Basal margin of vegetative leaf. (Scale bars. A: 1 mm for 12; B: 20 μ m for 8 to 11, 13, 15; C: 1 mm for 14. All drawn from the type specimen).



Fig. 16. *Macromitrium humboldtense*, 3 apices of vegetative leaves. Scale bar: 100 μ m. From the type specimen.

brownish, 50-60 μ m wide at base, percurrent to excurrent in a rough hyaline or pale red-brown point, up to 0.25 mm long. **Upper cells** unistratose, rounded quadrate to short oblong, 10-15 μ m long, 7-12 μ m wide, narrower near the nerve, thick-walled, bulging, with 1-3 slender papillae per cell, up to 5 μ m high in cross section, the marginal cells smaller, quadrate; transitional cells few, with one rounded papilla, oblong, lumina wide and irregular, longitudinal walls strongly thickened, more or less porose; **lower cells** long rectangular to linear, forming a short base to the leaf, 1/7-1/8 of its length, 18-45 μ m long, 7-12 μ m wide, longitudinal walls thick and porose, lumina not very narrow, more or less as wide as the walls, smooth to prorate, but the upper ones sometimes with a rounded papilla.

Dioicous (?). **Perichaetial leaves** inconspicuous, similar to vegetative leaves, but basal cells with thinner walls and wider lumina. **Vaginulae** glabrous, with many paraphyses. **Setae** thin, smooth, sinuose, 15-20 mm long. Young **calyptrae** narrowly mitrate, glabrous, finely plicate, 4 mm long. Young **capsule** long exserted, cylindrical, operculum with a long, straight rostrum.

Etymology: The specific epithet is based on the name of the second highest summit of New Caledonia, Mt Humboldt, where the new species was collected. Original adjectives based on morphological characters are hard to find in the genus *Macromitrium* since nearly 950 specific or infraspecific names already exist (<http://www.tropicos.org/namesearch.aspx>, accessed on 21/12/2015).

Ecology: This species was found at 1600 m asl, one of the highest elevations in New Caledonia, on ultramafic rock in montane scrubland.

Distribution: The species is known from a single collection in the southern province of New Caledonia.

DISCUSSION

Macromitrium humboldtense is a very distinct species characterised by 1) a soft habit, when dry with leaves irregularly twisted, loosely spirally arranged, the apical part of the leaf often wavy, with the unevenly oriented tips producing a shaggy effect, 2) relatively short branches, 3) large branch leaves > 3.6mm, narrowly lanceolate to narrowly triangular, regularly decreasing in width from the basal 1/8, long acuminate, ending in a piliform apex, hyaline or red-brown at the tip, 4) laminal cells papillose, the upper cells mainly rounded quadrate, pluripapillose, occupying more than 3/4 of the leaf length, the transitional cells few, unipapillose, the lower cells long rectangular to linear, with straight lumina, extending only a short distance from the base, smooth or with those nearest the transitional cells with a single papilla, 5) setae long (>15 mm), flexuose, smooth and 6) calyptrae glabrous. Among these characters, the shape of the piliform apex is noteworthy since it has the appearance of a long arista, but in reality the lamina extends along the costa in two narrow wings, so that the costa is mainly percurrent, only excurrent in a short hyaline or red-brown point.

As part of an ongoing study of the genus *Macromitrium* in New Caledonia the first author reviewed the protologues of all the species originally described from New Caledonia as well as the published descriptions of other species reported from this territory (see references in Pursell & Reese, 1982; Thouvenot & Bardat, 2010). No more than three have long aristate leaves: *Macromitrium humboldtense*, *M. rufipilum* Cardot (Cardot, 1908) and *M. larrainii* (Thouvenot & Yong, 2015). Their main features are compared in Table 1. The recently described *M. larrainii* is a larger plant, with a leaf shape similar to the new species, but it is easily recognized by its uniformly smooth leaf cells, its leaves more tightly appressed when dry, its costae excurrent in longer aristae, and its branches longer (up to 25 mm). *Macromitrium rufipilum*, known only from the type specimen and a few sparse collections made more than a century ago, is the most morphologically similar species to *M. humboldtense*, sharing a similar leaf areolation. However, the leaf shape is lanceolate-ligulate, the upper lamina is wider, 0.37-0.48 mm wide at 1/4 from the top, ending in an obtuse apex, abruptly contracted to a longer, smooth arista, up to 1.5 mm long and entirely composed of the excurrent nerve, reddish, with a hyaline tip (Fig. 7). Furthermore, it is a firmer plant with dense spirally twisted branch leaves, the leaf margins are not toothed, the papillae in the upper leaf cells are larger, in cross section up to 10 µm high, the transitional cells are numerous, and the lower leaf cells are longer with narrower lumina, 1/4 the cell width (up to 1/2 the cell width in *M. humboldtense*).

Macromitrium pulchrum var. *aristatum* Thér., another *Macromitrium* species described from New Caledonia, has leaves with a short arista. However, it is a very distinctive species on account of its robust habit, with the branches larger, more than 20 mm long, the leaves firm, carinate, circinate above when dry, abruptly contracted to the aristae, and the upper leaf cells with very stout and branched papillae.

Thouvenot & Yong (2015) reviewed all the piliferous species in the neighbouring regions, in comparison with *M. larrainii* and this new species is clearly distinct. Considering the piliferous species from Australia, *M. peraristatum* Broth., *M. funiforme* Dixon, *M. dielsii* Broth. ex Vitt & Ramsay, all have smooth upper leaf cells, smaller leaves (less than 2.5 mm long), conspicuous sheathing perichaetial leaves and longer branches (except *M. dielsii*); whilst *M. diaphanum* Müll.Hal. is

Table 1. Main features of the four long aristate *Macromitrium* in New Caledonia, from type material and examined specimens

	<i>M. humboldtense</i>	<i>M. rufipilum</i>	<i>M. pulchrum</i> var. <i>aristatum</i>	<i>M. larrainii</i>
Branch length	3-7 mm	5-12 mm	15-22 mm	8-25 mm
Branch leaves when dry	leaves twisted, loosely spirally arranged, soft, hardly carinate below	leaf apex curved, leaves twisted, spirally arranged, firm, carinate	leaf apices curved to circinate, leaves loosely spirally twisted, firm, carinate	leaves erect, loosely twisted, not spirally arranged
Branch leaf size	3.6-4.6 mm long, 0.5-0.8 mm wide	3 mm long, 0.8 mm wide	3.3-3.5 mm long, 0.67-0.7 mm wide	1.2-2.7 mm long, 0.2-0.5 mm wide
Branch leaf shape	narrowly lanceolate, widest at 1/8 below, long acuminate, the arista long winged	lanceolate-ligulate, the lamina abruptly tapering, obtuse	narrowly lanceolate, short acuminate, the lamina abruptly tapering, acute	narrowly lanceolate, long acuminate, the arista shortly winged
Nerve	percurrent to excurrent	excurrent	excurrent	excurrent
Arista	concolorous, long winged below with a hyaline or red-brown excurrent point up to 0.25 mm long	reddish, thin and flexuose, up to 1.5 mm long, entirely composed of the costa	short, up to 0.2 mm long, entirely composed of the costa	concolorous, thin, shortly winged below, up to 1 mm long
Upper cells	rounded quadrate to short oblong, bulging, 1-3 slender papillae	rounded quadrate to short oblong, papillae strong	quadrate, papillae very stout, branched	unevenly oblong to isodiametric, smooth
Basal cells	linear to long rectangular, 18-45 µm long, lumina 1/2 cell width, upper cells papillose, lower smooth	linear to long rectangular, 35-70(85) µm long, narrow lumina 1/4 cell width, upper cells papillose, lower smooth	linear, lumina narrow, upper cells papillose, lower smooth	linear, 50-60 µm × 8 µm, smooth

distinguished by the bistratose to multistratose laminae in the upper parts of the leaves (Vitt & Ramsay, 1985, 2006). The Malesian-Melanesian *M. crinale* Broth. et Geh. has smooth upper leaf cells and longer branches (Vitt *et al.*, 1995). Furthermore the lumina of the basal cells are sigmoid, the leaves are wider and taper to unistratose, filiform apices, with the costae at most percurrent. The following species are distinctive in their leaf shape shortly narrowed below the more or less long aristae: *M. cuspidatum* Hampe from Indonesia and Papua New Guinea also has long branches up to 25 mm, and sigmoid lumina in the basal cells (Vitt *et al.*, 1995), *M. longipilum* A. Braun ex Müll. Hal. from Indonesia and Malesia (Eddy, 1996) and *M. piliferum* Schwaegr. from Hawaii (Bartram, 1933) both have densely appressed branch leaves, long aristae, and the latter has pilose calyptae. Finally the Bornean *M. ochraceoides* Dixon has long acuminate leaves, but shorter than in *M. humboldtense*, less than 3.5 mm long and more strongly carinate, the branches are funiculate, with leaves densely appressed when dry and the lumina of the basal cells are sinuose (Dixon, 1935).

From an ecological point of view, New Caledonia has a tropical-oceanic climate. The ultramafic massif of Mt Humboldt (1618 m) receives an annual rainfall of about 4,000 mm (Moniod, 1966), and is the highest mountain in Province Sud, about 225 km south-east of the metamorphic massif of Mt Panié (1628 m) in Province Nord. Microendemism in New Caledonia is often underlined as an important aspect of New Caledonian biodiversity (Grandcolas *et al.*, 2008). The shape of this 500 km long island, together with a steep relief and a sharp diversity in geological structure, has created a mosaic of habitats, more or less isolated by landscape features.

The known distribution of the three long cuspidate *Macromitrium* species from New Caledonia could be investigated from this perspective since *M. larrainii* is restricted to the northern highest mountain (Mt Panié, at 1200-1600 m a.s.l.), whilst the single specimen of *M. humboldtense* was found near the summit of the southern Mt Humboldt (1600 m). *M. rufipilum* is reported from two localities at lower elevations (+/- 500 m), one is only 70 km north-west of *M. humboldtense*, the other 40 km north-west of *M. larrainii*. The number of specimens and localities is insufficient to draw sound conclusions on the status of these species and their ecological preferences. However, we can take note that high elevation species of *Macromitrium* might be largely endemic in Papua New Guinea (Vitt *et al.*, 1995) and the aristate species in Australia (*M. peraristatum*, *M. dielsii* and *M. uniforme*), are known only from high elevation areas (Thouvenot & Yong, 2015).

Additional specimens examined:

***Macromitrium rufipilum* Cardot.** NEW CALEDONIA. Balade, *s.d.*, Vieillard n°1715 (isotypes PC 0096531, 0096534); Canala, 500 m, Bogosa Rücken, 27 Oct. 1911, *Dr Fritz Sarasin s.n.* (PC 0737584).

***Macromitrium pulchrum* var. *aristatum* Thér.** NEW CALEDONIA. *Sin. loc.*, 1906, *Franc s.n.* (PC0083721).

***Macromitrium larrainii* Thouvenot & K.T.Yong.** NEW CALEDONIA. Province Nord, Hienghène, summit of Mont Panié, 9 Oct. 2012, *J. Larrain 35846* (holotype PC0167650); Mt Panié, 1200 m, 13 Sept. 2001, *F. Müller NC98* (DR).

CONCLUSION

Further field surveys in New Caledonia with a focus on *Macromitrium* will be necessary to understand precisely the geographical patterns and ecological characteristics of the individual species, including elevation, geological substrate and geographic isolation. One of the pending question is whether the morphological characters of leaves in the New Caledonian piliferous species such as size, shape and long piliform apex are an adaptation to environmental conditions in the highest elevations or the consequence of an evolution linked to the isolation on the top of remote mountains (allopatry, microendemism).

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