cryptogamie
Bryologie
2019 • 40 • 16

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art. 40 (16) — Published on 16 October 2019
www.cryptogamie.com/bryologie

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Cryptogamie, Bryologie est indexé dans / Cryptogamie, Bryologie *is indexed in:*
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Cryptogamie, Bryologie est une revue en flux continu publiée par les Publications scientifiques du Muséum, Paris
Cryptogamie, Bryologie *is a fast track journal published by the Museum Science Press, Paris*

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Adansonia, Geodiversitas, Zoosystema, ***Anthropozoologica, European Journal of Taxonomy, Naturae,*** **Cryptogamie sous-sections** ***Algologie, Mycologie.***

Diffusion – Publications scientifiques Muséum national d'Histoire naturelle
CP 41 – 57 rue Cuvier F-75231 Paris cedex 05 (France)
Tél. : 33 (0)1 40 79 48 05 / Fax : 33 (0)1 40 79 38 40
diff.pub@mnhn.fr / http://sciencepress.mnhn.fr

ISSN (imprimé / *print*) : 1290-0796 / ISSN (électronique / *electronic*) : 1776-0992

A review of the genus *Macromitrium* Brid. (Orthotrichaceae, Bryophyta) in New Caledonia

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Submitted on 22 October 2018 | Accepted on 28 Février 2019 | Published on 16 October 2019

Thouvenot L. 2019. — A review of the genus *Macromitrium* Brid. (Orthotrichaceae, Bryophyta) in New Caledonia. *Cryptogamie, Bryologie* 40 (16): 167-217. https://doi.org/10.5252/cryptogamie-bryologie2019v40a16. http://cryptogamie.com/bryologie/40/16

ABSTRACT
Macromitrium Brid., one of the richest moss genera in New Caledonia, has not so far been revised. In the vicinity, only New Zealand, Australia and Papua New Guinea have benefited from a comprehensive overview of *Macromitrium* species. A review of the morphological characters of the types, completed by many fresh specimens collected since 2000, enables to clarify the relationship between the 46 taxa inherited from past and present bryological contributions since 1857 and to define five main morphological patterns among the *Macromitrium* species in New Caledonia. Taxonomic treatment includes synonymies, typifications, descriptions, ecological and geographical features. Eventually 24 taxa are accepted at specific or infraspecific rank. Among them, 14 are locally endemic, including three varieties.

KEY WORDS
Orthotrichaceae, morphology, musci, New Caledonia, lectotypification, new combination.

RÉSUMÉ
Révision du genre Macromitrium Brid. *(Orthotrichaceae, Bryophyta) en Nouvelle Calédonie.*
Le genre *Macromitrium* Brid., un des plus riches genres de mousse en Nouvelle-Calédonie, n'a pas été révisé jusqu'à ce jour. Dans les régions voisines, seules la Nouvelle-Zélande, l'Australie et la Papouasie Nouvelle-Guinée ont bénéficié d'une révision complète des espèces de *Macromitrium*. L'examen des caractères morphologiques des types, auxquels s'ajoutent de nombreux spécimens collectés récemment lors de missions en Nouvelle-Calédonie depuis 2000, a permis de clarifier les relations entre les 46 taxa hérités des contributions des bryologues depuis 1857 et de définir cinq principales configurations morphologiques parmi les espèces présentes en Nouvelle-Calédonie. Le traitement taxonomique comprend synonymies, typifications, descriptions, écologie, aires géographiques. Finalement, 24 taxa de niveau spécifique ou infra spécifique sont retenus, parmi lesquels 14 dont trois variétés sont endémiques de Nouvelle-Calédonie.

MOTS CLÉS
Orthotrichaceae, morphologie, mousses, Nouvelle-Calédonie, lectotypification, combinaison nouvelle.

INTRODUCTION

In our current state of knowledge, four genera of Orthotrichaceae are present in New Caledonia, *Macromitrium* Brid. being, by far, the most species rich, besides *Desmotheca* Lindb. and *Leratia* Broth. & Paris with one species each one and *Schlotheimia* Brid. with three species (Thouvenot & Bardat 2010). Following the most recent literature (Thouvenot 2018), *Macromitrium* is one of the richest moss genera in New Caledonia, including 46 names. The first species found in the country, *Macromitrium brachypodium* Müll.Hal., has been described by Müller (1857), followed by eight more species by Bescherelle (1873), including *Drummondia villosa* Besch. and *Micromitrium brevicaule* Besch. During the following century, Thériot (1907, 1908, 1909, 1910a, b, 1914, 1921a, b, 1929) and Brotherus (1906, 1909, 1911) added respectively 22 and six new names, including varieties, Cardot (1908) two new species, whilst three species abroad described where added to the region (Brotherus 1911; Vitt *et al.* 1995, Pursell & Reese 1982). In their check-list of New Caledonian mosses, Pursell & Reese (loc. cit.) listed 45 names, whilst Thouvenot & Bardat (loc. cit.) quoted 43 specific or infra specific taxa, of which 32 were endemic. More recently, Thouvenot & Yong (2015), Thouvenot & Müller (2016) and Thouvenot (2018) added three new species. The current review retains 24 species or infraspecific taxa.

New Caledonian *Macromitrium* taxa have never been revised in an extensive way, whilst complete studies of the genus were achieved in New Zealand (Vitt 1983), Australia (Vitt & Ramsay 1985a, b) and Papua New Guinea (Vitt *et al.* 1995). These papers are of great interest for the knowledge of the genus in New Caledonian context, especially in drawing evolutionary patterns, taxonomic methodology and morphological overviews including their ecological meanings. During these studies, researches included some New Caledonian types and other specimens so that D.H. Vitt was able to identify synonymies and to select lectotypes of New Caledonian species. Then unpublished, these lectotypes are included here with reference to D.H. Vitt's annotations *in Schedae* inserted in the specimen pockets. On another hand, the studies of Chinese *Macromitrium* add some important views, especially in the group of species with multi-layered upper cells (Guo & He 2014). In this context, the notes *in Schedae* let by S. Guo at PC were useful. In addition, researches of J. Wilbraham & Ellis (2010; Wilbraham 2016) on the African Orthotrichaceae provide an interesting light on some New Caledonian species.

MATERIAL AND METHOD

To carry out this study, we checked the type specimens conserved in the bryophyte general herbarium at PC, especially from the Bescherelle's, Thériot's and Cardot's herbaria, as well as duplicates of Le Rat's collections that E.G. Paris sent to Brotherus and thus represent putative isotypes for species described by Brotherus. Paris' herbarium is conserved at Rennes University (REN). In addition, we checked some types from Helsinki (H-BR) and Edinburg (E) and reviewed the informations and pictures of the type specimens included in virtual herbaria: New York Botanical Garden Steere Herbarium, National History Museum Data Portal (BM), Muséum national d'Histoire naturelle (PC). When significant original samples were chosen, lectotypes were designated and complete descriptions provided for all the species originally defined. Then we could check more than 200 recent specimens gathered between 2003-2016 by L. Thouvenot, F. Müller and J. Larraín in addition to older herbarium specimens at PC. Unless otherwise specified, all the selected specimens are kept in the author's private herbarium with duplicates in PC.

For the type specimens, branches in dry and wet habits, dwarf male plants, sporophytes, perichaetia and vaginulae were observed and measured under stereo microscopes, a few leaves were taken from the middle of branches in order to describe their shape and areolation. When recent specimens were available, each one was described in all details, and parts which could not be dissected from the type specimen, e.g. perichaetium or capsule features, was used for present descriptions.

Since we have not access to molecular analysis facilities, our study is only based on the morphological characters, but we are aware of its limits regarding to present taxonomic methodologies involving molecular features and phylogenetic analysis process. However, considering the need of clarification in a more than one century old nomenclature and pendant more accurate reviews which may wait many years to be undertaken, we propose this provisional overview of *Macromitrium* in New Caledonia which obviously deserves better. Nevertheless, we hope that our analysis could contribute to improve the knowledge of the bryophyte place in the biodiversity of this region, a widely recognized hot spot (Myers *et al.* 2000; Von Konrat *et al.* 2008).

MORPHOLOGICAL NOTES

The morphological characters used to describe and differentiate *Macromitrium* species are well commented in Vitt (1983) and Vitt & Ramsay (1985a, b). We believe unnecessary to give a further detailed review and we only develop here some of them with special interest for New Caledonian species. Then we will define artificial morphological groups bringing together species with similar sets of striking characters, in order to propose synonymies beside patterns of characters useful to differentiate good species.

Morphological characters

Branch and seta sizes

The branch and seta sizes are more or less variable in most species, but combinations of these two features can be helpful to separate some groups, especially those with extreme modalities: both branch and seta sizes are very short, less than 6 mm long, in *Macromitrium brevicaule* (Besch.) Broth, *M. brachypodium, M. sarasinii* Thér. (*M. hemitrichodes* var. *sarasinii* (Thér.) Thouvenot, new combination) or *M. aurescens* var.

caledonicum (Thér.) Thouvenot whilst both are longer, more than 25 mm long, in *M. pulchrum* Besch. or *M. cardotii* Thér. Short setae and long branches are characteristic of *M. leratii* Broth. & Paris, *M. salakanum* Müll.Hal. or *M. laevigatum* Thér. and the opposite characterize *M. microstomum* (Hook. & Grev.) Schwägr. or *M. renauldii* Thér. The setae are very short in *M. brachypodium* and this species shows the only case of emergent capsule, whilst in all other New Caledonian species capsules are exserted. In the key to species, limit values are given so that, in the New Caledonian context, species groups could be separated without overlap. As branch sizes are usually very variable along a same stem, depending on their development stages, only the most mature branches, when present the fertile ones, have to be considered. (See Appendix 1).

Branch leaf habits

In *Macromitrium*, the habits are usually very different in dry and wet conditions since hydration makes the leaves spreading away from the axis in various degrees. This behaviour is common in the plants tolerating successions of drying and moist periods, as it is often the case in corticolous habitats. The moist habit allows some discriminations at first glance e.g. in *M. pulchrum* var. *pulchrum* vs *M. pulchrum* var. *neocaledonicum* (Besch.) Thouvenot or *M. francii* Thér. vs *M. pilosum* Thér., but the dry habit is so far the most useful. When drying, the leaves are twisting with their apices curving inward in various ways or not, so that, when dry, the branches may have either a rope like habit when their leaves are tightly appressed, erect directed or spirally coiled, the apices then usually straight or slightly incurved, hidden between the neighbouring leaves; or a curly or shaggy appearance when the leaves remains loosely erect or unevenly coiled around the branches, more or less individually twisted, with their apices incurved to circinate and side or backward directed. Although variable in some species, the dry habit is a useful feature for identifying most of the *Macromitrium* species (Figs 1, 2).

Branch leaf shapes

The branch leaves are mostly lanceolate in outline, usually with a wider lower part, oval to oblong, and a narrower upper part lanceolate to ligulate. The smaller species tend to have oblong, ligulate or oval to short lanceolate leaves. In some specimens, the leaves are typically long ligulate e.g. *Macromitrium ligulaefolium* Broth., *M. villosum* var. *intermedium* Thér. The lamina width usually decreases shortly in upper end, but some species like *M. cardotii*, *M. humboldtense* Thouvenot & Frank Müll., *M. larrainii* Thouvenot & K.T.Yong, *M. leratii,* have significantly long acuminate laminae. The leaves are often carinate, sometimes strongly so that they cannot be flattened under cover glass with strong costae protruding on back. But soft leaves are a characteristic feature of *M. humboldtense*.

Upper cells arrangements

The upper cells are usually single-layered and unevenly lined up, but some striking arrangements are very distinctive. *Macromitrium tongense* Sull. and the New Caledonian taxa related to have an original set of multi-layered upper cells which has often be over-looked by the authors of the original diagnoses: additional cells are disposed in patches on both sides of a lamina made of cells in staggered files. The fragile apices of *M. leratii* are typically two-layered in some extent. The single-layered laminae of *M. renauldii* and *M. taoense* Thér. have upper cells arranged in regular rows with transverse walls inconspicuous so that they look like continuous bands of rounded lumina. In addition, *M. leratii* and *M. laevigatum* have upper cells arranged in lines.

Upper cells characteristics

The upper cells are usually small and isodiametric, but their shape features are of high importance to separate the species. The lumen shapes, used to characterize the cells, may be quadrate, rounded, oblong. The walls are usually medium thick, and the external ones may be flat or bulging. In some specific cases they are strongly thickened and high protruding on both sides. They can be smooth or with several more or less conspicuous papillae, rounded or acute, never single-papillose. The upper areolation is usually opaque, light to olive green, eventually more or less red tinged, gradually lightening in transitional part.

Basal cells

The relative extent of the characteristic basal cells may be distinctive and measured as a proportion of the whole length. The characteristic basal cells are long rectangular to linear, put in longitudinal files, smooth or with single papillae, low rounded to high conical, which are usually scattered or disposed in files, especially along plicae or margins. Typically, the papillae are usually denser toward the top, aside the transitional part, and often lacking in the extreme basal ranks. Rarely they are numerous thorough. The cell walls are medium-thick or very thick, either evenly so and the lumina are straight, or unevenly so and the lumina are sinuous, curved to sigmoid. The lumina are straight in most New Caledonian species, but some cells with sinuous lumina are present in *Macromitrium hemitrichodes* var. *sarasinii*, *M. leratii*, *M. renauldii*, *M. salakanum*, more obviously in *M. laevigatum*, *M. taoense* and *M. tongense* Sull. When the lower areolation is few differentiated, the cells in lower part are oblong to short rectangular like the intermediate cells, but in many cases, there are a few ranks of basal cells sharply longer with porose and papillose walls in *M. aurescens* var. *caledonicum*, *M. francii* and *M. pilosum* but smooth in *M. brachypodium* and *M. brevicaule*.

Apices and costae

The apices are mostly short acute to obtuse with the costae percurrent or ending in apiculi or short excurrent in mucrones. The distinguishing features are: 1) apices varying from obtuse to rounded, at most retuse, especially when the leaves are ligulate in the whole or only in the upper lamina, e.g. in *Macromitrium brachypodium*, *M. ligulaefolium*, *M. pulchrum* var. *neocaledonicum*; and 2) long excurrent costae in the aristate species which are significantly many in New Caledonia in comparison to neighbouring countries: *M. humboldtense*, *M. larrainii*, *M. panduraefolium* Thouvenot and *M. rufipilum*

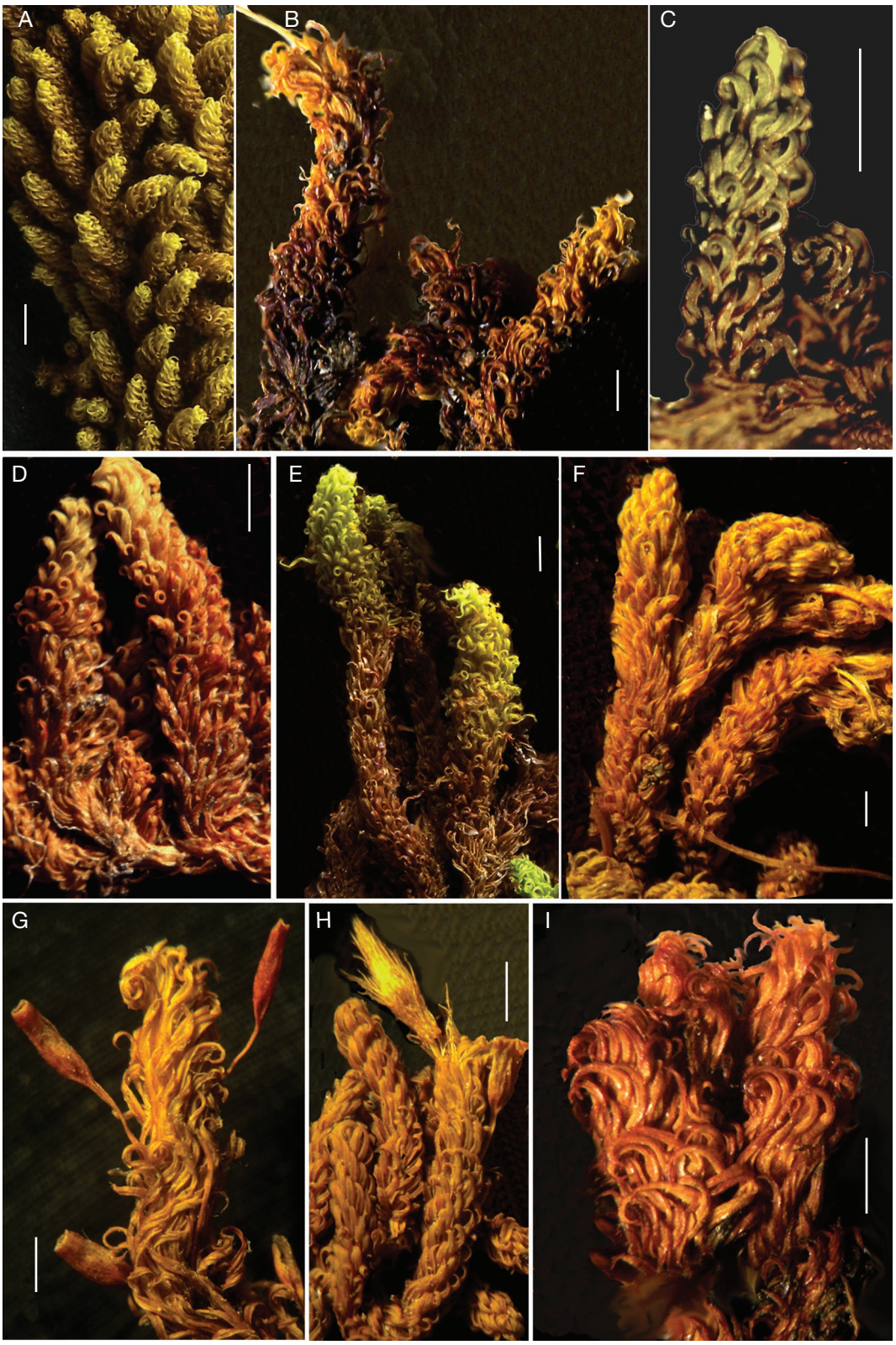

Fig. 1. — Dry branch habits of *Macromitrium* Brid. (I) **A**, *M. microstomum* Hook. & Grev.; **B**, *M. cardotii* Thér.; **C**, *M. francii* Thér.; **D**, *M. laevigatum* Thér.; **E**, *M. leratii* Broth. & Paris.; **F**, *M. taoense* Thér.; **G**, *M. plicatum* Thér.; **H**, *M. pilosum* Thér.; **I**, *M. pulchrum* Besch. From type specimens (**B**, **D**, **F-I**), from specimens *Thouvenot NC881* (**A**), *NC2379* (**E**), from specimen *Coulerie COU85* (**C**). Scale bars: 1 mm.

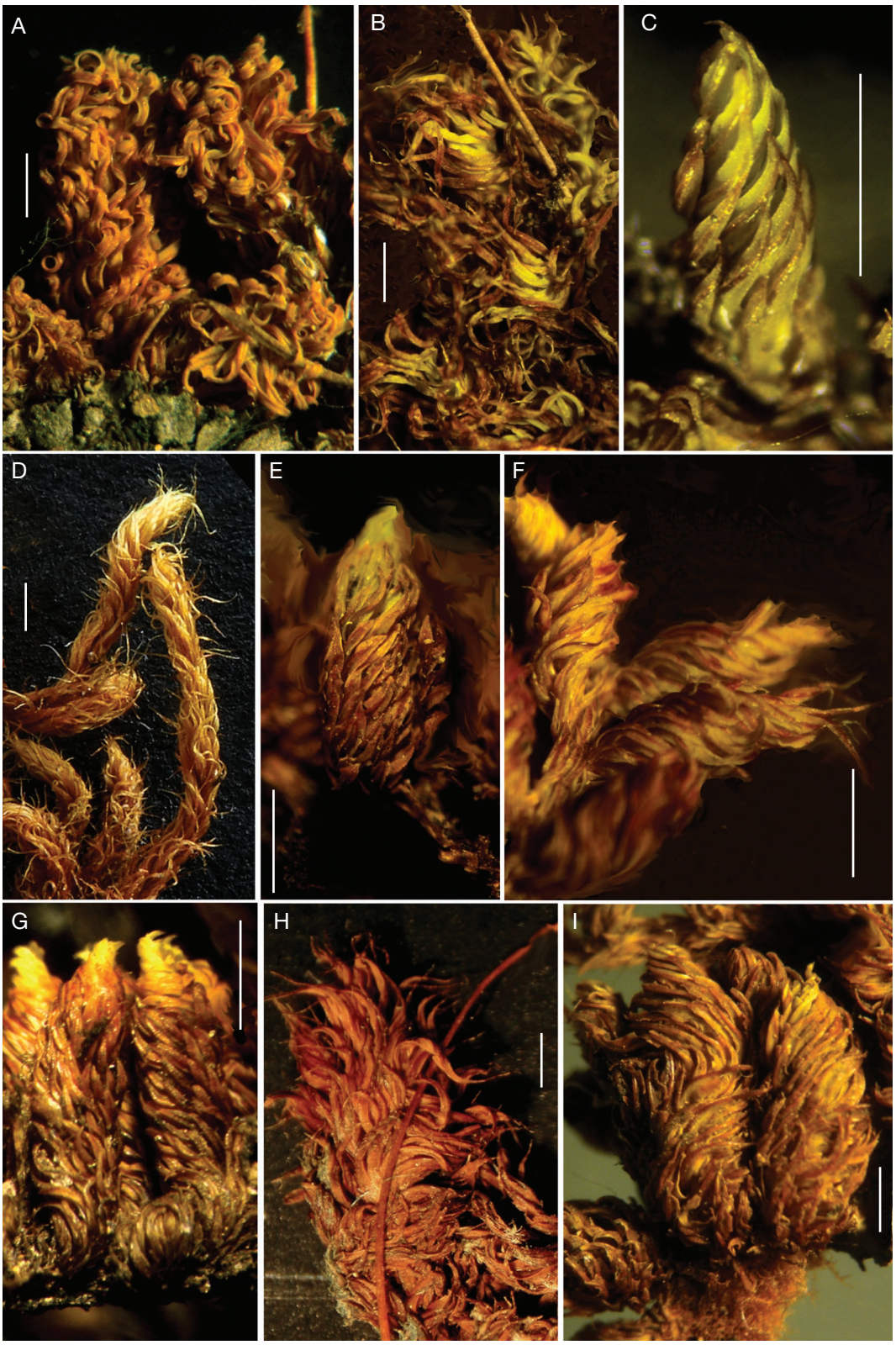

Fig. 2. — Dry branch habits of *Macromitrium* (II) **A**, *M. sarasinii* Thér.; **B**, *M. humboldtense* Thouvenot & Franck Müll.; **C**, **F**, *M. panduraefolium* Thouvenot; **D**, *M. larrainii* Thouvenot & K.T.Yong; **E**, *M. tongense* Sull.; **G**, *M. subvillosum* Broth. & Paris; **H**, *M. rufipilum* Cardot; **I**, *M. aurescens* var. *caledonicum* (Thér.) Thouvenot. From type specimens (**A**-**D**, **F**, **H**, **I**), from specimens *Müller NC755* (**E**), *NC764* (**G**). Scale bars: 1 mm.

Cardot. Besides, *M. cardotii*, *M. pulchrum* var. *aristatum* Thér. and *M. plicatum* var. *aristatum* Thér. have a relatively shorter aristae, less than 100 µm long, a size which may be accepted as a limit for the character "aristate" being distinctive.

Note
The characters of stem leaves are omitted in the descriptions below since they have a low diagnostic value in that context.

Morphological groups
Group of species with aristate leaves
In New Caledonia, five species possess leaves with conspicuous aristae: *Macromitrium humboldtense*, *M. larrainii*, *M. panduraefolium*, *M. rufipilum* and *M. pulchrum* var. *aristatum*. The first two species have narrow long acuminate leaves whereas the others have leaves with obtuse to short acute apices. Only *Macromitrium larrainii* have completely smooth leaves; it shares a large branch length with *M. pulchrum* var. *aristatum*, but the latter have leaves with strongly papillose upper cells in addition to obtuse apices. *Macromitrium rufipilum* has medium sized branches, oblong-ligulate leaves with widely obtuse to rounded apices. M. *humboldtense* and *M. panduraefolium* both have short branches but differ in habit, the first showing a shaggy appearance with soft leaves loosely patent, contorted so that the aristate apices are unevenly spreading whereas the second have branches fusiform with the leaves tightly spirally appressed. Thouvenot (2018) give a key to the aristate species of New Caledonia and neighbouring countries (Australasia, Malesia, Pacific Islands) and Thouvenot & Müller (2016) a comparative table for the four New Caledonian aristate taxa known at that time.

Long excurrent costae and a reddish colour are linked to ecological constraints in the habitats in high altitude (Vitt & Ramsay 1985; Thouvenot & Yong 2015). In addition, the endemism of the bryophytes in the tropical islands increase with the elevation (Enroth 1990) and New Caledonia is notorious to host many micro-endemic species due to its elongated shape, rough relief, varied geology and morpho-geological history (Grandcolas *et al.* 2008). Therefore, most of these species are candidate to a micro-endemic status.

Francii *group*
Macromitrium francii, *M. pilosum* and var. *brevifolium* Thér., *M. koghiense* Thér. and var. *spiricaule* Broth. & Paris, *M. subsessile* Broth. & Paris, *M. contractum* share an important set of morphologic characters, some of them being also found in *M. orthostichum* Nees ex Schwägr. and *M. brachypodium*. We emphasize the small size of these plants, especially the setae, the vaginula long hairs reaching the capsule, the calyptrae with erect long hairs, conspicuously spreading only in *M. orthostichum*, the short branch leaves, ovate-lanceolate in outline, with obtuse apiculate to mucronate apices, the very reduced basal part, hardly occupying 1/10 the whole length of the leaves, the relatively short basal cells with lumina fairly wide, 15-30(-35) µm long, (5-)7-10 µm wide, sparsely to densely unipapillose. The species of this group have medium to low but always present basal papillae. That excludes *M. brachypodium* whose leaf basal parts are thoroughly smooth. Moreover, this species has longer ligulate leaves and naked vaginulae. Conversely, *M. orthostichum* has strong basal papillae and can be distinguished by the spreading hairs of the calyptrae. A few more species could be confused with this morphologic group: *M. ligulaefolium* have thicker branches, leaves longer with a different outline, narrowly lanceolate to ligulate and basal cells longer, occupying a short but conspicuous basal part, M. *involutifolium* var. *involutifolium* (Hook. & Grev.) Schwägr. is a larger plant with branches reaching 15 mm long, leaves 2-3 mm long and cylindrical capsule on setae up to 5 mm long.

Thériot (1907) described *M. francii* and *M. pilosum* in the same paper distinguishing the latter by wet branch leaves spreading-recurved versus erect-incurved, smaller cells, 6 µm wide versus 8-10 µm and narrower lumina of the basal cells, well differentiated from intermediate cells, in contrast to *M. francii,* in which they remain shorter and wider, similar to the intermediate ones. In the field, we were able to observe recurrently these differences. *M. francii* in dry conditions has erect and twisted leaves with incurved to circinate apices exposed by the side so that the branches are curly, whereas in wet condition, they are erect-patent with the upper part somewhat incurved. *M. pilosum* in dry conditions has erect-appressed leaves displaying the back with incurved apices directed adaxially, often hidden between the neighbouring leaves so that the branches are funiculate, whereas in wet conditions, they are spreading and more or less recurved.

The difference in leaf orientation is linked to the adaptation to moisture conditions in the habitat (Bowen *in* Glime 2006). Therefore, this feature is here considered with attention given its putative significance in the evolution process of the genus. The same view will be adopted in the *Pulchrum* group: in a conservative way, we keep apart both species because of their striking habit difference, but they could turn to be merely forms of the same species following further phylogenetic studies.

All the types of the other species in this group are similar to *M. pilosum* with the following minor differences if any: shorter branches in *M. koghiense* but not in the var. *spiricaule*, or smaller cells in *M. subsessile* Broth. & Paris. Therefore, they will be reduced in synonymy.

Leratii *group*
Macromitrium leratii, *M. salakanum* and var. *majus* are very similar at first glance and look also like *M. semperi* Müll.Hal. which was cited by Vitt *et al.* (1995) but without precise reference in New Caledonia. Their common features are: 1) large plants with long and robust curly branches usually 10-20 mm long in normal forms; 2) leaves long and narrow, more than 2 mm long; 3) areolation with small papillose upper leaves, arranged in longitudinal rows and long smooth basal cells with sinuous lumina; 4) setae short to medium, 2.5-4(-8) mm long; 5) vaginulae and calyptrae naked (top of calyptra slightly hairy in *M. salakanum*); and 6) perichaetial leaves conspicuously sheathing the seta bases.

Macromitrium leratii is very frequent in New Caledonia and can be found in various ecological conditions so that it

varies in size and shape. The type and some fresh specimens observed are characterized by long branches up to 40 mm long and reddish colour, but depauperate forms are green and smaller and can easily be confused with *M. salakanum* or *M. semperi*. The most faithful character for distinguishing *M. leratii* is the locally bistratose top end of the vegetative leaves, whereas the latter two have single-layered cells thorough. In addition, *M. leratii* is distinct from *M. semperi* by the perichaetial leaf apices obtuse to rounded and mucronate, like in *M. salakanum,* instead of shortly acuminate and cuspidate, and from *M. salakanum* by the calyptrae fully naked instead of sparsely haired on the top. Contrary to that has been earlier stated, colour and size of branches and setae are variable and cannot be used to differentiate *M. leratii* from these morphologically close species.

M. plicatum Thér. and its varieties (here synonyms of *M. involutifolium* subsp. *ptychomitrioides* (Besch.) Vitt & H.P.Ramsay and *M. laevigatum* superficially look like this group of species but the former is easily distinguished by smooth upper cells and hairy calyptrae and the latter by shorter leaves which are strongly sub-duplicate in upper part and remain incurved when moist.

Pulchrum *group*

Macromitrium pulchrum, and its varieties, *M. neocaledonicum* Besch., *M. cardotii* and *M. rufipilum* share many morphological characters: 1) medium to large plants, brown to olive green, often red tinged, densely branched, branches simple or with fastigiated branchlets, thick and obtuse, medium to long, branch leaves when dry loosely appressed to erect, individually twisted, with incurved to circinate apices oriented to the side so that the margin is exposed; 2) branch size ranging (4-)8-16(-20) mm long, up to 25 mm in *M. neocaledonicum*; 3) branch leaf large, (2.2-)2.5-3.6(-4.5) mm long; 4) branch leaf areolation very constant: upper cells relatively large, unevenly so in a same leaf, (7-)10-20(-30) µm long, round to ovate or oblong, strongly bulging, the external wall protruding, convex to conical, with small papillae simple or branched, basal cells linear with thick walls, narrow straight lumina and rounded single papillae scarce, concentred in upper basal part, margins or plicae; 5) perichaetial leaves little differentiated, not sheathing the setae bases; 6) vaginulae with short paraphyses, without long conspicuous hairs; 7) calyptrae naked; 8) setae large 15-30 (-35) mm long; and 9) capsules oblong, 1.5-2 mm long, with plicate and narrowed rim.

We emphasize the areolation characters of this group of plants in association with the branch sizes, the dry habits, the leaf and seta sizes. The differences emphasized by the authors concern few characters, which will be addressed in detail in the respective paragraphs. In this way, *M. neocaledonicum* differs from *M. pulchrum* mainly by a difference in the leaf habit in wet condition. As stressed in the paragraph on *Francii* group, this feature is considered as significant. *M. cardotii* and *M. rufipilum* are more easily differentiated: the former has a characteristic leaf shape and the latter long aristae and more widely obtuse leaf apices.

Since all but *M. pulchrum* are known from a few specimens, their specific status need further studies with more material and molecular insight. Meanwhile, we propose below to keep these plants apart with specific or varietal status.

Villosum *group*

M. villosum (Besch.) Broth. and its varieties, *M. densifolium* Thér., *M. ludoviciae* Broth. & Paris, *M. chrysoneuron* Müll. Hal., *M. subvillosum* Broth. & Paris from New Caledonia, *M. tongense* from Tonga and Fiji Islands, *M. tahitisecundum* Margad. from Society Islands are very similar and belong to a group of species characterized by short branches, setae short to medium, and above all, a special organization of the upper cells, with patches of small spherical papillose cells more or less densely scattered on both surfaces of the upper half of laminae, so that transverse sections of the laminae are irregularly one- to three-layered. More species in the world have these features and are the subject of current researches. For example, *M. serpens* (Burch. ex Hook. & Grev.) Brid. from Africa (Magill & Van Rooy 1998) is easily distinguished by the branch habit when dry, curly with leaves twisted and circinate at apices, instead of spirally arranged with leaves obliquely appressed; *M. nepalense* (Hook. & Grev.) Schwägr. has lower cells short rectangular with straight lumina (Guo & He 2014).

Differences between the types of the New Caledonian names are reviewed below. The numerous taxa described under various names is an example of the past attempts to describe the diversity of forms at species level. In this group, the most important common character, the multi-layered cell organization in the upper parts of the branch leaves, has been overlooked by almost all the former authors (Guo & He 2014), so that minor characters were emphasized for distinguish the taxa. Actually, the diversity in the names expresses the variability inside a continuum which should be better seen as a single species. The earlier name is *Macromitrium tongense* whose specimens exhibit a well-developed areolation of multi-layered upper cells; at the other extreme of the range of variation in areolation complexity, *Macromitrium subvillosum* and *M. villosum* var. *intermedium* Thér. have a nearly single layer with a few patches of superficial cells at the leaf apex or none.

TAXONOMIC TREATMENT

Macromitrium Brid.

Muscologia Recentiorum, Suppl. 4: 132 ('1819') [1818].

Description

For the genus type description, we refer to Vitt (1983) and Vitt & Ramsay (2006). We only mention below the main distinguishing features in the New Caledonian context. *Macromitrium* plants are epiphytic on trunk, branches or twigs, rarely saxicolous, characterized by: 1) creeping stems

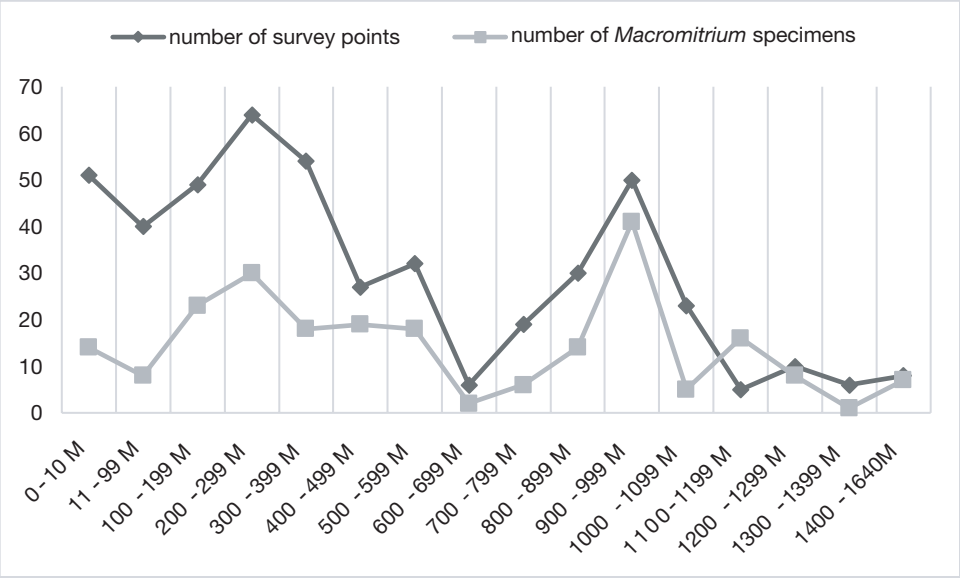

Fig. 3. — Frequency of the *Macromitrium* Brid. species compared to the collecting efforts inside the altitudinal classes.

giving rise to dense upturned branches, simple to bifurcate, rarely fastigiated; 2) stem and branch leaves usually different in shape; 3) branch leaves with different habits in dry and moist conditions, when wet usually straight to recurved or sigmoid, more or less widely spreading, when dry the various arrangements are important for species discriminating; and 4) branch leaf areolation usually different from top to down, typically with three different parts, this pattern being very useful to identify the species: – upper part usually single-layered, rarely multi-layered in patches or limited to apices, opaque, green to red tinged, with cells isodiametric to short oblong, flat or bulging, usually with a few small papillae, rarely smooth, mostly irregularly arranged, less frequently in regular longitudinal files, – transitional part short or long, variously green becoming colourless top-down, unfrequently null with abrupt transition to lower part, possibly reaching the base in some groups of species, transitional cells progressively longer toward base, oblong to short rectangular, with single papillae, rarely smooth; – lower part developed or not, then reduced to a few elongate cells in one or few basal rank, when developed colourless, with more or less elongate cells, rectangular to linear, thick-walled or not, regularly so or not, in relation to lumina wideness and orientation, straight, curved or sinuous, papillae single, rounded, low to high, usually scattered, aligned or not on plicae or margins, more rarely dense or absent; 5) costae single, strong to thin, reaching the apices, percurrent, often excurrent in mucrones, less frequently in more or less long aristae; 6) margins plane, in some case narrowly recurved in one side at base, at most crenulate-papillose in upper part, rarely smooth, usually smooth in basal part, or with scattered papillae; 7) when known, sexual condition pseudautoicous, very rarely autoicous, dwarf male plants present on the female branches, at vegetative leaves axils; 8) perichaetia are significantly conspicuous when exceeding the vegetative leaves, sheathing or not the seta bases, more often inconspicuous, perichaetial leaf size being then similar to the vegetative ones or smaller; when differentiated, perichaetial leaves larger or not, mostly hyaline, the short celled, opaque upper tissues restricted to small part below the apices, papillose or not; 9) setae upright, straight to sinuous, either medium to long and thin and twisted to the left or short and thick untwisted or shortly below the urn; 10) vaginulae either naked, possibly with short paraphyllae, or hairy with conspicuous long hairs visible among the perichaetial leaves or longer, sometimes reaching the capsule; 11) calyptrae large, mitrate, usually covering a large part of the capsule, very rarely conspicuously shorter, naked or with more or less dense hairs, erect or rarely bristling; 12) capsules erect, ovoid, elliptic or unfrequently cylindrical, rims contracted or not, plicate or smooth, erect or incurved, rarely collapse, brownish or concolorous; 13) peristomes single or absent, teeth sometimes very short or caducous or reduced to short membranes; and 14) spores papillose, usually anisomorphic, rarely isomorphic.

Biogeography

Genus *Macromitrium* is a pantropical-southern temperate genus (Vitt & Ramsey 1985b). In an historical view, the xerophytic preadaptation of this genus favoured its success in colonizing relatively xeric habitats in rain forests (Vitt & Ramsay 1985b). Like in Australia, a group of species, all small sized, are found in coastal habitats, sometimes subject to salt spray (*M. brachypodium*, *M. brevicaule*, *M. tongense*, *M. ligulaefolium*) but only *M. brevicaule* is restricted to such habitats. On the other hand, leaves of the species limited to cloud forests and scrublands at highest elevations (*M. humboldtense*, *M. cardotii*, *M. larrainii*) are usually large and aristate. But in most cases, *Macromitrium* species inhabit habitats mesic to wet in a wide range of elevations and vegetations, usually in moderate to light exposure (canopy, bushes, edges, open

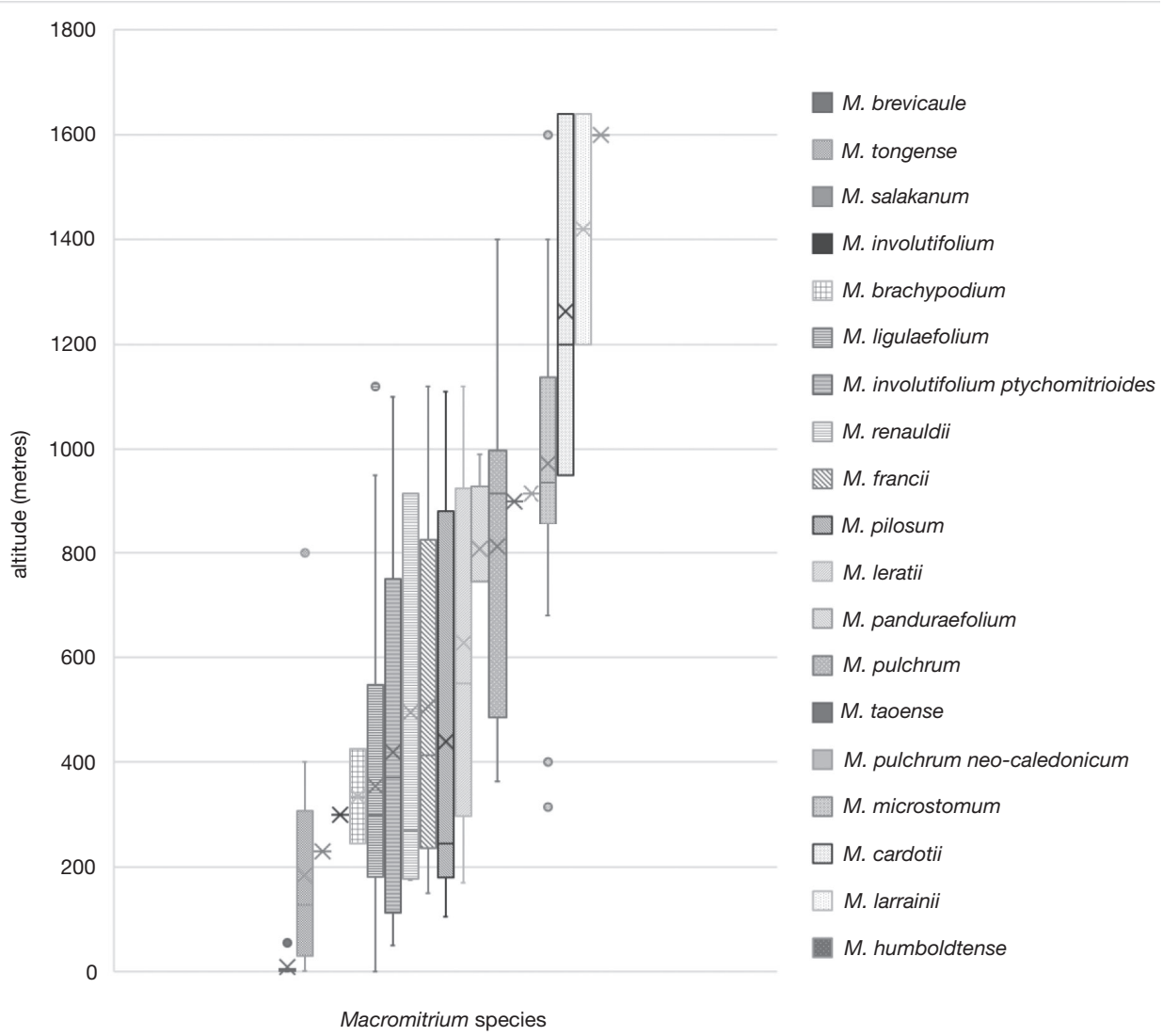

Fig. 4. — Altitudinal range of New Caledonian *Macromitrium* Brid. (Species *M. aurescens* var. *caledonicum* (Thér.) Thouvenot, *M. laevigatum* Thér., *M. hemitrichodes* var. *sarasinii* (Thér.) Thouvenot and *M. rufipilum* Cardot not shown due to the lack of data).

forests, gallery forests). Their distribution in New Caledonia can be consulted on the web site of the organisation Endemia (http://endemia.nc/flore/fiche6935).

The altitudinal graph (Fig. 3) shows a weaker presence of *Macromitrium* plants at the lowest elevations, below 500 m. Regarding the specific diversity with respect to the altitudinal ranges (Fig. 4), the majority of the species occurs in lowland and medium elevation, avoiding coastal area, with a first group between 50 and 1200 m (lowland, hills and medium mountains): *M. involutifolium* subsp. *ptychomitrioides*, *M. renauldii*, *M. francii*, *M. pilosum* and *M. leratii*, together with *M. ligulaefolium* which may be found down to the coastline, and a second group somewhat more alticolous, avoiding lowland and reaching 1400 m or more: *M. pulchrum* and *M. microstomum,* together with the rare *M. panduraefolium* and *M. taoense*. At the lowest end of the altitudinal range, below 400 m, we find a group of lowland species with the most frequent *M. tongense* exceptionally reaching 800 m, *M. brachypodium* and the coastal *M. brevicaule.* In the same area, *M. salakanum*, *M. involutifolium* subsp. *involutifolium* and *M. aurescens* var. *caledonicum* are very rare species each one only known from a single specimen collected in lowland areas. On the opposite, a few species constitute a group of alticolous plants occurring above 950 m: *M. cardotii*, *M. larrainii* and *M. humboltense*, the two latters being known only from very scarce specimens (Appendix 2).

Among the 24 taxa of New Caledonian *Macromitrium*, the rate of endemism remains high (50%) since eleven *Macromitrium* species and three varieties are endemic. Five more occur also in scattered places in Australasia, two in South-western Pacific, the remaining spread across Malesia-Melanesia (1), Australasia-Indonesia (1), Paleotropical (1) and Pantropical (1) areas.

Key to the *Macromitrium* Brid. species in New Caledonia

1. Branch leaves long aristate, aristae ≥ 0.1 mm long 2
— Branch leaves muticous, apiculate or mucronate, if aristate, aristae < 0.1 mm long 7

2. Small species, most branches less than 10 mm long (with respect to the most developed, mainly fertile branches) 3
— Larger species, most branches more than 10 mm long (condition as above) 4

3. When dry, branches fusiform, leaves carinate, tightly spirally coiled ..... *M. panduraefolium*
— When dry, branches shaggy, leaves soft, unevenly erect-patent ..... *M. humboldtense*

4. Leaves smooth thorough, lanceolate, long narrowed into asymmetrical acumina ..... *M. larrainii*
— Leaves papillose, lanceolate to ligulate, acute to obtuse-rounded 5

5. Aristae reddish, at least some over 0.5 mm long, leaves ligulate with obtuse to rounded apices ..... *M. rufipilum*
— Aristae variously coloured, less than 0.3 mm long, leaves lanceolate with acute to narrowly obtuse apices 6

6. Leaves narrowly lanceolate to sub-triangulate, narrowed from shortly above the bases into long narrow acumina ..... *M. cardotii*
— Leaves lanceolate, widest above ⅕ leaf length above the base, with wider acumina, abruptly acute ..... *M. pulchrum* var. *pulchrum pro parte*

7. Plants small, branches ≤ 12 mm long (with respect to the most developed, mainly fertile branches) 8
— Plant medium to large, branches > 12 mm long (condition as above) 20

8. Upper part of leaves multi-layered, at least in patches or in the apices, superficial cells rounded and pluripapillose ..... *M. tongense*
— Leaves single-layered thorough 9

9. Leaves tongue-like, apices rounded to truncate, fusiform gemmae present on leaves, calyptrae naked, branches ≤ 3mm long ..... *M. brevicaule*
— Leaves oblong, lanceolate to ligulate, apices acute to obtuse, gemmae absent, calyptrae hairy, sometimes rarely so, branches > 3 mm 10

10. Setae shorter < 1.5(-2) mm long 11
— Setae longer > 2 mm long 13

11. Leaves ligulate, basal cells short, c. 2 × longer than wide, smooth, vaginulae naked, branches ≤ 5 mm long; rare plant from lowest altitudes ..... *M. brachypodium*
— Leaves oblong to lanceolate, a few basal cells longer, at least 3 x longer than wide, someone papillose, vaginulae long hairy, normal branches 5-7 mm long; plants frequent at all altitudes 12

12. When dry, branches curly, twisted leaves loosely erect with incurved to circinate apices directed to the side, in wet condition leaves erect-patent ..... *M. francii*
— When dry, branches funiculate, leaves erect to appressed, incurved apices adaxially directed, the upper ones somewhat twisted, in wet condition leaves spreading recurved ..... *M. pilosum*

13. Branches funiculate when dry, with leaves spirally coiled, apices straight or slightly incurved 14
— Branches not funiculate when dry, with leaves unevenly erect-patent, individually twisted, apices incurved to circinate 15

14. Branches thin, regularly rope-like, leaves twisted together, arranged in bands spirally coiled around the branches, upper cells smooth, setae long, 5-30 mm long, calyptrae naked, plants frequent at all altitudes ..... *M. microstomum*
— Branches short, not so thin, leaves individually coiled around the branches, upper cells papillose, setae short, < 5 mm long, calyptrae hairy, rare lowland species ..... *M. aurescens* var. *caledonicum*

15. Upper cells smooth, arranged in continuous longitudinal rows, setae long up to 25 mm long 16
— Upper cells papillose or, if smooth, not in continuous longitudinal rows, setae shorter ≤ 7 mm long 17

16. Calyptrae and vaginulae hairy, lower cells smooth or with a few single low papillae ..... *M. renauldii*
— Calyptrae and vaginulae naked, lower cells with numerous single high papillae ..... *M. taoense*

17. Leaves long ligulate, obtuse apiculate, 1.2-1.8 mm long, elongate basal cells few with single papillae scarce, branches short, 2-4(-5) mm long ..... *M. ligulaefolium*
— Leaves not long ligulate, elongate basal cells few or not, with many single papillae, branches short to medium, 3-6(-10) mm long 18

18. Setae longer, ≥ 15 mm ..... *M. pulchrum* var. *pulchrum pro parte*
— Setae shorter, < 10 mm 19

19. Calyptrae very hairy, basal hairs wide spreading, leaves ≤ 1.3 mm long, broadly ligulate to short lanceolate, basal cells with wide straight lumina ..... *M. orthostichum*
— Calyptrae with scarce erect hairs, leaves 1.4-2.4 mm long, leaf lower half wide oblong, upper half ligulate to lanceolate, basal cells very thick walled with sinuous or straight narrow lumina ..... *M. hemitrichodes* var. *sarasinii*

20. Lower cells short rectangular or with a few ranks of longer cells at base 21
— Long lower cells occupying a conspicuous 1/3 leaf length 22

21. Capsule with erect rim, peristome present, branches medium sized up to 10-15 mm long ..... *M. involutifolium* subsp. *involutifolium*
— Capsule with collapse rim, peristome absent, branches longer, up to 30 mm long ..... *M. involutifolium* subsp. *ptychomitrioides*

22. Lower cells smooth 23
— Lower cells papillose 25

23. Leaves medium, ≤ 1.7 mm long, upper laminae shortly narrowed in obtuse to acute apices ..... *M. laevigatum*
— Leaves longer, > 1.7 mm long, upper laminae progressively narrowed in a very long and narrow acumen .. 24

24. Calyptrae naked, apices of vegetative leaves partly bi-layered, frequent species ..... *M. leratii*
— Calyptrae sparsely hairy, apices of vegetative leaves single layered thorough, rare plant ..... *M. salakanum*

25. Leaves narrowly lanceolate to sub-triangular, progressively narrowed from shortly above the base, acumina very narrow ..... *M. cardotii*
— Leaves lanceolate to lanceolate-ligulate, widest at ⅕ leaf length or more above the base 26

26 – Leaves erect-patent in moist condition, leaf apices narrowly obtuse to acuminate, short aristate to muticous, branches simple or rarely furcate ..... *M. pulchrum* var. *pulchrum pro parte*
— Leaves spreading-recurved when moist, leaf apices obtuse to rounded, mucronate or not, branches with fastigiated branchlets ..... *M. pulchrum* var. *neocaledonicum*

Macromitrium aurescens var. ***caledonicum***
(Thér.) Thouvenot, comb. nov.
(Figs 2I, 5)

Basionym. — *Macromitrium cylindromitrium* var. *caledonicum* Thér., *Bulletin de l'Académie Internationale de Géographie Botanique* 19: 21 (1909).

Type. — **New Caledonia**. Bourail. (lecto-, designated here *fide* Guo *in* Sched. [2007]: "Bourail, 1905, *Le Rat s.n.*, comm. Franc": PC[PC0083687]!).

Total range. — *Macromitrium aurescens* s.l. occurs in Australia and New Caledonia. The variety *caledonicum* is known only from the type locality in South Province of New Caledonia.

Description

Sexual condition
Unknown, the type variety is pseudautoicous according to Vitt & Ramsay (1985a).

Plant
Small, creeping stems with short branches up to 3-5 (-10) mm long.

Branches
When dry with leaves obliquely appressed, spirally coiled around the axis, strong costae prominent at back, when moist erect to slightly patent.

Branch leaves
1.6-1.8 mm long, 0.35-0.55 mm wide, ligulate to oval-lanceolate, strongly carinate in lower part, apex obtuse mucronate, costae thick, ending just below the apex to short excurrent.

Upper cells
Single-layered, 10-12 µm wide, isodiametric, rounded, bulging, with a few small papillae, intermediate cells quadrate to short rectangular, with a single conical papilla, lower cells in a few basal ranks filling less than 1/10 length of the leaf,

20-30 µm long, 10-12 µm wide, short rectangular with thicker porous walls and unevenly sinuous lumina, some with a single high papilla.

Perichaetial
Leaves more or less similar to the vegetative ones.

Calyptrae
Narrowly cylindrical, 3-5 mm long, hairy.

Setae
Short, 5 mm long, straight to slightly curved, vaginulae with long hairs.

Capsules
Narrowly cylindrical, 2 mm long, with irregularly or not plicate rim, peristome not seen in New Caledonian specimen.

Remarks

In the diagnosis, Thériot (1909) emphasize the leaf length of the New Caledonian plants as the only difference with the Australian *Macromitrium cylindromitrium* Müll.Hal. currently synonym of *M. aurescens* Hampe, whose leaf lengths range from 2 to 2.6 mm (Vitt & Ramsay 1985a). Due to the scarcity of New Caledonian specimens, we cannot decide if the status of variety is valid or not for this plant. But it is likely synonym of the type variety. In addition, ecological requirements seem more or less similar; the type locality of the variety *caledonicum*, Bourail, is situated at low elevation in the south western plain, the driest part of the island, where *Melaleuca quinquenervia* and *Casuarina collina* forests are abundant, while the type variety, a north eastern Australia endemic, is found on barks of *Melaleuca*, *Grevillea* and *Casuarina* at low elevation (Vitt & Ramsay 1985a).

Macromitrium aurescens and its variety share with a handful of species, namely *M. brachypodium*, *M. brevicaule*, *M. francii*, *M. orthostichum,* some typical features as: 1) short branches; 2) short setae; 3) leaves ligulate or oval-lanceolate, short to medium sized; 4) upper cells strongly papillose; and 5) basal cells few, short or long, with a few high single papillae. It differs from everyone by having a narrow cylindrical urn, 2 mm long and sub-conduplicate leaves ending in hooked, cucullate apices. When dry, leaves are spirally whorled around the branches.

The latter character is shared with *Macromitrium brevicaule* which is smaller, has lingulate leaves with fusiform gemmae and naked calytrae.

In addition, *Macromitrium brachypodium* and *M. francii* have shorter setae.

Macromitrium orthostichum is distinct by its stout and prorate setae.

Macromitrium brachypodium Müll.Hal.

Botanische Zeitung (Berlin) 15: 778 (1857).

Type. — **New Caledonia**. "Île des Pins", *Cuming s.n.* (lecto-, H-BR [designated by Vitt & Ramsay, 1985]; isolecto-, PC[PC0096548]!).

Illustrations and description. — Vitt & Ramsay (1985a).

Distribution in New Caledonia. — *Macromitrium brachypodium* is very rare, with only one report in South Province (type locality, Île des Pins) and one in North Province, in a very disturbed environment. Due to the scarcity of the data, its ecological range in New Caledonia remains unknown.

Total range. — New Caledonia and Lord Howe Island. Its occurrence in mainland Australia must be confirmed according to Vitt & Ramsay (2006).

Selected specimen. — **New Caledonia**. Province Nord, Koumac, Tiebaghi ultramafic massif, on bark in small remnant of the moist forest amongst scrubland, in the vicinity of a former mining village, 28.IX.2008, *Thouvenot NC288* (PC).

Description

Pseudautoicous. *Macromitrium brachypodium* may be identified by: 1) small size of branches, less than 6 mm long, 0.8-1 mm wide; 2) branch leaves when dry erect to oblique, individually twisted, the incurved apices exposed by the margins, when wet patent to spreading, slightly sigmoid; 3) branch leaves 1.5-2.5 mm long, ligulate, obtuse to short acute, mucronate; 4) upper cells rounded, 6-8 µm, bulging, thick-walled, with *c.* 4 small rounded papillae; 5) basal part of leaves undifferentiated, with a few short rectangular lower cells, smooth; 6) perichaetial leaves longer than the vegetative ones, 3.5 mm long or more; 7) vaginulae naked; 8) calyptrae hairy; 9) setae very short, 1-1.5 mm long; and 10) capsules oblong, 1-1.3 mm long, smooth, rims erect, not plicate, peristomes single. It could be confused with other small species with little differentiated basal part. For differences with *M. brevicaule* and *M. aurescens*, see under the latter.

Macromitrium francii and *M. pilosum* have longer branches, smaller leaves with papillose basal cells, vaginulae with conspicuous long hairs and capsule mouth plicate.

In addition, *Macromitrium orthostichum* calyptrae have bristly hairs. See discussion in the paragraph dealing with the *Francii* group.

Macromitrium brevicaule (Besch.) Broth.

Naturlichen Pflanzenfamilien I (3): 486 (1903).

Micromitrium brevicaule Besch., *Annales des Sciences naturelles, botanique*, sér. 5, 18: 211 (1873). — Type: New Caledonia. Balade, *Vieillard 1734* (Lecto-, BM [Vitt & Ramsay 1985a]; iso-, PC[PC0096499, PC0108104]!). — *Macromitrium brevicaule* var. *latifolium* Broth. *et* Paris, *nom. herb.* — Type: New Caledonia, "Insula pinorum, cataractorum Koumania", 1909, *Le Rat s.n.* (Reference specimen: PC0096523! *pro parte*).

Illustrations and description. — As *Macromitrium wattsii*: Vitt (1983).

Distribution in New Caledonia. — This lowland species was collected between 0-55 m a.s.l. in North Province (type locality), South Province main island and Île des Pins.

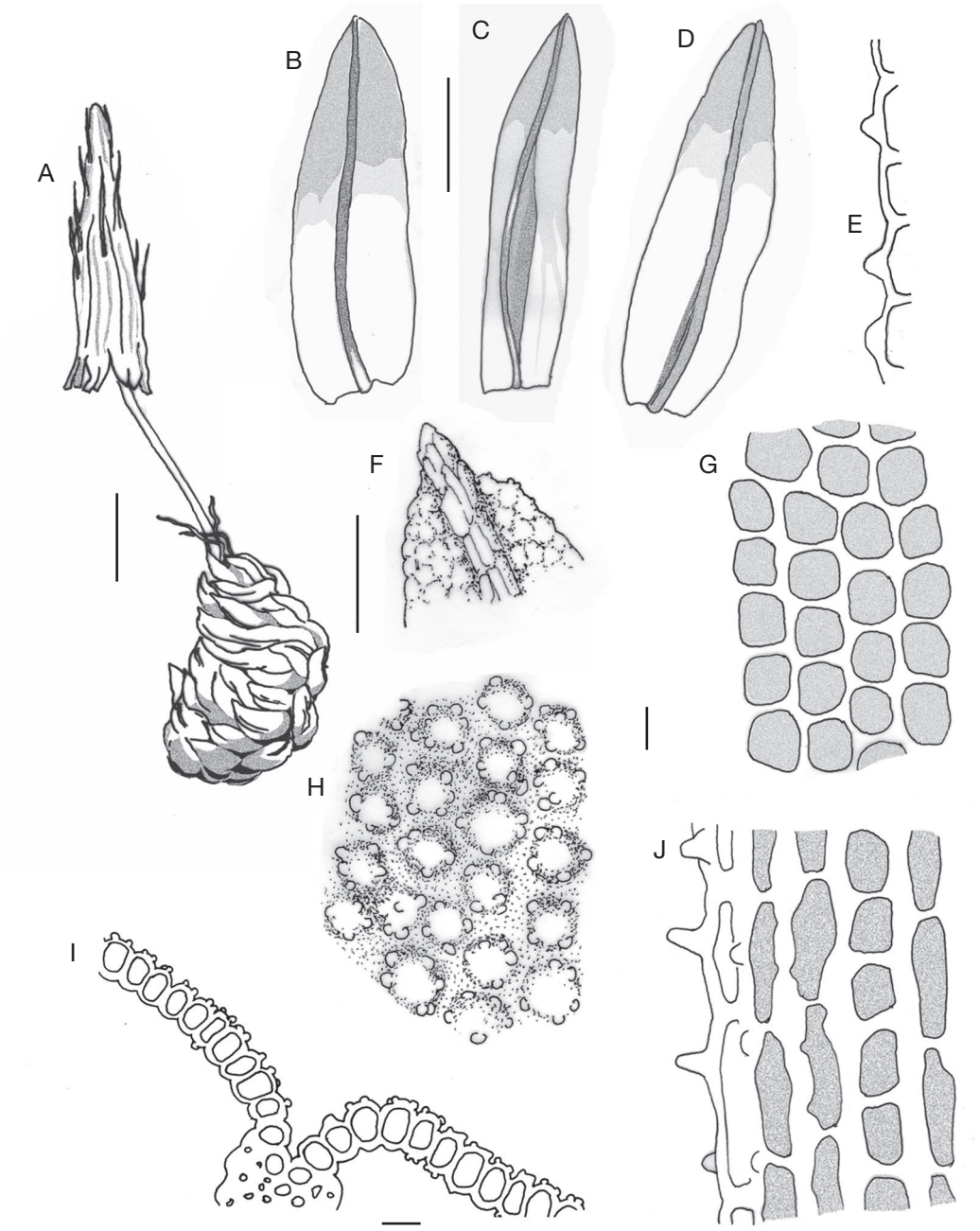

FIG. 5. — *Macromitrium aurescens* var. *caledonicum* (Thér.) Thouvenot: **A**, dry branch with sporophyte; **B**-**D**, branch leaves; **E**, intermediate cells in side view; **F**, branch leaf apex; **G**, transitional cells; **H**, upper cells in surface view; **I**, transverse section in top quarter of branch leaf (fragment); **J**, basal cells. All drawn from the lectotype. Scale bars: A, 1 mm; B-D, 500 µm; E, G, H, J, 10 µm; F, 100 µm; I, 20 µm.

TOTAL RANGE. — Australasia.

SELECTED SPECIMENS. — **New Caledonia**. Province sud, Nouméa, Tina, 24.IX.2012, on calcareous rock in mangrove, 0 m, *Thouvenot NC898*, on bark in dry forest, 5 m, *Larraín 35301*; J.-M. Tjibaou Center, 24.IX.2012, mangrove, 0 m, *Thouvenot NC900*; Yaté, St Gabriel, 22.IX.2008, on *Pandanus* roots in coral islet, 2 m, *Thouvenot NC93* (PC); Bourail, Gouaro-Deva, 25.IX.2008, on bark in riparian forest, 55 m, *Thouvenot NC1121*; on bark in coastal forest, 2 m, *Thouvenot NC1126* (PC); Île des Pins, Kuto, 30.XII.2010, *Guionnet NC505*.

DESCRIPTION

Pseudautoicous

Plant

Small, dark green, creeping stems with dense short branches, (1.5-)3-4 mm long.

Branches

When dry with leaves tightly spirally coiled, carinate with conspicuous white costae, erect-spreading when moist.

Branch leaves
Lingulate, short and wide, 1-1.4 mm long, 0.3-0.5 mm wide, L/l = *c.* 3, apex obtuse to slightly retuse, mucronate, costae thick, strongly prominent at back, excurrent in a mucro.

Upper cells
Single-layered, small, 7-8(-10) µm wide, rounded-quadrate, bulging, thick walled, with several small papillae, evenly ranked, marginal cells smoother and clearer in one rank, intermediate cells few, quadrate to oblong, very thick walled, lumina rounded to elliptic, smooth, lower cells very few, rectangular, 7-20 µm long, 7-10 µm wide, less thick walled, smooth.

Fusiform gemmae
Present on leaves.

Perichaetial leaves
Similar to the vegetative ones.

Calyptrae
Naked, margin laciniate. Setae short, 5 mm long, thick, straight to flexuous, vaginulae naked or nearly so.

Capsules
Oblong-elliptic, 2 mm long, with 8 ribs on the small rim.

Peristome
Single.

Remarks
Macromitrium brevicaule is easily identified when propagules are seen. In addition, it may be separated from other small species with small setae and short and few basal cells by: 1) the linguiform short leaves with wide obtuse to truncate apex; 2) the smooth basal cells; 3) the naked calyptrae; and 4) its ecology: *M. brevicaule* grows at the lowest altitudes, often in mangrove or dry forest, in coastal saltwater environment or riparian forest.

With hand lens, sterile dry plants might be confused with *Macromitrium tongense* which has similar short branches with tightly spirally arranged leaves, but isolated leaves have another shape and microscopical examination shows the multi-layered upper areolation and the papillose lower cells of the latter.

The specimen of PC labelled *Macromitrium brevicaule* var. *latifolium* contains a large part of *M. tongense* and a small part of *M. brevicaule*. A new specimen recently collected in 2012 in Île des Pins corresponds to this plant which do not differ from the type.

Macromitrium cardotii Thér.
(Figs 1B, 6)

Diagnoses d'Espèces et de Variétés nouvelles de Mousses 8ème article: 5 (1910).

Type. — **New Caledonia**. Tao, forêt, sur les écorces, alt. 600 à 800 m, 1910, *Franc s.n.* (lecto-, designated here PC[PC0096512]!; isolecto-, PC[PC0137618]!).

Distribution in New Caledonia. — An infrequent species, corticolous in cloud forests and shrublands in the highest parts of the mountains, frequently foggy.

Total range. — Endemic to New Caledonia.

Selected specimens. — **New Caledonia**. Province Nord, Hienghène, Mont Panié, 18.IX.2001, on the path from the road RPN3 to the summit, epiphyte in a very wet forest, *c.* 1200 m, *Frank Müller NC128* (DR); Hienghène, summit of Mont Panié, 09.X.2012, epiphyte in open shrub vegetation and forest with *Agathis montana* and *Araucaria schmidii*, 1640 m, *Larraín 35875*. Province sud, Dumbéa, Montagne des Sources, 21.IX.2016, on bark in mountain wet forest with *Araucaria rulei*, 950 m, Thouvenot NC2331.

Description
Dioicous (?).

Plant
Medium sized, upper parts yellow-green often red tinged, older lower parts red-brown, creeping stems loosely branched.

Branches
Medium to long, 8-20 mm long, 2 mm wide, slightly curved, simple or sometimes furcate, when dry curly with dense leaves loosely erect, individually twisted, carinate, the apex incurved to circinate or cork-screw like, when moist erect to patent, the apex little incurved to straight.

Branch leaves
Large, 3-4.5 mm long, 0.35-0.75 mm wide, narrowly lanceolate, long acuminate, widest above the base at *c.* 0.15 the leaf length, upper part obscure, basal part translucent, ¼-⅕ the leaf length, apex acute rarely asymmetrically truncate, mucronate to aristate, aristae up to 250 µm long, costae relatively thin, excurrent, margins papillose-crenulate, slightly recurved in one side near base.

Upper cells
Single-layered, relatively large, 10-20 µm long, 7-12 µm wide, thick walled, with rounded to oblong lumina green or red, outer walls thicker, strongly bulging, with several papillae simple or furcate, marginal cells smaller in 1-2 bands, intermediate cells short rectangular, thick walled, nodulose at angles, with single rounded papillae, lower cells elongate, rectangular to linear, 25-75 µm long, 7-12 µm wide, very thick walled, walls 3-4 µm wide, more or less porous, lumina straight, narrow, single papillae usually numerous, rounded to high conical.

Perigonium
Not seen.

Perichaetia
More or less conspicuous, loosely erect, not sheathing, perichaetial leaves similar to the vegetative, but longer aristate.

Calyptrae
Narrow, plicate, naked.

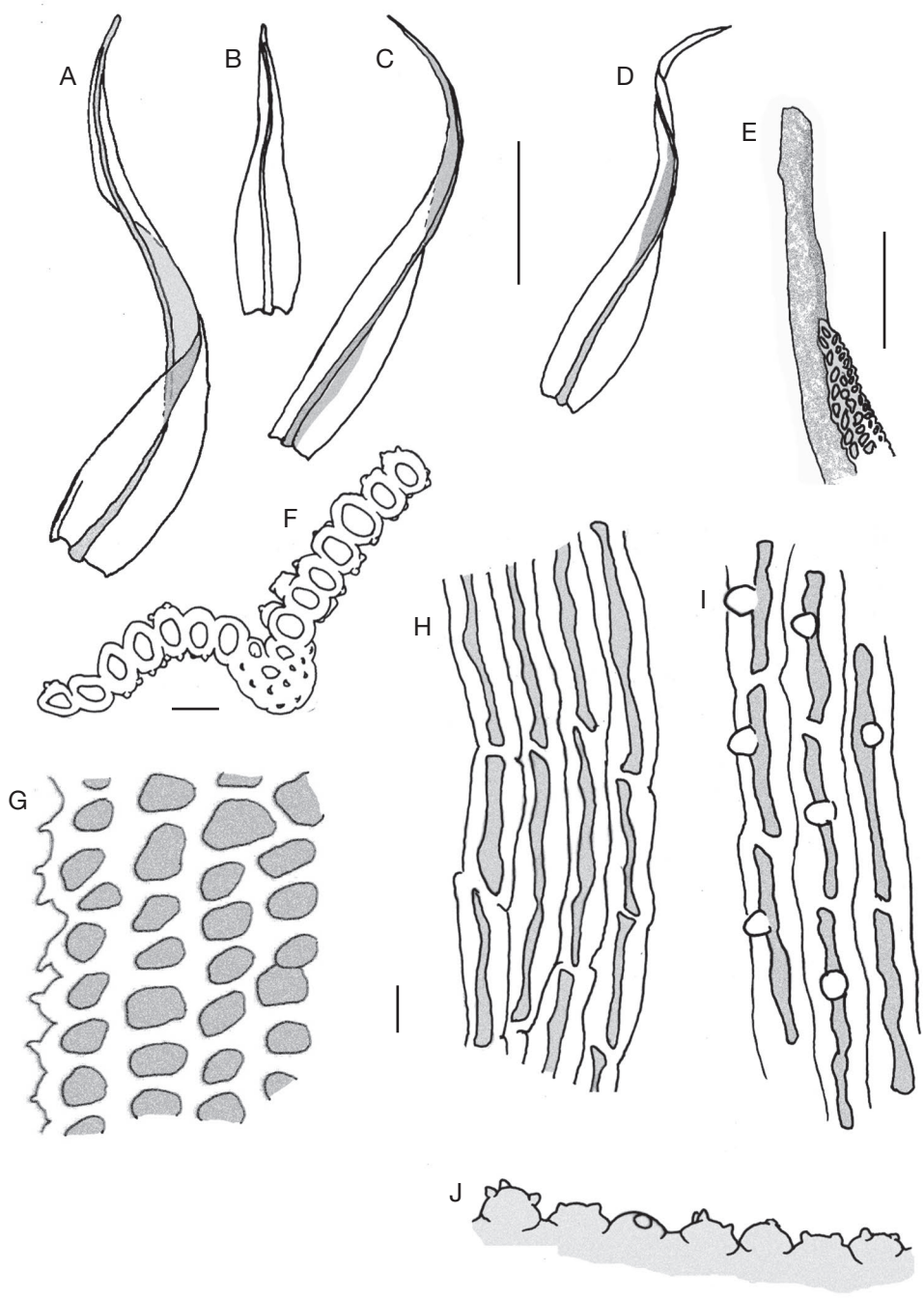

Fig. 6. — *Macromitrium cardotii* Thér.: **A-D**, branch leaves; **E**, branch leaf apex; **F**, transverse section in top quarter of branch leaf; **G**, upper cells; **H**, **I**, basal cells; **J**, upper cells in side view. Scale bars: A-D, 1 mm; E, 100 µm; F, 20 µm; G-J, 10 µm. All drawn from the lectotype.

Setae
Usually large, 10-35mm long, thin, straight, vaginulae hairless but with short paraphyses.

Capsules
2 mm long, 0.5 mm wide, narrowly oblong, smooth, plicate below the small rim.

Peristomes
Present, single, caducous.

Remarks
Macromitrium cardotii is characterized by: 1) long branches red tinged to brown, usually simple; 2) large narrow leaves gradually narrowing from a short basal part to a narrowly acute apex usually short aristate, papillose thorough; 3) upper cells bulging with thicker external walls protruding, in section lens or cone like, with several small papillae; 4) long setae with oblong capsules; 5) peristomes single, caducous; and 6) naked calyptrae.

The leaf shape and the presence of a peristome distinguish it from *M. pulchrum* and *M. neo-caledonicum* which, other-

wise, share comparable leaf size, seta size and cell network. The gametophytes of *M. pulchrum* and its varieties as well as *M. rufipilum* differ from *M. cardotii* as follow:

Macromitrium pulchrum and varieties: obtuse to shortly acute leaf apices, muticous or short aristate, and shorter branches or, if longer, leaves recurved to squarrose when moist.

Macromitrium rufipilum : longer red aristae, ligulate leaves with obtuse apices and smooth basal cells.

Sterile plants of *M. leratii* might be difficult to separe from *M. cardotii* in the absence setae, shorter in *M. leratii*, but the gametophytes of *M. leratii* may be separated from by the following characters: smooth basal cells, small upper cells, 6-8 µm long, locally two-layered, percurrent nerve.

The specimen selected as lectotype is labelled in accordance with the diagnosis and is dated on January 1910. Since the travelling time from New Caledonia to France was usually three months at that time, that is consistent with the date of publication of the new species: November 1910.

Macromitrium francii Thér.
(Figs 1C, 7)

Bulletin de l'Académie internationale de Géographie botanique 17: 308 (1907).

M. contractum Thér., *Bulletin de l'Académie internationale de Géographie botanique* 18: 253 (1908). — Type: New Caledonia, Mt Dzumac. (lecto- fide Vitt [1980]: New Caledonia, Mt Dzumac, 700 m, avril 1905, *Le Rat s.n.* [not *Franc s.n.*] [Herbarium Thériot n°66] PC[PC0137649]!; iso-, PC[PC0137650, PC0137651]!) **syn. nov.**

Type. — **New Caledonia**. 1906, *Franc s.n.* (Renauld *missit*) (lecto-, designated here: New Caledonia, 1906, *Franc s.n.* [Herbarium Bonati *ex* herbarium Thériot] PC[PC0096496]!; iso-, PC[PC0738574!, PC0137702!, PC0137704!, PC0137705] *p.p.*!)

Distribution in New Caledonia. — *Macromitrium francii* is frequent in North and South Province, in areas with various geologic substrates including calcareous ones, on barks and twigs, more than 1 m above the ground, from lowland up to 1200 m in scrublands, riparian forest, dry or wet or cloud forests.

Total range. — Endemic to New Caledonia.

Selected specimens. — **New Caledonia**. Province Nord, Poindimié, Pömwaga, 350 m, 11.X.2012, *Thouvenot NC924*; Hienghène, La Gùèn (Panié), 550 m, 8.X.2012, *Larraín 35922*; Ponérihouen, Aoupinié, 1000 m, 2.X.2012, *Larraín 35585*. Province Sud, vicinity of Nouméa, 1907, *Franc s.n*. PC0137701 (PC); Nouméa, 1908, *Franc s.n.* PC0096496 (PC); Païta, trail to Dzumac massif, 915 m, 18.IX.2008, *Thouvenot NC290* (PC); Thio, Mt Ningua, 1120 m, 29.IX.2012, *Thouvenot NC873*; Yaté, Madeleine falls, 240 m, 8.X.2015, *F. Müller NC265* (DR); Rivière Bleue Natural Park, 6.IX.2001, *F. Müller NC290* (DR).

Description

Pseudautoicous
Dwarf male plants on leaf axis of female branches.

Plant
Medium, upper parts light green, lower parts olive green to light brown, creeping stems densely branched.

Branches
Thin, small to medium, (2-)5-8(-10) mm long, (0.5-)0.8-1 mm wide, straight to slightly curved, simple or furcate, when dry usually unevenly curly, not funiculate, with leaves erect, individually twisted flexuous, carinate, the apex incurved to circinate, exposed by the margin, when moist erect-patent, the apices usually little incurved.

Branch leaves
Small to medium, (0.75-)1-1.5 mm long, (0.22-)0.3-0.4(-0.5) mm wide, oblong to lanceolate in outline, laminae ligulate to lanceolate from a wider basal part ovate to oblong, the apices acute to obtuse and apiculate or mucronate, upper parts obscure to translucent, basal parts undifferentiated, costae thick, ending in the apices or apiculi, margins papillose crenulate, plane.

Upper cells
Single-layered, small, rounded to oval, (7-)10-12 mm wide, thin walled, bulging, with 3-5 small papillae per cell, the cells roughly aligned, marginal cells smaller in one row, usually oblate, transitional cells reaching the base, oval to short rectangular, thick walled, with single rounded papillae, lower cells few, rectangular, 15-35 µm long, 5-10 µm wide, thick walled, lumina relatively wide, lower cells with single rounded papillae scarce but present on most of the leaves .

Perichaetia
Inconspicuous, perichaetial leaves similar to the vegetative ones, someone more triangular in outline.

Calyptrae
With dense and erect hairs.

Setae
Very short, 1-1.5(-2) mm long, erect, vaginulae with long hairs reaching the capsule.

Capsules
Short exserted, 1(-1.2) mm long, ovoid to elliptic, smooth, rims plicate, brown, small, incurved.

Peristomes
Single.

Spores
Anisomorphic 12-35 µm.

Remarks
As stated above, *Macromitrium francii* is close to the other species brought together in the *Francii* group. When fertile, the very short setae of *M. francii* and the long hairy vaginulae are distinctive but vegetative parts of the plants could be confused with species with short or medium curly branches as *M. involutifolium* var. *involutifolium*, *M. ligulaefolium* and *M. hemitrichodes* var. *sarasinii*. They can be separated from as follow:

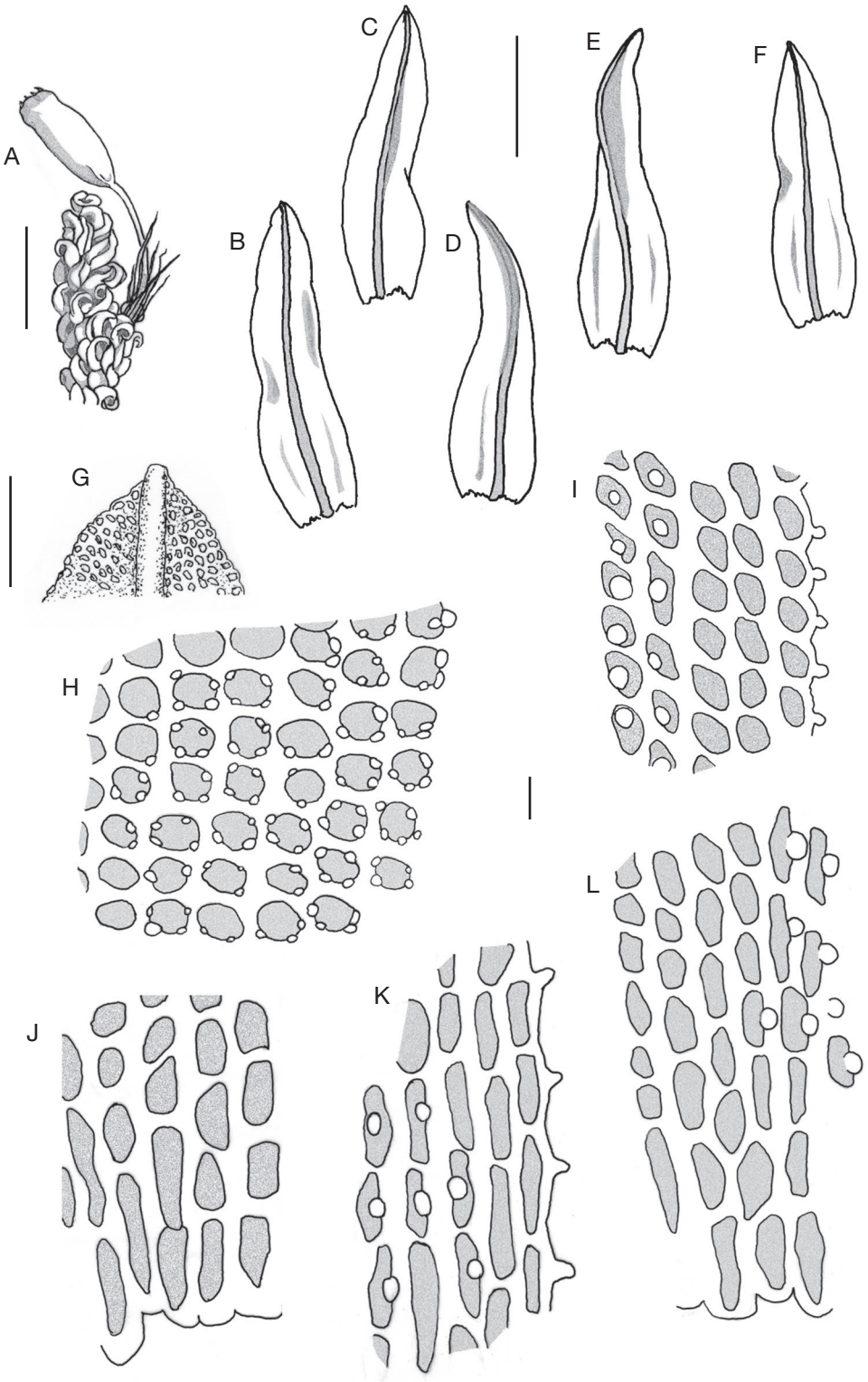

FIG. 7. — *Macromitrium francii* Thér.: **A**, dry branch with sporophyte; **B**-**F**, branch leaves; **G**, branch leaf apex; **H**, upper cells; **I**, transitional and marginal cells; **J**, **L**, basal cells; **K**, basal and marginal cells. Drawn from the isotype PC0096496 (G, H, J), from the specimen *Franc PC0137701* (**D**, **E**, **L**), from the specimens *Thouvenot NC1007* (**A**, **I**, **K**), *NC2264* (**B**, **C**, **F**). Scale bars: A, 1 mm; B-F, 500 µm; G, 100 µm; H-L, 10 µm.

Macromitrium involutifolium var. *involutifolium* has longer leaves, 2-3 mm long, and branches, up to 15 mm long,

Macromitrium ligulaefolium has thicker branches, 1.5 mm wide, longer leaves, 1.5-2.7 mm long, narrowly ligulate to linear with conspicuous basal parts made of rectangular-elongate to linear cells, the third by longer lanceolate acuminate leaves, 1.6-2.4 mm long, strongly carinate and incurved in upper part.

Macromitrium hemitrichodes var. *sarasinii* has longer leaves, 1.6-2.7 mm long, with many distinctive basal cells.

For the lectotypification, we first looked for pockets of the original Thériot herbarium in PC but we could not find amongst them any part of the original collection made by Franc in 1906. The single original pocket of *M. francii* from Thériot herbarium at PC contains specimens gathered in 1907. Thériot (1907) pointed out that the specimens collected by Franc were sent to him by Renauld, so we could observe many isotypes from the Renauld herbarium, unless it could be certain that Thériot saw them. Therefore, we prefer to consider parts sent by Thériot to bryologist fellows and to select as lectotype an isotype from the Bizot herbarium which is copious, fertile and homogeneous, while the others are mixed with different *Macromitrium* species.

Macromitrium contractum was first described by Thériot (1908), then reduced to synonymy with *M. noumeanum* (synonym of *M. involutifolium*) by the same author (Thériot 1921b) who finally reinstate it as a distinct species (Thériot 1929). The lectotype was designated by Vitt (1980) as follow "Nouvelle-Calédonie: Mont Dzumac récoltée par M. Franc", herbier Thériot. But the determinavit label let at PC do not have this precision and is annexed to a pocket extracted from Thériot's herbarium with the same locality name but collected by Le Rat. The handwritten abreviation "fig.", and the successive delated mentions "*Macrocoma contractum* n.sp." and "*noumeanum* ß forma" are arguments in favour of an original specimen used by Thériot to define this species. In addition, another pocket (PC0137651) including a duplicate bears the printed mention "leg. Franc" who was deleted and replaced by "Le Rat" handwritten by Thériot, that could explain the confusion of the original diagnose in the collector name, repeated by Vitt (1980). The examination of the lectotype showed resemblance with *M. francii* as well as with *M. noumeanum*. But the differences with *M. francii* are relatively low and quantitative, the branches, leaves and setae being longer but not so much, respectively 10-20 mm, 1.5-1.7(-1.9) mm and 1.8-2 mm, while the differences with *M. noumeanum* are more important: leaves exhibiting a different shape, in addition, strongly papillose especially in upper part and the elliptic capsules being shorter. Here we consider *M. contractum* as a form of *M. francii*.

Macromitrium hemitrichodes var. ***sarasinii***
(Thér.) Thouvenot, comb. nov.
(Figs 2A, 8)

Basionym. — *Macromitrium sarasinii* Thér., *Nova Caledonia-Forschungen in Neu-Caledonien und auf den Loyalty-Inseln, B. Botanik* 1: 25 (1914).

Type. — **New Caledonia**. Mt Canala, alt. 650 m, 1911, *Sarasin 334*. (lecto-, designated here PC[PC0096515]!).

Distribution in New Caledonia. — *Macromitrium hemitrichodes* var. *sarasinii* is only known from two specimens collected before 1952 in Province Nord.

Total range. — This variety is endemic of New Caledonia.

Selected specimens. — **Australia**. *Macromitrium hemitrichodes* North South Wales, Mt Lindsay, IX.1900, *W. Forsyth*, com. Brotherus PC[PC0659543]; Java, sin. loc., s.d., *Korthals s.n.*, Herb. Lugd. Batav., PC[PC0659544].
New Caledonia. *M. sarasinii* Province Nord, corticolous on *Tapeinosperm*a, mesophilous forest, ridge between the two Télème branches, west to Mt Colnett, *c.* 850 m, 11.IX.1951, *Hürlimann 2928*, PC[PC0659540].

Description

Sexual condition
Unknown.

Plant
Small, orange brown in herbarium, creeping stems densely branched.

Branches
Thick, short, 3-6 mm long, simple, when dry strongly curly, leaves erect individually twisted, carinate, the apex incurved to circinate, exposed by the margin, when moist spreading incurved.

Branch leaves
Medium to large, 1.6-2.7 mm long, 0.4-0.7 mm wide, strongly carinate, laminae lanceolate to triangular above the wider oval bases, upper parts opaque, basal parts translucent, 1/6-1/4 the total leaf length, apices acuminate to acute, costae ending below the apices to excurrent in a mucro, margins entire.

Upper cells
Single-layered, quadrate rounded, 6-10 µm wide, bulging, very thick walled with several small papillae, marginal cells sometimes smooth in one rank, transitional cells becoming gradually longer, from hexagonal to short rectangular, walls unevenly thickened, lumina narrowly rhomboidal, with single rounded papillae, lower cells rectangular elongate, 25-50 µm long, 7 µm wide, very thick walled, lumina narrow, straight to wavy, single papillae numerous, eventually displayed on plicae, low to high rounded.

Perichaetia
Short, inconspicuous, loosely erect, not sheathing, perichaetial leaves smaller than the vegetative ones.

Calyptra
Not seen.

Setae
Short, 5-6 mm long, thin, vaginulae with short inconspicuous paraphyses.

Old capsules
Elliptic, strongly 8-plicate, rims plicate erect.

Peristome
Not seen.

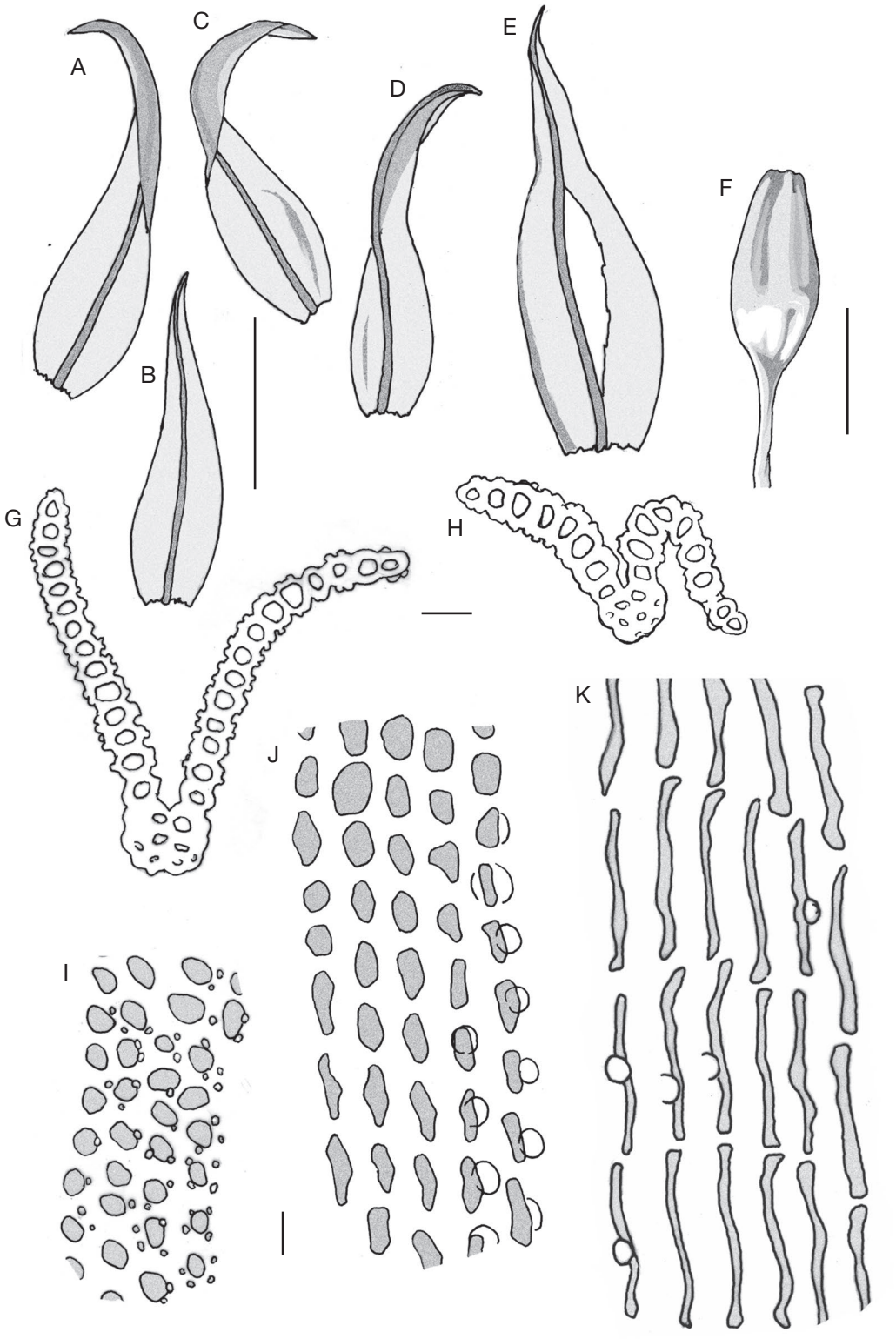

Fig. 8. — *Macromitrium hemitrichodes* var. *sarasinii* (Thér.) Thouvenot **A**-**E**, Branch leaves; **F**, Capsule; **G**,**H**, Transverse section in upper third of branch leaf; **I**, Upper cells; **J**, Transitional cells; **K**, Basal cells. All drawn from the lectotype of *M*. *sarasinii* Thér. except for **B**, **F** from the specimen *Hürlimann 2829*. Scale bars: A-F, 1 mm; G, H, 20 µm; I-K, 10 µm.

Remarks

Macromitrium hemitrichodes var. *sarasinii* is characterized by: 1) very short but thick branches which are strongly curly when dry, the leaves loosely erect twisted with curved to circinate apices; 2) large branch leaves lanceolate above wider oblong bases; 3) very thick walled cells, the upper ones small, quadrate rounded, strongly bulging, pluripapillose, the basal ones elongate with narrow lumina straight or slightly sinuous,

with numerous single papillae, intermediate cells numerous; 4) medium setae, mostly 6 mm long; and 5) elliptic capsules 8-plicate when dry.

We agree whith Thériot (1914) who stressed the similitude of this plant with the Australian *Macromitrium hemitrichodes*. Many features are identical, especially size and shape of branch leaves and their general habit in dry condition, most areolation characters, sporophyte, ect. Thériot related primarily the differences to quantitative assessment which have a low significance at species rank: more robust plant, shorter setae, larger leaves with relatively longer and less papillose basal parts, costae ending above the apices, ect. We reviewed the type specimen of *M. sarasinii* and found that all the sizes selected by Thériot to characterize his new species were included in the variability of *M. hemitrichodes*, according to the description by Vitt & Ramsay (1985) and our observation of *M. hemitrichodes* specimens. Only basal cells length, reaching 50 µm long, and leaf length, 1.6-2.7 mm long, can differentiate *M. sarasinii*. As in the case of *Macromitrium aurescens* var. *caledonicum*, these differences with the type variety are restricted to quantitative characters and, in our opinion, *M. sarasinii* is at most a variety of *M. hemitrichodes*. Further collections in New Caledonia and surrounding regions will allow to clarify this status. The status of *Macromitrium hemitrichodes* var. *hemitrichodes*, which is said endemic to eastern Australia, then could need ammendment. In addition, a sample labelled *M. hemitrichodes* and collected in Java by Korthals (around 1850) (PC), shows intermediate sizes in basal cell and leaf lengths, but longer branches, up to 20 mm long, and needs further investigations on more material from Java.

Macromitrium humboldtense
Thouvenot *et* Frank Müll.
(Figs 2B, 9)

Cryptogamie, Bryologie 37: 296-299, figs. 1-6, 8-16 (2016).

Type. — **New Caledonia**. South Province, Mt Humboldt, *c.* 1600 m, 31.VIII.2003, *F. Müller NC763* (holo-, DR! ; iso-, PC[PC0723602]!).

Illustrations and description.— Thouvenot & Müller (2016).

Distribution in New Caledonia. — This species was found on ultramafic rocks in montane scrubland of Mt Humboldt, at 1600 m a.s.l. one of the highest altitudes in New Caledonia. It is candidate to micro-endemic status since it is only known from a single collection on the summit of Mt Humboldt which is an isolated high mountain in the large southern ultramafic massif of Grande Terre, the main island of the archipelago.

Total range. — Endemic to New Caledonia, South Province.

Description
Macromitrium humboldtense is a very distinctive species characterised by: 1) a soft habit, when dry, leaves irregularly twisted, loosely spirally arranged, the apical parts of the leaves often wavy, with the unevenly oriented tips producing a shaggy effect; 2) short branches 3-7 mm long; 3) large branch leaves 3.6-4.6 mm long, 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, up to 250 µm long; 4) laminal cells papillose, the upper cells mainly rounded quadrate, pluripapillose, occupying more than ¾ 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 cells in the higher basal part with a single papilla; 5) setae 15-20 mm long, flexuous and smooth; and 6) calyptrae naked. Among these characters, the shape of the piliform apices is noteworthy since they have the appearance of long aristae, but the laminae really extend in wings along both sides of the costae, so that the costae are mainly percurrent or excurrent in a short point.

Macromitrium involutifolium (Hook. *et* Grev.) Schwägr. subsp. *involutifolium*

Species Muscorum Frondosorum, Suppl. 2,2: 144 (1827).

M. noumeanum Besch. *Annales des Sciences naturelles, Botanique* sér. 5, 18: 208 (1873). — Type: New Caledonia, "ad truncos in sylvis prope Noumea", *Balansa 2535*; "Canala, supra cataractam", *Balansa 2539*; "In Nova-Caledonia comm. Schimper", *Krieger s.n.* (lecto-, *Balansa 2535* BM-Besch; syn-, BM-Besch [Vitt & Ramsay, 1985a]; isolecto-, PC108006 [BESB1948]!); isosyn-, PC[PC0083697]!).

Illustrations and description. — Vitt & Ramsay (1985a).

Distribution in New Caledonia. — We are only aware of a few specimens of this plant from New Caledonia and cannot define the New Caledonian distribution or ecology of this species which is frequent in eastern Australia from sea level to mid elevation, on rocks or trunks Vitt & Ramsay 2006).

Total range. — New Caledonia and eastern Australia (Vitt & Ramsay 2006*).*

Selected specimen. — **New Caledonia.** Province Nord, Pouhembout, Forêt Plate, 300 m, 7.IX.2003, *F. Müller NC758* (DR).

Description
Macromitrium involutifolium subsp. *involutifolium* is characterized by: 1) medium sized plants, much fertile, with branches medium, up to 10 mm long; 2) branch leaves erect-twisted with incurved to circinate apices giving the branches a curly habit; 3) leaves narrow, long lanceolate, sometimes ligulate, 0.5 mm wide, 2.1-2.7 mm long, smooth in upper part; 4) lower cells few, rectangular with straight lumina; 5) short setae, 1.5-5 mm long; 6) perichaetia inconspicuous, not sheathing the seta base; 7) vaginulae and calyptrae hairy; and 8) capsules long elliptical, with single peristome and plicate rim erect and firm.

The latter character distinguishes the type subspecies from *M. involutifolium* subsp. *ptychomitrioides* which has cylindrical capsules with collapse rims and lacking peristome as well as a usually more robust habit and leaves with more defined basal parts made of longer cells.

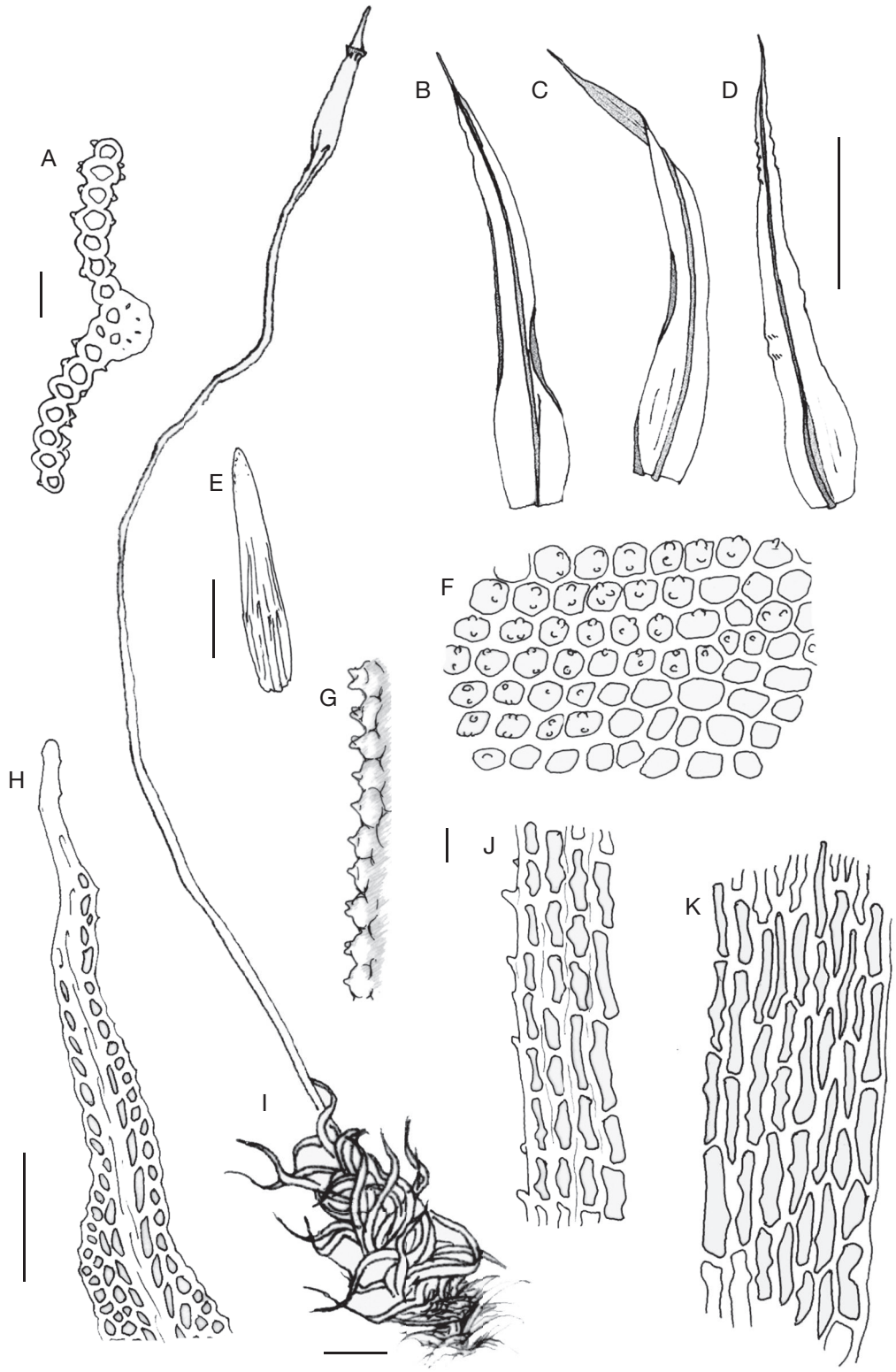

FIG. 9. — *Macromitrium humboldtense* Thouvenot & Franck Müll.: **A**, transverse section in top quarter of branch leaf; **B**-**D**, branch leaves; **E**, calyptra; **F**, upper cells; **G**, upper cells in side view; **H**, branch leaf apex; **I**, dry branch with sporophyte; **J**, transitional and marginal cells; **K**, basal and marginal cells. All drawn from the holotype. Scale bars. A, 20 µm; B-E, I, 1 mm; F, G, J, K, 10 µm; H, 100 µm.

Depauperate specimens could be confused with *Macromitrium francii*, but the latter has smaller leaves, strongly carinate, different in shape, and densely papillose especially in upper parts. In addition, its setae are very short and the hairs of the vaginulae reach the capsules which are shorter, ovoid to elliptic.

Macromitrium involutifolium subsp. ***ptychomitrioides***
(Besch.) Vitt & H. P. Ramsay
(Figs 1G, 10)

Journal Hattori Botanical Laboratory 59: 378 (1985).

M. ptychomitrioides Besch., *Annales des Sciences naturelles ,Botanique* sér. 5, 18: 208 (1873). — Type: New Caledonia, Canala, *Balansa 2540* (lecto-, BM [Vitt & Ramsay 1985a]; isolecto-, PC[PC0096507]!).

M. plicatum Thér., *Bulletin de l'Académie internationale de Géographie botanique* 17: 307 (1907). — Type: New Caledonia, "environs de Nouméa", 1906, *Franc s.n.* (lecto-, designated here *fide* Guo *in Sched.* [2007] PC[PC0083710]!) **syn. nov**.

M. plicatum var. *aristatum* Thér., *Bulletin de l'Académie internationale de Géographie botanique* 20: 99 (1910). — Type: New Caledonia, "environs de Nouméa", *Le Rat s.n*. (lecto-, designated here: PC[PC0083716]!) **syn. nov.**

M. plicatum var. *obtusifolium* Thér., *Diagnoses d'Espèces et de Variétés nouvelles de Mousses* 8: 4 (1910). — Type: New Caledonia, "Monts Koghis, forêt, troncs d'arbre, alt. 300 m", *Franc s.n.* (lecto-, designated here *fide* Guo *in Sched.* [2007]: PC[PC0083719]!) **syn. nov**.

Illustrations and description. — Vitt & Ramsay (1985a).

Distribution in New Caledonia. — Species found in central (type specimen) and southern parts of the main island, from lowland up to 1100 m a.s.l. apparently avoiding seaside and highest mountains. It grows as an epiphyte in dry or wet forests preferably in edges, river or road sides, clearings, ect.

Total range. — New Caledonia, eastern Australia, Norfolk Island and Tubai Island in French Polynesia (Vitt & Ramsay 1985).

Selected specimens. — **New Caledonia**. Province Sud, Mont-Dore, Demazures forest, 330-420 m, 28.IX.2016, *Thouvenot NC2364*; Yaté, Rivière Bleue Natural Park, Pont Germain, 175 m, 5.X.2016, *Thouvenot NC2372*; Thio, Mt Ningua, 1100 m, 29.IX.2012, *Larraín 35487*; Farino, Grandes Fougères Natural Park, 370 m, 22.IX.2016, *Thouvenot NC2339*; Païta, Nodwé, 40-80 m, 24.X.2012, *Thouvenot NC768.*

Description

Here we provide the description of the type of *M. plicatum* and other specimens from New Caledonia.

Pseudautoicous
Dwarf male plants on leaf axis of female branches.

Plant
Medium to large young upper parts light green, main parts bronze-green to brown, creeping stems densely branched.

Branches
Medium to long (3-)5-25(-35) mm long, 1.5(-2) mm wide, straight to slightly curved, simple or fastigiate, when dry curly, with leaves erect to patent, individually twisted, strongly carinate, the apices circinate to enrolled, exposed by the margin, when moist erect to patent, sinuous with basal and middle parts recurved and apices incurved.

Branch leaves
Large 2.3-3.5(-4.2) mm long, 0.3-0.8 mm wide, narrowly lanceolate, apices acuminate, acute, sometimes narrowly obtuse apiculate, upper parts clear, transitional parts medium to long, basal parts differentiated, relatively short, (1/8-)1/4 the whole leaf length, costae strong prominent on back, ending in apices or short excurrent in mucrones, margins entire, recurved to one side near base.

Upper cells
Medium to large (8-)10-15 µm wide, single-layered, roughly aligned, rounded-quadrate, walls thickened at angles, bulging, smooth to low papillose, marginal cells smaller in one row or undifferentiated, transitional cells progressively becoming longer, short rectangular, unipapillose, papillae rounded scarce to numerous, concentrated near the base, lower cells elongated to linear (20-)25-45(-100) µm long, (6-)7-8 µm wide, walls porous, thick to very thick (2.5 µm), lumina narrow, straight, single rounded papillae null or scarce and localized.

Sporophytes
Numerous on each fertile branch.

Perichaetia
Inconspicuous.

Calyptrae
Plicate, hairy.

Setae
Short, 1.5-3.5 mm long, vaginulae with more or less conspicuous hairs.

Capsules
1-2 mm long, 0.5 mm wide, elliptic to narrowly oblong, smooth, rim slightly plicate, brown, erect.

Peristome
Absent.

Remarks

This species is easily separated from other New Caledonian species by: 1) usually robust plants, profusely fertile, with fastigiated branches; 2) branch leaves erect-twisted with incurved to circinate apices giving the branches a curly habit; 3) leaves narrow, long lanceolate, sometimes ligulate, smooth in upper part; 4) lower cells elongate linear with straight lumina; 5) short setae; 6) perichaetia inconspicuous, not sheathing the seta base; 7) vaginulae and calyptrae hairy; and 8) capsules narrowly oblong to cylindrical, without peristome, with collapse rim. So, it differs from the other robust species in New Caledonia by many characters as straight lumina of basal cells, abundant sporophytes, smooth upper cells and inconspicuous perichaetia. The main difference in the varieties of *M. plicatum* described by Thériot is the apex shapes which are obtuse and mucronate in var. *obtusifolius*, aristate in var. *aristatum* whose type shows the highest values of leaf and branch sizes, respec-

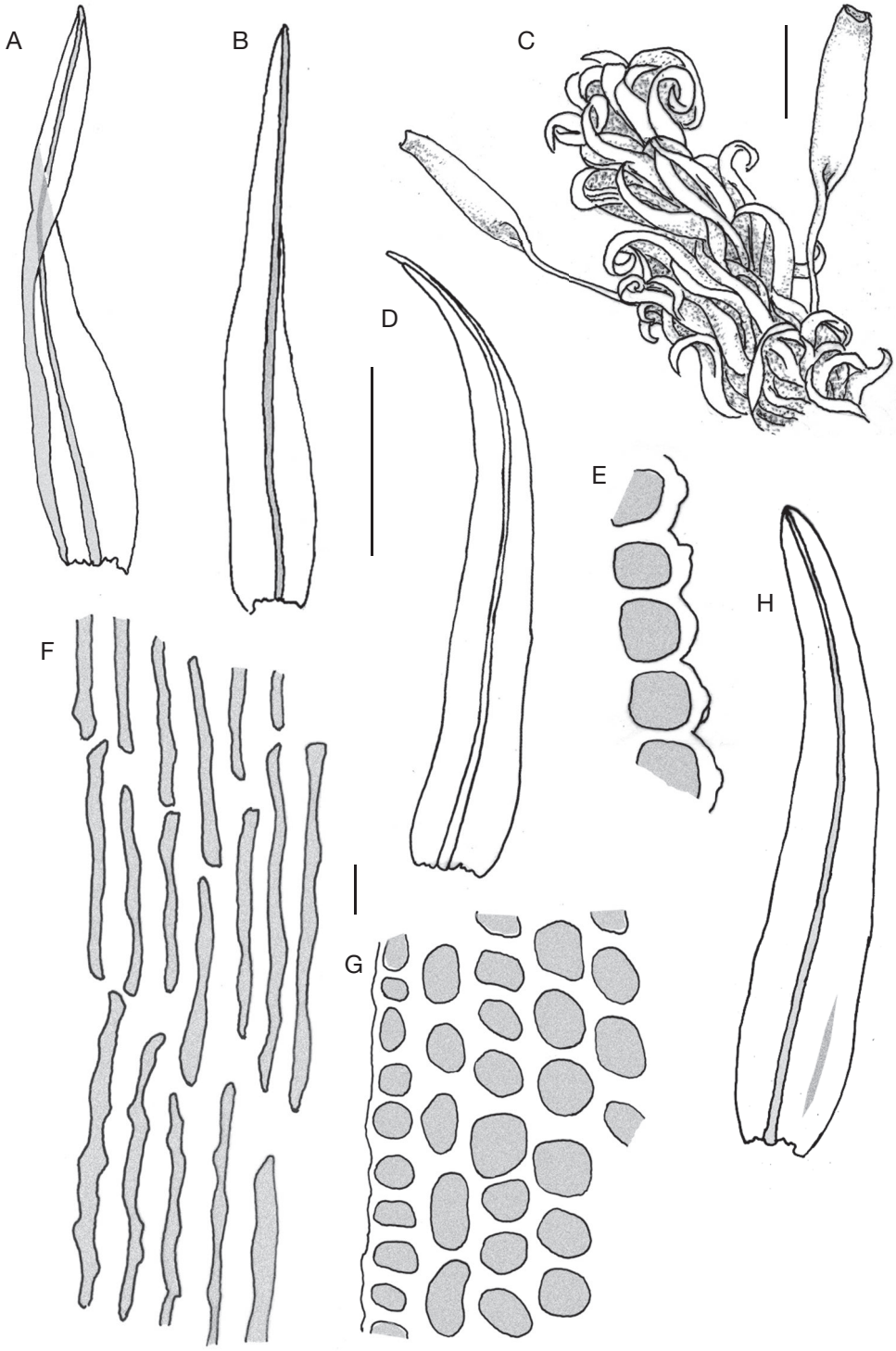

Fig. 10. — *Macromitrium involutifolium* subsp. *ptychomitrioides* (Besch.) Vitt et H.P.Ramsay: **A**, **B**, **D**, **H**, branch leaves; **C**, dry branch with sporophyte; **E**, upper cells in side view; **F**, basal cells; **G**, upper cells. All drawn from the lectotype of *M. plicatum* Thér. except **D** from the lectotype of *M. plicatum* var. *aristatum* Thér. and **H** from the lectotype of *M. plicatum* var. *obtusifolium* Thér. Scale bars: A-D, H, 1 mm; E-G, 10 µm.

tively 4.2 mm long and 35 mm long. All these morphological features can be included in the variability of *M. involutifolium* subsp. *ptychomitrioides* as described by Bescherelle (1873) and Vitt & Ramsay (1985). In Vitt & Ramsay's description and drawnings (1985) as well as in the specimens observed, the costa endings are variable, from below the apices to excurrent in short arista. In *M. plicatum* var. *aristatum*, the costa excurrence reaches 0.1 mm, in accordance with the character of

"gigant" form of this specimen among the others (see above in the chapter "morphological characters").

Macromitrium laevigatum Thér.
(Figs 1D, 11)

Diagnoses d'Espèces et de Variétés nouvelles de Mousses 8: 5 (1910).

Type. — **New Caledonia**. Mt Koghis, troncs d'arbre, *Franc s.n.* (lecto-, designated here *fide* Guo *in Sched.* [2007]: 1909, *Franc s.n.* PC[PC0083685]!; isolecto-, PC[PC0083686!, PC0083687]).

Distribution in New Caledonia. — This species is only known from the type collection and a few old specimens, without locality indicated. Thus, its distribution and ecology remain unknown.

Total range. — Endemic to New Caledonia (South Province).

Selected specimen. — **New Caledonia**, 1913, *Franc s.n.*, PC0721080 (Herbarium I. Thériot) (PC).

Description

Sexuality
Unknown.

Plant
Medium, young upper parts light green, main parts usually light more or less red tinged, at least the costae, creeping stems densely branched.

Branches
Medium, 10-20 mm long, 1-1.5 mm wide, straight, simple or furcate, when dry curly, with leaves erect to patent, individually twisted, strongly carinate, the apices circinate to coiled and exposed by the margin, when moist patent and sinuous with basal and middle parts recurved and apices incurved. When mounted, leaf apices remain incurved and carinate and hard to flatten.

Branch leaves
Medium, 1.3-1.7 mm long, 0.3-0.4 mm wide, lanceolate to ligulate above oblong basal parts, apices obtuse to shortly acute or apiculate, upper parts obscure, transitional parts very short, basal parts differentiated (1/2-)1/3 the whole leaf length, costae thin, ending in apices or short excurrent in mucrones or apiculi.

Upper cells
Small, 7-8 µm wide, single-layered thorough, in conspicuous longitudinal rows, quadrate with rounded lumina, thick walls, not bulging, strongly papillose, marginal cells undifferentiated, transitional cells poorly differentiated, lower cells smooth thorough, rectangular elongated, 20-35 µm long, 8-10 µm wide, thick walled, lumina narrow, sinuous.

Perichaetia
Conspicuous, sheathing the setae base, inner perichaetial leaves hyaline, oblong-ligulate to sub-triangular, apices obtuse, costae ending in the apices.

Calyptrae
Plicate, naked.

Setae
Short, 2-2.5 mm long, vaginulae naked.

Capsules
2 mm long, elliptic, smooth, rims slightly plicate, brown, erect.

Peristomes
Single.

Remarks
In the diagnosis, Thériot (1910b) describes cells smooth thorough (*omnibus laevibus*, hence the name *laevigatum*), while, in the type, the upper cells have numerous small papillae.

According to Thériot, *Macromitrium laevigatum* is close to *M. leratii* but smaller in all parts. But, in *M. laevigatum*, the wide acute apices, single-layered, of the relatively shorter branch leaves are distinctive, especially from the smallest forms of *M. leratii,* whose branch leaves are long acuminate and locally bistratose at apices.

Macromitrium salakanum and *M. semperi* have similar appearance by the shape and arrangement of branch leaves as well in dry as in wet conditions, but both are larger plants and, in addition, the first have hairy calyptrae and the second aristate perichaetial leaves.

Macromitrium larrainii Thouvenot & K.T.Yong,
(Figs 2D, 12)

Cryptogamie, Bryologie 36: 344-346, fig. 1-15 (2015).

Type. — **New Caledonia**. North Province, Hienghène, summit of Mt Panié, *c.* 1640 m, 9.X.2012, *Larraín 35846* (holo-, PC[PC0167650]!; iso-, NOU! KLU, F, CONC, NY, S).

Illustrations and description. — Thouvenot & Yong (2015); Müller *et al.* (2016).

Distribution in New Caledonia. — So far only known from Mt Panié, the highest summit in the country.

Total range. — Endemic to North Province of New Caledonia.

Selected specimens. — New Caledonia, Province Nord, Mt Panié, along the hiking trail from RPN3 to the summit, *c.* 1200 m, 13.IX.2001, *F. Müller NC98* & *NC202* (DR).

Description
Macromitrium larrainii is well characterised by: 1) long branches up to 25 mm long; 2) lanceolate branch leaves distinctively slender, laminae widest near base, very narrow and asymmetrical above; 3) a very shaggy habit due to the long, thin aristae up to 1 mm long and excurrent costae of the branch leaves irregularly arranged; 4) cells smooth throughout the leaves; 5) upper leaf cells irregular in shape and size and basal ones linear and evenly thick-walled, with straight lumina; and 6) setae 8-10 mm long.

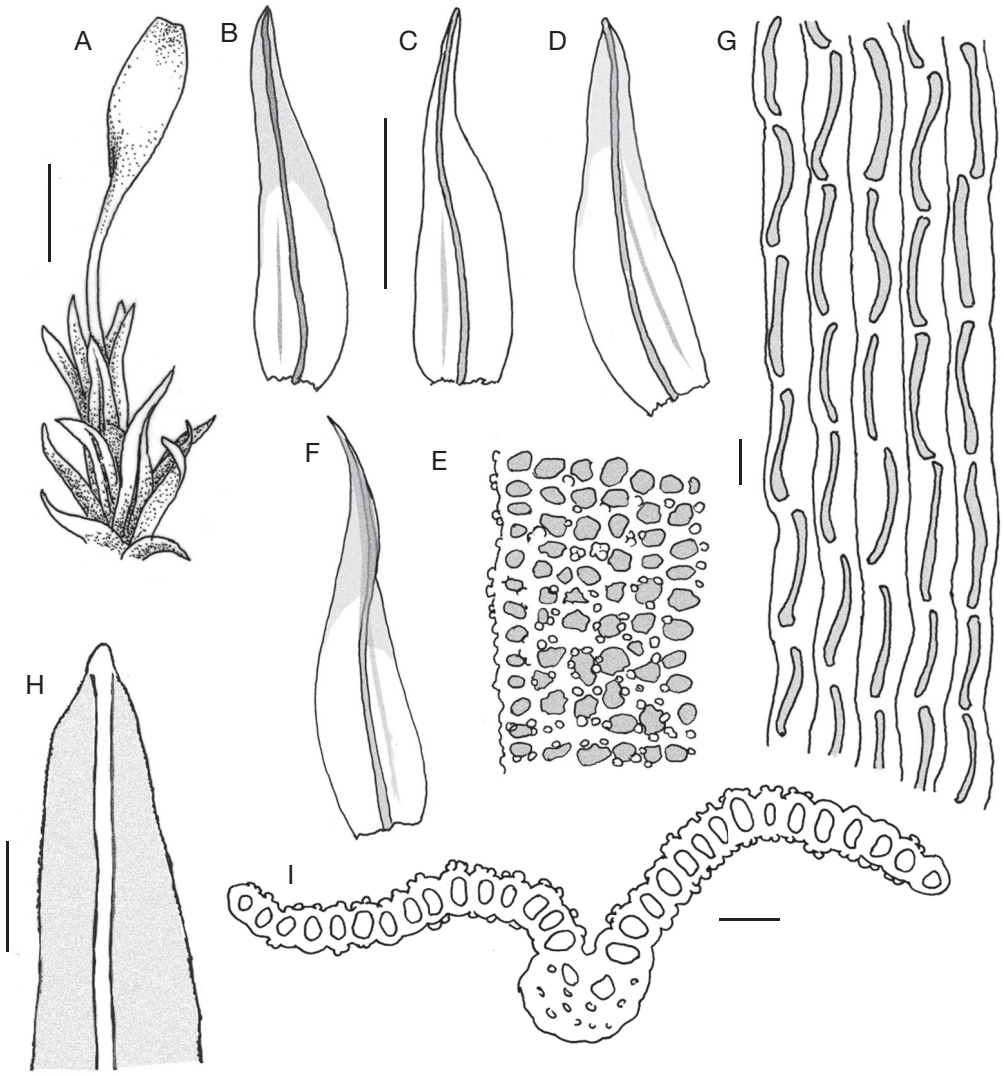

FIG. 11. — *Macromitrium laevigatum* Thér.: **A**, top of branch with perichaetium and sporophyte; **B-D**, **F**, branch leaves; **E**, upper cells; **G**, basal cells; **H**, branch leaf apex; **I**, transverse section in upper third of branch leaf. All drawn from the lectotype. Scale bars: A, 1 mm; B-D, F, 500 µm; E, G, H, 10 µm; I, 20 µm.

Epiphyte growing on barks in rain and cloud forests and scrublands, at higher altitudes, this species is candidate to micro-endemic status since it is only known from two collecting places relatively close one from the other, in the northernmost part of the Central Range.

Macromitrium leratii Broth. & Paris (Figs 1E, 13)

Öfversigt af Finska vetenskaps-societetens förhandlingar 48 (15): 12 (1906).

Macromitrium salakanum var. *majus* Besch., *Annales des Sciences naturelles, Botanique* sér. 5, 18: 210 (1873). — Type: New Caledonia, "Ad arborum truncos montis Mou, 1200 m", *Balansa 2978, 2981*; "in monte Mi", *Balansa 916* (lecto-, designated here: *Balansa 2978* PC[PC0138026]!; syn-, PC[PC0138024, PC0138025, PC0138027, PC0138028]!).

Macromitrium leratii var. *erectifolium* Thér. *Rev. Bryol.* 48: 16 (1921). — Type: New Caledonia, Île des Pins, 1874-76 (lecto-, designated here *fide* Guo *in Sched.* [2007]: PC0083688!) **syn. nov.**

TYPE. — **New Caledonia**. "in silvaticis montis Dzumac, alt. 1100 m. et in monte Ouin, ad arbores, alt. 1000 m", *Le Rat s.n.*; Prony, *Etesse s.n.* (lecto-, "In silvaticis montis Dzumac, alt. 1100 m, VII.1904", *Le Rat s.n.*, "marked as a probable isotype in H-BR by D.H. Vitt in 1983" (H) [Vitt *et al.* 1995]; syn-, H; isosyn-, Mt Ouin, VII.1905, *Le Rat s.n.*, PC[PC0096510, PC013779]!).

DISTRIBUTION IN NEW CALEDONIA. — Present in North and South Province.

TOTAL RANGE. — East Australia, Lord Howe Island, New Caledonia.

SELECTED SPECIMENS. — New Caledonia, Province Nord, Ponérihouen, Mt Aoupinié, 950 m, 2.X.2012, *Larraín 35612*; Hienghène,

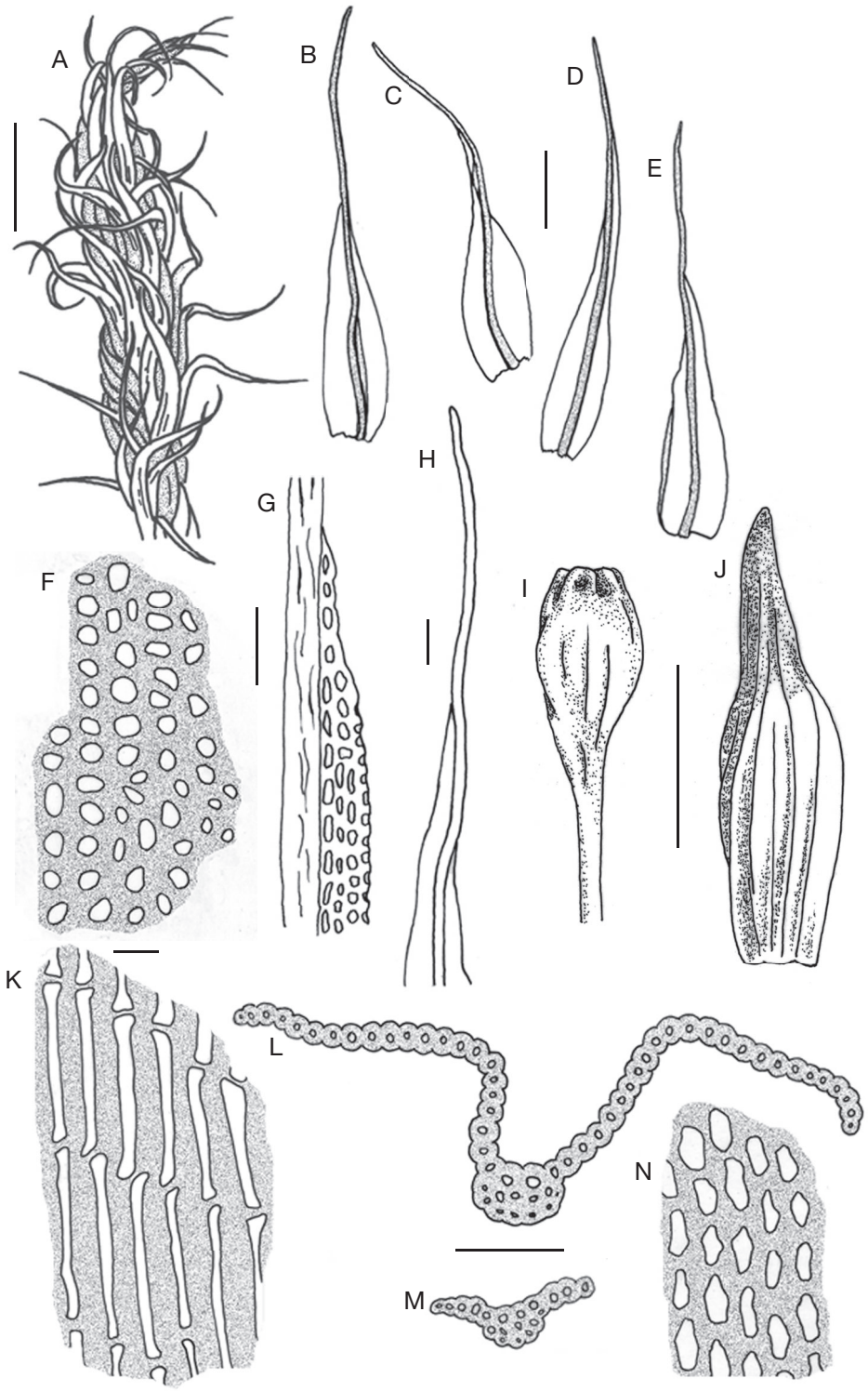

Fig. 12. — *Macromitrium larrainii* Thouvenot & K.T.Yong: **A**, upper part of dry branch; **B**-**E**, branch leaves; **F**, upper cells; **G**-**H**, branch leaf apices; **I**, capsule; **J**, calyptra; **K**, basal cells; **L**, transverse section in basal part of branch leaf; **M**, transverse section in top quarter of lamina; **N**, transitional cells. All drawn from the holotype, except **I**, **J** from the specimen *Müller NC98*. Scale bars: A, I, J, 1 mm; B-E, 500 µm; F, K, N, 10 µm; G, L, M, 50 µm; H, 100 µm.

trail to La Guen, 10.X.2012, *Thouvenot NC1025*; Touho, Pombeï, 415 m, 12.X.2016, *Thouvenot2287*; Province Sud, Yaté, base of Pic du Grand Kaori, 250 m, 22.X.2012, *Thouvenot NC734*; Rivière Bleue Nature Parc, La Tranchée, 220 m, 19.X.2016, *Thouvenot NC2379* (PC); Pont Germain, 170 m, 5.X.2016, *Thouvenot NC2390*; Mont-Dore, Demazures forest, 360 m, 28.IX.2016, *Thouvenot NC2362* (PC); Païta, Mt Dzumac, 920 m, 19.IX.2016, *Thouvenot NC2237* (PC); Mt Mou, 1110 m, 17.IX.2016, *Thouvenot NC2231*; Dumbéa, Mt Bouo, 930 m, on rocks, 16.IX.2016, *Thouvenot NC2301* (PC); Thio, Mt Ningua, 1120 m, 29.IX.2012, *Thouvenot NC869*; Dumbéa, Montagne des Sources Nature Reserve, 28.IX.2012, 550 m, *Larraín 35473*; Boulouparis, Mt Do, 1000 m, 27.IX.2012, *Larraín 35412*.

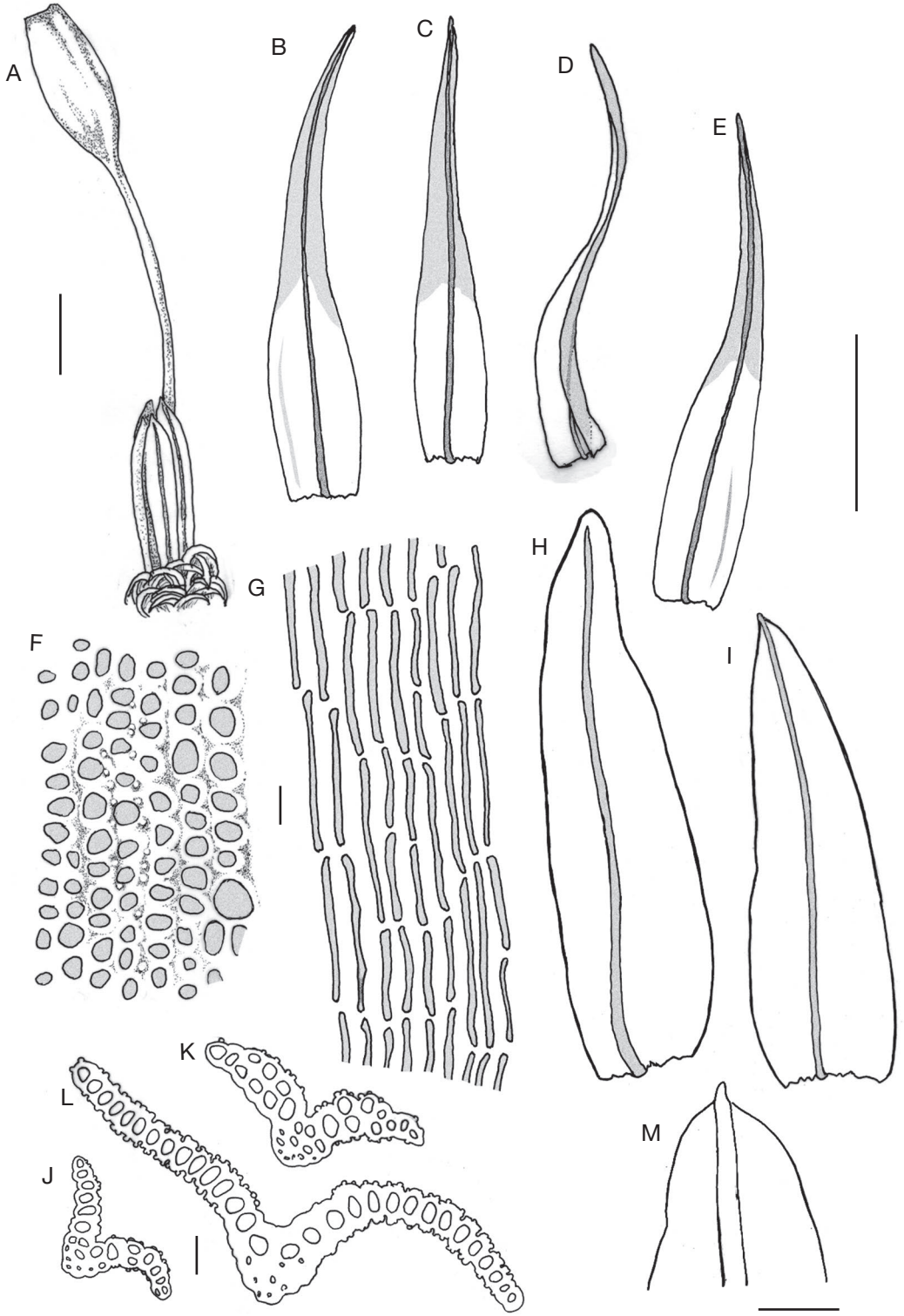

Fig. 13. — *Macromitrium leratii* Broth. & Paris: **A**, perichaetium and sporophyte; **B**-**E**, branch leaves; **F**, upper cells; **G**, basal cells; **H**, **I**, perichaetial leaves; **J**, **K**, transverse section in apices of branch leaves; **L**, transverse section in upper third of branch leaf; **M**, perichaetial leaf apex. Drawn from isotypes *PC0096510* (**K**, **L**) and *PC0096497* (**A**); from specimens *Thouvenot NC1018* (**B**, **C**, **E**), *NC870* (**D**), *NC2237* (**H**, **I**); *Larraín 35492* (**F**, **G**, **M**); *Müller NC210* (**J**). Scale bars: A, 1 mm; B-E, H, I, 1 mm; F, G, 10 µm; J-L, 20 µm; M, 100 µm.

Description

Pseudautoicous
Dwarf male plants on leaf axis of female branches.

Plant
Large to medium, young upper parts green, main parts usually red brown to dark brown, rarely olive green, creeping stems densely branched.

Branches
Thick and long, (4-)10-25(-40) mm long, 1.5-2 mm wide, straight to slightly curved, simple or furcate, when dry curly, with leaves erect to patent, individually twisted, carinate, the apices circinate to coiled, exposed by the margins, when moist spreading and sinuous with middle parts squarrose and apices incurved.

Branch leaves
Large, (1.6-)2-3.5 mm long, 0.3-0.5 mm wide, narrowly lanceolate, long acuminate, ending in acute apices, upper parts obscure, transitional parts shorter, basal parts differentiated, translucent, (1/2-)1/3 the whole leaf length, costae thin, percurrent, margins sub-entire, plane or recurved at base on one side.

Upper cells
Partly bistratose at apices, elsewhere single-layered, in conspicuous longitudinal rows, small, 6-8 µm long, 6-8(-12) µm wide, quadrate with rounded to oval lumina, thick walled, not bulging, with several small papillae per cell, marginal cells undifferentiated or smaller in one row, transitional cells short rectangular, walls unevenly thickened and smooth, lower cells smooth thorough, linear, 20-50(-60) µm long, 7-8 µm wide, very thick walled 3-5 µm thick, lumina narrow, straight or slightly sinuous in the same leaf.

Perichaetia
Conspicuous, sheathing the setae base, inner perichaetial leaves oblong to oblong-lanceolate, apices widely rounded to obtuse, hyaline, costae ending below the apices to short excurrent, cells very thick walled, linear at base to rounded-oblong in upper part.

Calyptrae
Plicate, naked.

Setae
Short, 3-7 mm long, vaginulae naked.

Capsules
1.5(-2) mm long, ovoid to elliptic, smooth, rim slightly plicate, brown, erect.

Peristome
Single.

Spores
(12-25 µm) finely papillose.

Remarks
The partly bistratose apex of vegetative leaves has been hitherto overlooked in *Macromitrium leratii* while this feature is important to differenciate this species from the nearly similar *M. semperi* or *M. salakanum*. Likewise, the shape of perichaetial leaves has been mistaken in Vitt & Ramsay (1985a). These authors describe and illustrate "acuminate-stoutly cuspidate acute apices" of the perichaetial leaves while the isotype and New Caledonian specimens observed exhibit constantly wide obtuse to rounded mucronate apices in sheathing perichaetial leaves which are more often oblong lanceolate.

In this way, the perichaetial leaves separate *M. leratii* from *M. semperi* which have lanceolate perichetial leaves with the apices acuminate and aristate. *M. semperi* was quoted from New Caledonia without any precise reference (Vitt *et al.* 1995). As we could not find any sample of this species, we believe that mention of *M. semperi* is based on misidentifications and must be removed from the New Caledonian flora.

Conversely, *M. leratii* shares perichaetium characters with *M. salakanum* but it may be separated from by the bistratose apices and long acuminate shape of vegetative leaves, as well as the naked calyptrae.

The synonymy of *M. salakanum* var. *majus* with *M. leratii* was established by Brotherus (1906) who emphazised the absence of peristome in *M. leratii* as distinctive from *M. salakanum*, but we could observe some capsules with peristome, mostly caducous, in both type specimens. The invalid name *Macromitrium seleniblastum* Müll.Hal. *m.s.* is written on the specimen PC0138025, *Balansa 916. Macromitrium leratii* var. *erectifolium* is just a robust form with strongly coiled leaf apices and longer branches. The type specimen is sterile so that we cannot find distinctive feature dealing with perichaetium or sporophyte.

Macromitrium leratii is frequent at all but extreme altitudes, between 100-1200 m, relatively more frequent in the higher band of 800-1200 m. It was collected in scrublands, wet or dry forests at 100-900 m a.s.l. and up to 1200 m in tall scrublands and open cloud forests. It usually grows on bark of trunks or twigs but depauperate forms may rarely be found on rocks. The more robust plants are growing in half-light situations in scrublands, forest edges, open forests, ect.

Macromitrium ligulaefolium Broth.
(Fig. 14)

Öfversigt af Finska Vetenskaps-Societetens Förhandlingar 40: 170 (1898).

M. brevipilosum Thér., *Bulletin de l'Académie internationale de Géographie botanique* 18: 253 (1908). — Type: New Caledonia, "versant ouest du Mont Koghis, 300 m", *Franc s.n.* (lecto-, designated here PC[PC0137607]!; isolecto-, PC[PC0137608-10, PC0096495]!).

M. cucullatum Thér., *Bulletin de l'Académie internationale de Géographie botanique* 19: 307 (1907). — Type: New Caledonia, "environs de Nouméa, 1906", *Franc s.n.* (lecto-, designated here *fide* Guo *in Sched.* [2007] PC[PC0083639]!).

Macromitrium perminutum Broth. & Paris, *Öfversigt af Finska Vetenskaps-Societetens Förhandlingar* 51A (17): 15 (1909). — Type: New Caledonia, "L'Hermitage prope Nouméa, ad cortices arborum", *Le Rat s.n.* (holo-, H *fide* Vitt *in Sched.* [1983] H.BR[H.BR2563014]!; iso-, PC[PC0083637]!).

Illustrations and description. — Vitt (1983). Here we provide a description of the type of *M. brevipilosum*.

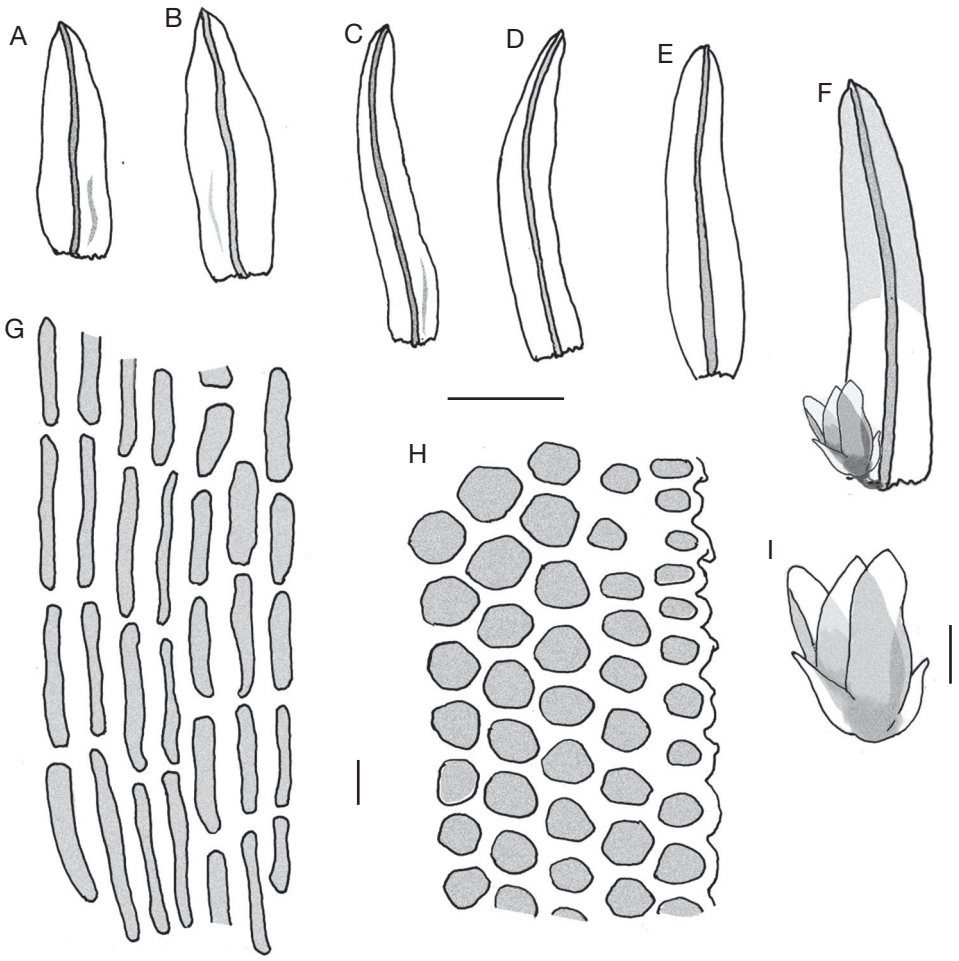

Fig. 14. — *Macromitrium ligulaefolium* Broth.: **A**-**E**, branch leaves; **F**, branch leaf with dwarf male plant; **G**, basal cells; **H**, upper cells; **I**, dwarf male plant. Drawn from *M. brevipilosum* Thér. lectotype (**F**-**I**) and isotype *PC0096495* (**A**-**D**) and *M. cucullatum* Thér. lectotype (**E**). Scale bars: A-F, 500 µm G, H, 10 µm; I, 100 µm.

Distribution in New Caledonia. — *M. ligulaefolium* is very frequent anywhere below 700 m, rarely up to 1150 m.

Total range. — Australasia. Eastern Australia, Tasmania, New Zealand (Vitt & Ramsay 2006). Common in Australia and New Zealand, it was considered as endemic of these countries but, as stressed by Vitt (1983), this species was expected to "have a more extensive range in the Pacific Islands".

Selected specimen. — **New Caledonia**. Province Nord, Touho, Tipiléi valley, 100-400 m, 12.X.2012, *Thouvenot NC1015* (PC); Pombéi, 249 m, 12.X.2016, *Thouvenot NC2275*; Hienghène, La Guen (Panié massif), 550 m, 8.X.2012, *Thouvenot NC1024* (PC); Poindimié, Povila, 350 m, 11.X.2012, *Thouvenot NC916*; Poindimié, Nessapoué, 40 m, 4.IX.2012, *Thouvenot NC907*; Province Sud, Païta, Nodwé, 40-80 m, 24.X.2012, *Thouvenot NC1004*; Thio, Mt Ningua, 1120 m, 29.IX.2012, *Thouvenot NC864*; Dumbéa, Montagne des Sources Strict Nature Reserve, 950 m, 21.IX.2016, *Thouvenot NC2061*; Yaté, Rivière Bleue Nature Park, 175 m, 5.X.2016, *Thouvenot NC2225*; Plaine des Lacs, on *Retrophyllum minor*, 245 m, 6.X.2016, *Thouvenot NC2369* (PC); Mont Dore, Prony village, 10 m, 21.IX.2012, *Thouvenot NC875* (PC); Farino, Grandes Fougères Nature Park, creek Houé, 425 m, on *Araucaria sp.*, 22.IX.2016, *Thouvenot NC2338*; Nouméa, Jean-Marie Tjibaou Cultural Centre, 1 m, mangrove, 24.IX.2012, *Thouvenot NC899* (PC); Koghis, *c.* 700 m, 9.IX.2001, *F. Müller NC198* (DR).

Description

Pseudautoicous

Dwarf male plants on leaf axis of female branches.

Plant

Small, creeping stems densely branched.

Branches

Short, thin, 3-4(-5) mm long, 0.6-1 mm wide, when dry curly, not funiculate, with leaves erect, individually twisted, carinate, the apex incurved to circinate, exposed by the margins, when moist erect to patent, the apices usually little incurved.

Branch leaves

Medium, 1.2-1.8 mm long, 0.28-0.35 mm wide, ligulate obtuse with apiculate apices, upper parts obscure to translucent, transitional parts long, basal parts short, costae strong,

protruding on the back, ending in the apiculi, margins papillose crenulate.

Upper cells
Single-layered, small, quadrate-hexagonal with rounded lumina, *c.* 10 mm wide, thin walled, bulging, with 3-5 small papillae per cell, the cells roughly aligned, transitional cells quadrate to short rectangular, thick walled, bulging, with single rounded papillae, lower cells few, rectangular elongate, 15-40 µm long, 10 µm wide, thick walled, lumina relatively wide, straight, cells with single rounded papillae scarce but present on most of the leaves.

Perichaetia
Inconspicuous, perichaetial leaves lanceolate, progressively acuminate, shorter and wider than the vegetative ones.

Calyptrae
Naked at base, with a few short hairs on the top.

Setae
Short, 2-5(-6) mm long, erect, vaginulae with inconspicuous hairs.

Capsules
Short exserted, 1-1.2 mm long, elliptic, smooth, rim plicate, red brown, small, incurved.

Peristome
Absent.

Spores
Not seen.

Remarks
In New Caledonia, *Macromitrium ligulaefolium* is characterized by: 1) very short branches tightly curly when dry; 2) short setae; 3) ligulate branch leaves medium length; 4) a few basal cells long rectangular; 5) calyptrae with short hairs confined to the top; 6) vaginula hairs inconspicuous; and 7) peristome absent. As stressed by Thériot (1908), the plants here brought together under this name may be separated from the other New Caledonian *Macromitrium* with short branches, short setae and plicate capsule rims by the short and scarce hairs of the calyptrae.

In the superficially similar *Macromitrium brachypodium, M. francii* and *M. pilosum* the vaginulae are conspicuously long hairy, the branches longer and the setae shorter.

M. hemitrichodes var. *sarasinii* has numerous long basal cells with narrow lumina.

Vitt & Ramsay (1985a: 448) considered *M. brevipilosum* as a synonym of *M. ligulaefolium*, without examination of the type. We could find type specimens in PC so that we agree with these authors, on the basis of most straits, but these New Caledonian plants have smaller leaves, less narrowly ligulate in most cases. Furthermore, the peristome is absent while, in *M. ligulaefolium*, it may be present, reduced or absent. Two more names synonymized by Vitt & Ramsay (op. cit.), *M. cucullatum* and *M. perminutum* are plants singularized by nearly smooth cells and upper half of branch leaves strongly carinate, difficult to flatten between slide and slip cover, so that the apex seems cucullate. Their branch length, 2-3 mm long, are the smallest in the range.

Macromitrium ligulaefolium was frequently collected from seaside to medium elevation, rarely above 700 m, often in half-light, relatively dry condition such as mangroves, anthropized environments, secondary forests, forest edges, shrublands, dry forests, wet forest with higher Araucarias, ect. Always epiphytes, on usually various kind of trunks, even on the usually moss free *Melaleuca quinquenervia*, on branches and twigs, rarely on thatched roof, ect.

Macromitrium microstomum (Hook. & Grev.) (Fig. 1A)

In Schwägr. *Species Muscorum Frondosorum*, suppl. 2, 2: 130 (1827).

M. pacificum Besch., *Annales de Sciences naturelles, Botanique*, sér. 5, 18: 209 (1873). — Type: New Caledonia, "in summo monte Mi", *Balansa 917*," in monte Humboldt", *Balansa 2536*;" in monte Mou", *Balansa 2974* (lecto-, *Balansa 917* BM000982740 [Vitt & Ramsay, 1985a]; isosyn-, PC[PC0096533, PC0137855]!).

M. pacificum var. *brevisetum* Thér., *Bulletin de l'Académie internationale de Géographie botanique* 20: 99 (1910). — Type: New Caledonia, Mt Koghis, *Franc s.n.* (lecto-, PC[PC0096531]!; isolecto-, PC[PC0137852-3]!).

M. pacificum var. *longisetum* Thér., *Bulletin de l'Académie internationale de Géographie botanique* 20: 99 (1910). — Type: New Caledonia, "Dent de St Vincent", *Franc s.n.* (lecto-, designated here PC[PC0096529]!) **syn. nov**.

Illustrations and description. — Vitt (1983); Vitt *et al.* (1995).

Distribution in New Caledonia. — *M. microstomum* is frequent in North and South Provinces.

Total range. — Australia. New Zealand, Indonesia, Philippine Islands, Papua New Guinea, South Pacific Islands, Hawaï, Central America, West Indies (Vitt & Ramsay 2006).

Selected specimens. — **New Caledonia**. Province Nord, Touho, Tipiléi valley, waterfall, 315 m, 12.X.2012, *Thouvenot NC1279*; Ponérihouen, Aoupinié, 1000 m, 20.X.2012, *Thouvenot NC882*; Hienghène, Panié massif, 1245 m, 9.X.2012, *Thouvenot NC1382*; Ouégoa, Mandjélia, 730 m, 5.X.2012, *Thouvenot NC876*; Province sud, Païta, Mt Humboldt, 1600 m, 31.VIII.2003, *F. Muller NC766* (DR); path to Mt Ouin, 900 m, 19.IX.2016, *Thouvenot NC2318* (PC); Dzumac massif, 840 m, 26.IX.2012, *Thouvenot NC881*; Mt Mou, 900 m, 10.IX.2001, *F. Müller NC427* (DR); Sarraméa, Dogny plateau, 943 m, 26.IX.2016, *Thouvenot NC2267* (PC); Bouloupari, Mt Do, 875 m, 25.X.2012, *Thouvenot NC1023* (PC); Thio, Mt Ningua, 1284 m, elfin forest, 24.IX.2016, *Thouvenot NC2346* (PC); Yaté, Rivière Bleue Nature Park, 680 m, 20.IX.2016, *Thouvenot NC2326*; Pic du Grand Kaori, 400 m, 4.X.2016, *Thouvenot NC2227*; Dumbéa, Montagne des Sources Strict Nature Reserve, 745 m, 21.IX.2016, *Thouvenot NC2387*; path to Mt Bouo, 850 m, 9.IX.2001, *F. Müller NC230* (DR).

Description
The types of *Macromitrium pacificum* as well as other New Caledonian specimens of *M. microstomum* are easily recog-

nized with the naked eyes or with hand lens by the habit of the branches in dry condition together with the length of the setae. This species is characterized by: 1) dense branching, short and thin branches 2-4(-10) mm long, 0.5-1 mm wide, when dry regularly funiculate with leaves twisted together in rows spirally coiled around the branches, leaf apices incurved to circinate; 2) small leaves narrowly lanceolate (0.7-)1-1.5 mm long; 3) cells smooth thorough, not bulging, thick walled, the upper ones small 5-10 µm long, 3-8 µm wide, the lower linear, up to 50 µm long, with narrow straight lumina; 4) perichaetia conspicuous, erect along the seta bases; 5) usually long thin setae (5-)10-30 mm long; 6) capsules oblong, 1.5 mm long, with very small mouths and plicate erect rims, peristome single; 7) naked calyptrae; and 8) autoicous condition and spores isomorphic. In New Caledonia, *M. microstomum* can only be confused with *M. taoense* (see under this species). The varieties described by Thériot are distinguished only by the length of the setae which is known to be a variable feature in the *Macromitrium* species with medium sized setae. Therefore, we do not keep them as distinct species. (Yu *et al.*, 2018).

The synonymy of *Macromitrium pacificum* with *M. microstomum* has been highlighted by Vitt (1983). Thereafter, Yu *et al.* (2018) have synonymized the variety *brevisetum* but hesitated to include the variety *longisetum* as they could not observe type specimen. Here we formalize its status and designate an original specimen as a lectotype.

In New Caledonia, *Macromitrium microstomum* is a mountain epiphyte, very frequent above 600 m up to the highest altitudes, rare below (300-400 m). It grows on trunks, branches and twigs in wet forests, riversides, elfin forests and mountain shrublands. It can be found in very shady environment, like near waterfall, as well as in sunny places in ultramafic bush.

Macromitrium orthostichum Nees *ex* Schwaegr.

Species Muscorum Frondosorum, Suppl. 4: 316, table 316a, fig 1-10 (1842).

Illustrations and description. — Dozy & Molkenboer (1859); Vitt *et al.* (1995).

Distribution in New Caledonia. — *M. orthostichum* was rarely found in New Caledonia.

Total range. — Tropical Africa, Indonesia, Malaysia, Melanesia, Philippine Islands, Tahiti (see Wilbraham 2016, for more details).

Selected specimen. — **New Caledonia.** Province Nord, Mt Panié, ad radices, II.1909, *Le Rat s.n.* PC[PC0721082]! (Herbarium Thériot, comm. Brotherus).

Description

Macromitrium orthostichum is close to *M. pilosum* with which it can easily be confused in sterile or immature conditions. Like this species, it is characterized by: 1) branches short, *c.* 5 mm long, funiculate, when dry, leaves erect appressed, incurved in upper part; 2) in wet conditions, branch leaves spreading squarrose recurved; 3) basal cells few, with many single papillae; 4) setae short, 2-4 mm long; and 5) peristome single. It can be separated from by: 1) vaginulae without conspicuous hairs; 2) setae verrucous; and 3) calyptrae shorter, covering half of the mature capsules, with many spreading hairs in basal part.

Macromitrium panduraefolium Thouvenot
(Fig. 15)

Cryptogamie, Bryologie 39: 444-448, figs 1-24 (2018).

Type. — **New Caledonia**. South Province, Dumbéa, Montagne des Sources Nature Reserve, *Neocallitropsis* plateau, 745 m, 21.IX.2016, *Thouvenot NC2329* (holo-, PC[PC0786119]!; iso-, author's private herbarium).

Illustrations and description. — Thouvenot (2018).

Distribution in New Caledonia. — *M. panduraefolium* was collected in two remote massifs, separated each other by 75 km and from Mt Humboldt, the locality of the nearest other aristate *Macromitrium*, by respectively 47 and 33 km. Therefore, this species is also candidate to micro-endemic status.

Total range. — Endemic to New Caledonia, only known from two localities in South Province.

Selected specimens (paratypes). — **New Caledonia**. Province Sud, Boulouparis, Mt Do, corticolous, on the bark at the basis of a dead *Araucaria* sp.; wet forest in an ultramafic massif; altitude 990 m; coordinates 21°45'S, 165°59'E; 15.IX.2016, *L. Thouvenot NC2306*; Dumbéa, Montagne des Sources Nature Reserve, *Neocallitropsis* plateau, on the bark of *Dacrydium araucarioides* in mountain scrubland in an ultramafic massif; 22°08'S, 166°35'E; altitude 745 m; 21.IX.2016, *L. Thouvenot NC2334*, *NC2386* (PC0786118!).

Description

Macromitrium panduraefolium is characterized by: 1) small branches fusiform, with leaves spirally appressed in dry condition, erect when moist; 2) costae of the vegetative and perichaetial leaves excurrent in conspicuous hyaline aristae; 3) branch leaves oblong-ligulate constricted at middle, rounded to obtuse or truncate at apex; 4) upper cells relatively large with thick bulging external walls and small acute papillae; 5) basal cells linear, all or most smooth, with straight lumina; and 6) exserted capsules with medium sized setae.

It may be separated from *Macromitrium rufipilum* by its smaller size in all features, branch habit in dry condition and original branch leaf outline.

Macromitrium panduraefolium is corticolous, the specimens were collected on the bark of endemic gymnosperms of the genera *Dacrydium* and *Araucaria* in mountain scrublands and wet forests on medium elevation ridges, 745-990 m a.s.l., in ultramafic massifs.

Macromitrium pilosum Thér.
(Figs 1H, 16)

Bulletin de l'Académie internationale de Géographie botanique 17: 308 (1907)

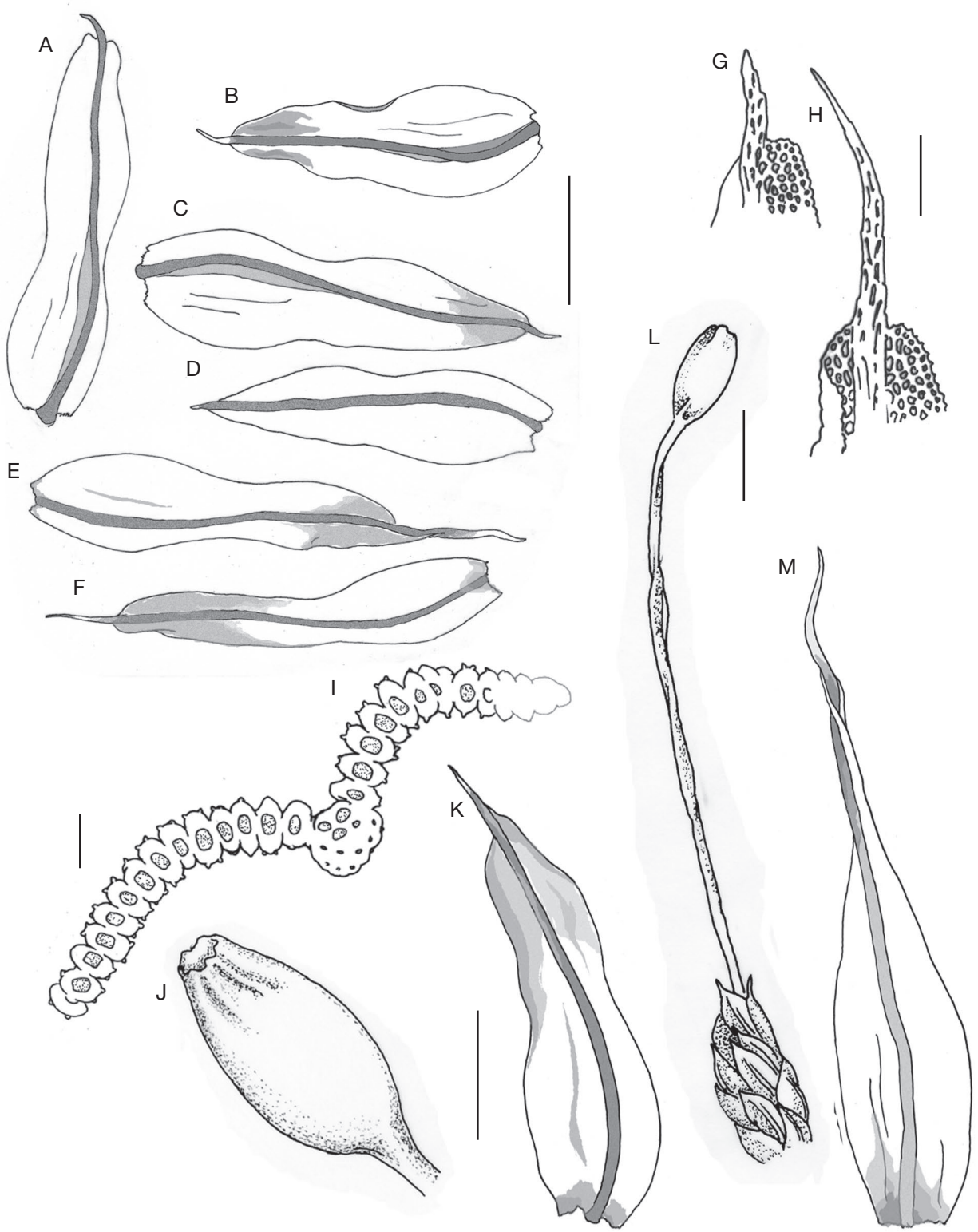

Fig. 15. — *Macromitrium panduraefolium* Thouvenot: **A**-**F**, branch leaves; **G**, **H**, branch leaf apices; **I**, transverse section in top quarter of branch leaf; **J**, capsule; **K**, **M**, perichaetial leaves; **L**, upper part of dry branch with sporophyte. All drawn from the holotype.Scale bars: A-F, J, K, M, 500 µm; G, H, 100 µm; I, 20 µm; L, 1 mm.

Macromitrium pilosum var. *brevifolium* Thér., *Bulletin de l'Académie internationale de Géographie botanique* 20: 99 (1910). — Type: New Caledonia, "pied des Koghis, forêt, 300 m", *Franc s.n.* (lecto-, designated here PC[PC0083718]!) **syn. nov**.

Macromitrium koghiense Thér., *Diagn. Esp. Var. Nouv. Mouss.* 8: 4 (1910). — Type: New Caledonia, «Mts Koghis, troncs d'arbre, alt. 500 m», *Franc s.n.* (lecto-, designated here PC[PC0096519]!) **syn. nov**.

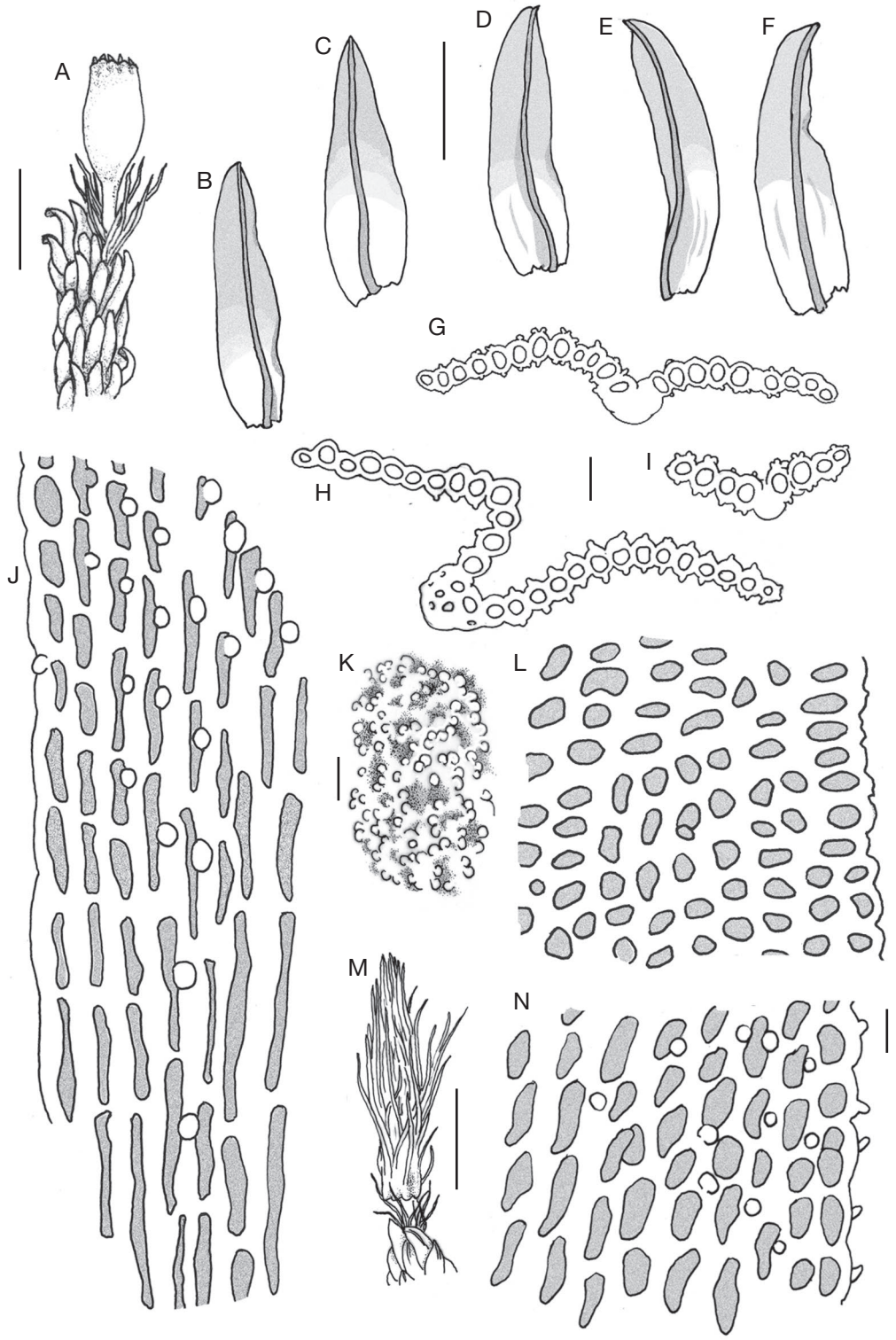

FIG. 16. — *Macromitrium pilosum* Thér.: **A**, upper part of dry branch with sporophyte; **B**-**F**, branch leaves; **G**, transverse section in upper third of branch leaf; **H**, transverse section in mid-leaf; **I**, transverse section in apex; **J**, basal and marginal cells; **K**, upper cells in surface view; **L**, upper and marginal cells; **M**, calyptra; **N**, transitional and marginal cells. Drawn from the lectotype (A, C, J-N), from the lectotype of *M. subsessile* Broth. & Paris (D-F), from the specimen *Guilloud NC2295* (B, G-I). Scale bars: A, M, 1 mm; B-F, 1 mm; G-I, 20 µm; J-L, N, 10 µm.

Macromitrium koghiense var. *spiricaule* Broth. & Paris, *Öfversigt af Finska Vetenskaps-Societetens Förhandlingar* 53A(11): 16 (1911). — Type: New Caledonia, Me Areimbo, *L. Le Rat s.n.* (lecto-, not seen; iso-, PC[PC0096520]!) **syn. nov**.

Macromitrium subsessile Broth. & Paris, *Öfversigt af Finska Vetenskaps-Societetens Förhandlingar* 51A: 17 (1909). — Type: New Caledonia, "Mt Dzumac, ad corticem arborum", *A. Le Rat s.n.* (lecto-, designated here REN[REN000099] [Herbarium E.G.

Paris]!; isolecto-, H[H-BR2561004]! [*fide* Isoviita *in Sched.* 1983], PC[PC0137890]!) **syn. nov**.

Type.— **New Caledonia**. "environs de Nouméa", 1906, *Franc s.n.* (lecto-, designated here Herbarium Thériot *s.n*. PC[PC0096514]!)

Distribution in New Caledonia. — *M. pilosum* was hitherto only found in South Province.

Total range. — Endemic to New Caledonia.

Selected specimens. — **New Caledonia**. Province Sud, Koghis, 1909, *Franc s.n.*, PC0721081 (PC); Thio, Mt Ningua, 1100 m, 29.IX.2012, *Larraín 35510*; Yaté, Plaine des Lacs, 245 m, 6.X.2016, *Thouvenot NC2389* (PC); Dumbéa, Trail to Dzumac massif, 900 m, 26.IX.2012, *Larraín 35355*; Yaté, Rivière Bleue Natural Park, 216 m, 22.IX.2016, *Thouvenot NC2243* (PC); Yaté, route à horaire, 105 m, 11.IX.2016, *Guilloud NC 2295*; Farino, Grandes Fougères Natural Park, 540 m, 22.IX.2016, *Thouvenot NC2343*; La Foa, Dogny plateau, 926 m, 26.IX.2016, *Thouvenot NC2357* (PC); Païta, Mt Mou, 1100 m, 17.IX.2016, *Thouvenot NC2310* (PC); Dumbéa, Mt Bouo, 930 m, 16.IX.2016, *Thouvenot NC2300*.

Description

Sexual

Condition unknown.

Plant

Medium, upper parts light green, lower parts olive green to light brown, creeping stems densely branched.

Branches

Thin, small to medium, 2-8(-12) mm long, 0.5-1 mm wide, straight to slightly curved, simple or furcate, when dry funiculate, with leaves erect to appressed, usually spirally arranged, carinate, the apex adaxially incurved and hidden between the neighbouring leaves, sometimes twisted on branch tips, when moist spreading recurved.

Branch leaves

Small to medium, 0.75-1.2(-1.6) mm long, 0.3-0.4 mm wide, usually lanceolate in outline, laminae lanceolate to ligulate from a wider basal part, the apices acute to obtuse and apiculate or mucronate, upper parts obscure to translucent, transitional parts short to long, basal parts undifferentiated to very short, (1/5-)1/8-1/10 the whole leaf length, costae thick, ending in apices or apiculi, margins papillose crenulate, plane.

Upper cells

Single-layered, rounded to oval, small, 6-10(-12) µm wide, thin walled, bulging, with 3-5 small papillae per cell, the cells roughly aligned, marginal cells undifferentiated or smaller in one row, usually oblate, transitional cells oval to short rectangular, walls unevenly thickened, with single rounded papillae, lower cells few, rectangular, 12-35 µm long, 7-8(-10) µm wide, thick walled, lumina wide or narrow in the same leaf, basal cells with single rounded papillae abundant to scarce but present on most of the leaves.

Perichaetia

Inconspicuous, perichaetial leaves similar to the vegetative.

Calyptrae

With dense and erect hairs.

Setae

Very short, 1-1.5(-2) mm long, erect, vaginulae with long hairs reaching the capsule.

Capsules

Short exserted, 1(-1.2) mm long, ovoid to elliptic, smooth, rim plicate, brown, small, incurved.

Peristome

Single.

Spores

Anisomorphic 20-45 µm.

Remarks

For differences with close species, see above paragraphs dealing with *Francii* group and *Macromitrium francii*. Amongst the new synonyms, *M. koghiense* does not show any difference with *M. pilosum*, *M. koghiense* var. *spiricaule* is a form with relatively long thin branches, up to 12 mm long. The pocket of the specimen at PC was first labelled "*M. spiricaule* B. P. *n. sp*." handwritten by Brotherus who sent it to Thériot, the latter added the name "*M. koghiense* Thér. ined." Likely, Brotherus tooks acompte of that in his publication. Therefore, the specimen PC could be selected as a lectotype, but it would be better to look for a more pertinent sample at H.BR. A part of the type of *M. subsessile*, sent by Brotherus, was annotated by Thériot as similar to *M. pilosum*. Indeed, our observation of type specimens as well as the Brotherus protolog support the synonymy with *M. pilosum*. The specimen kept in H-BR as a type (unpublished) lack sporophyte whereas Brotherus protolog includes its description. We therefore chose the fertile duplicate in Paris herbarium (REN) as the lectotype. The variety *brevifolium* of *M. pilosum*, only distinguished by short leaves, cannot be retained.

Macromitrium pilosum is frequent in ultramafic as well as sedimentary massifs, on barks and twigs one meter up above the ground, from lowland up to 1200 m in scrublands or riparian, wet and cloud forests. It is significantly more present at lowest altitude, 100-200 m.

Macromitrium pulchrum Besch. var. ***pulchrum***
(Figs 1I, 17)

Annales des Sciences naturelles, Botanique, sér. 5, 18: 210 (1873).

Macromitrium pulchrum var. *aristatum* Thér., *Revue bryologique* 48: 16 (1921). — Type: New Caledonia, *Franc s.n.* (lecto-, designated here *fide* Guo *in Sched.* [2007] PC[PC0083721]!) **syn. nov**.

M. pulchrum var. *densirete* Thér., *Revue bryologique* 49: 16 (1921). — Type: New Caledonia. Mt Koghis, XI.1909, *Franc s.n.* lecto-, designated here *fide* Guo *in Sched.* [2007] PC[PC0083722]!) **syn. nov**.

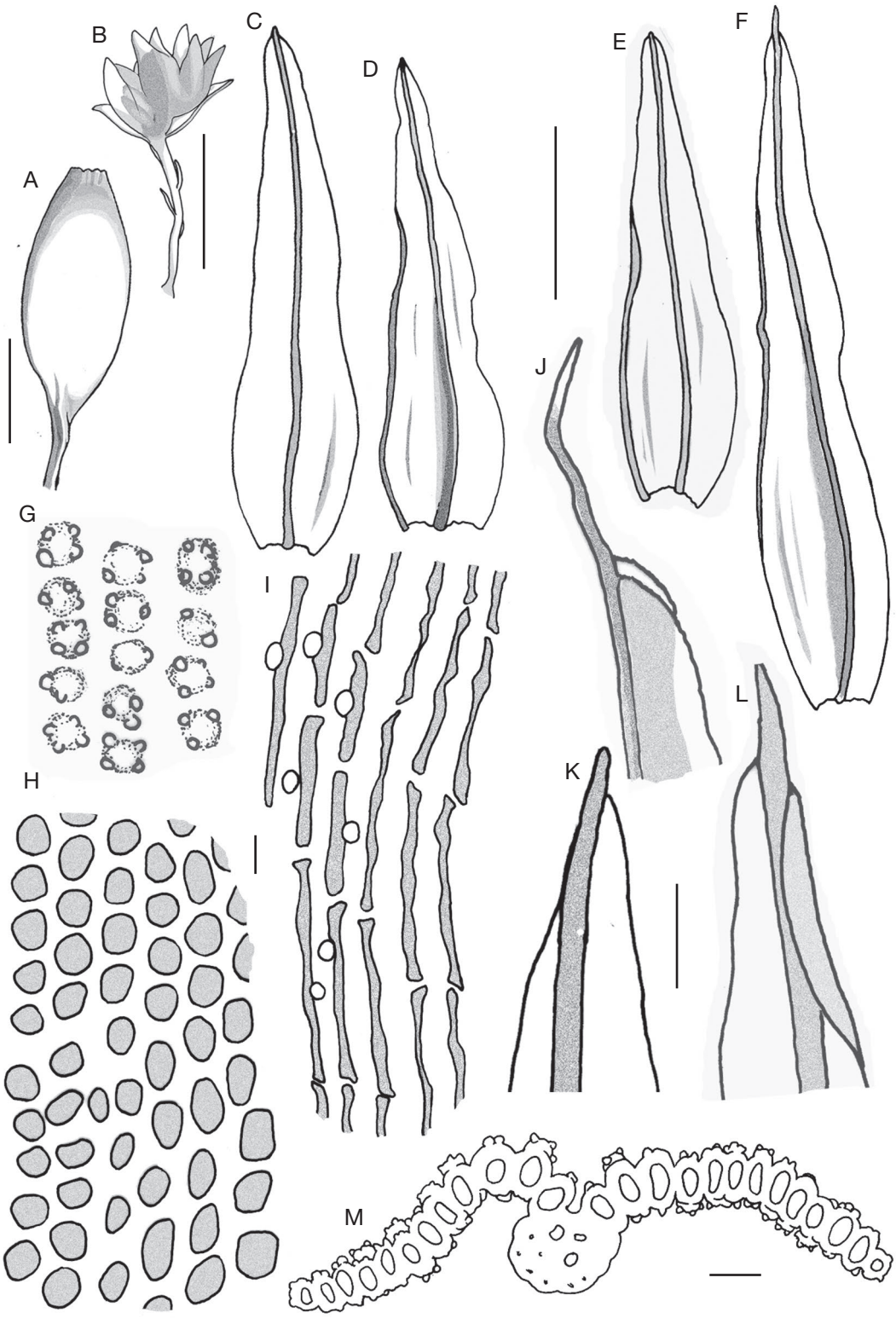

FIG. 17. — *Macromitrium pulchrum* Besch. var. *pulchrum*.: **A**, capsule; **B**, dwarf male plant; **C**-**F**. branch leaves; **G**, upper cells in side view; **H**, upper cells; **I**, basal cells; **J**-**L**, branch leaf apices of three varieties; **M**, transverse section in top quarter of branch leaf. Drawn from the isotype *PC0096501* (A, C, I, L), from the lectotype of *M. pulchrum* var. *densirete* Thér. (E, K, M), from the lectotype of *M. pulchrum* var. *aristatum* Thér. (F, J), from the specimens *Thouvenot NC2226* (B), *NC2247* (G, H), *NC2252* (D). Scale bars: A, 1 mm; B, 500 µm; C-F, 1 mm; G-I, 10 µm; J-L, 100 µm; M, 20 µm.

TYPES. — **New Caledonia**. "In monte Humboldt, 1200 m alt., *Balansa 2528*; in monte Mou, *Balansa 2980 partim"* (lecto-, *fide* Vitt *in Sched.* [1983] BM[BM000982761]; isolecto-, PC[PC0137910]!; syn-, PC[PC0096501, PC0137911, PC137912, PC137913]!).

DISTRIBUTION IN NEW CALEDONIA. — Widely distributed in North and South Province.

TOTAL RANGE. — Endemic to New Caledonia.

Selected specimens. — **New Caledonia**. Province Nord, Hienghène, Mt Panié massif, between Bwa Téan and Payolé, in wet mountain forest, 1245 m, 9.X.2012, *Thouvenot NC1374* (PC); Province Sud, Boulouparis, Mt Do, stunted vegetation with patches of *Araucaria montana* and *Notofagus* forests, 1000 m, 27.IX.2012, *Larraín 35414*; Dumbéa, Montagne des Sources, wet forest with *Araucaria rulei*, 950 m, 21.IX.2016, *Thouvenot NC2330* (PC); Dumbéa, Koghis, along the trail from Auberge des Koghis to the summit, *c.* 900m, 9.IX.2001, *Frank Müller NC116* (DR); Mt Humboldt, on the trail to the hut near the summit, 1400 m, 30.VIII.2003, *Frank Müller NC768* (DR); Thio, Mt Ningua, stunted forest, 1120 m, 29.IX.2012, *Thouvenot NC872*; Païta, Mt Mou, tall mountain scrubland, on ridge, 1110 m, 17.IX.2016, *Thouvenot NC2297* (PC); Yaté, Pic du Grand Kaori, tall scrubland, 363 m, 4.X.2016, *Thouvenot NC2371* (PC); Parc de la Rivière Bleue, open wet forest, 680 m, 20.IX.2016, *Thouvenot NC2249*.

Description

Pseudautoicous
Dwarf male plants on leaf axis of female branches.

Plant
Medium to large, upper parts light green, sometimes reddish, or olive green, lower parts light to dark brown, creeping stems densely branched.

Branches
Thick, medium to long, (4-)7-16(-20) mm long, 1.5-2 mm wide, straight to curved, simple or furcate, when dry usually unevenly curly, not funiculate, with leaves erect, individually twisted flexuous, carinate, the apex incurved to circinate, exposed by the margins, when moist erect to patent, usually little recurved or straight.

Branch leaves
Large, 2.5-4(-4.5) mm long, 0.4-0.8 mm wide, lanceolate in outline, laminae usually ligulate from a wider basal part ovate to oblong, the apex narrowly obtuse, mucronate to short aristate, in a few cases lanceolate acuminate, upper part opaque, basal translucent part occupying 1/3-1/5 the leaf length, aristae if any less than 0.2 mm long, costae medium thick, excurrent, margins papillose crenulate, plane or recurved on one side near base.

Upper cells
Single-layered, of various sizes ranging (7-)10-20(-30) µm long, (7-)10-12 mm wide, quadrate, rounded to oblong elliptic, thick walled, bulging, the external walls strongly protruding, rounded to conical with small papillae simple to furcate, the cells roughly aligned, marginal cells smaller in one row, transitional part usually short, transitional cells short rectangular, thick walled, walls irregular, porous nodulose, with single rounded papillae, lower cells rectangular elongate to linear, 20-55(-80) µm long, 7-10 µm wide, very thick walled, walls 2.5-3.5 µm wide, lumina straight, narrow, single papillae scarce, low to high rounded.

Perichaetia
More or less visible, erect, loosely sheathing the seta bases, perichaetial leaf sizes and papillae similar to the vegetative ones, lanceolate, mostly acuminate or acute, aristate, translucent thorough.

Calyptrae
Naked.

Setae
Long, (15-)18-30(-35) mm long, thin, flexuous, vaginulae naked.

Capsules
1.5-2 mm long, elliptic to narrowly oblong, smooth, rims plicate, brown, small, erect to incurved.

Peristome
Absent or reduced to a papillose membrane.

Spores
Anisomorphic (12-)15-32(-37) µm.

Remarks

Macromitrium pulchrum is easily recognized by: 1) medium to large size with long setae; 2) dense branching with simple branches, curly when dry, with leaves erect, individually twisted to curved apices exposed by the margins; 3) large branch leaves ligulate to lanceolate, with a widened basal part ovate oblong; 4) upper cells uneven in size, bulging because of the strongly protruding external walls, pluripapillose; 5) basal cells linear with very thick walls, straight narrow lumina and scarce single papillae; 6) calyptrae naked; and 7) capsules narrowly oblong, sub-cylindric, with brown erect plicate rims and peristome lacking or reduced to a short membrane.

Apart from the *Pulchrum* group, none of the other New Caledonian species exhibit such combination of characters, most of them being smaller species with smaller setae.

Other large species like *Macromitrium leratii, M. laevigateum* or *M. salakanum* have short setae and different leaf shape.

For differences with species of the *Pulchrum* group: *Macromitrium cardotii, M. rufipilum* and *M. pulchrum* var. *neocaledonicum*, which also are large plants and possess large setae, see comments in the corresponding paragraphs.

The varieties described by Thériot (1921a) show too minor differences to be kept here: *Macromitrium pulchrum* var. *densirete* more closely resemble *M. pulchrum* var. *neocaledonicum* (see below) but with the branch habit of *M. pulchrum var. pulchrum* when wet. *M. pulchrum* var. *aristatum* has leaves like the type variety but longer excurrent costae and longer branches which are variable intra-specific characters in the *Pulchrum* group. The type in PC has long branches, simple or fasciculate, up to 22 mm long, setae 18-20 mm long, basal cells with single scattered or ranked papillae. So, *M. pulchrum* var *densirete* and var. *aristatum* may be included in the variability of the type variety.

Macromitrium pulchrum is one of the most frequent species in New Caledonia, growing on trunks in wet mountain forests above 400 m, rarely at 300-400 m. It mostly inhabits cloud forests on ridges and summit up to 1400 m.

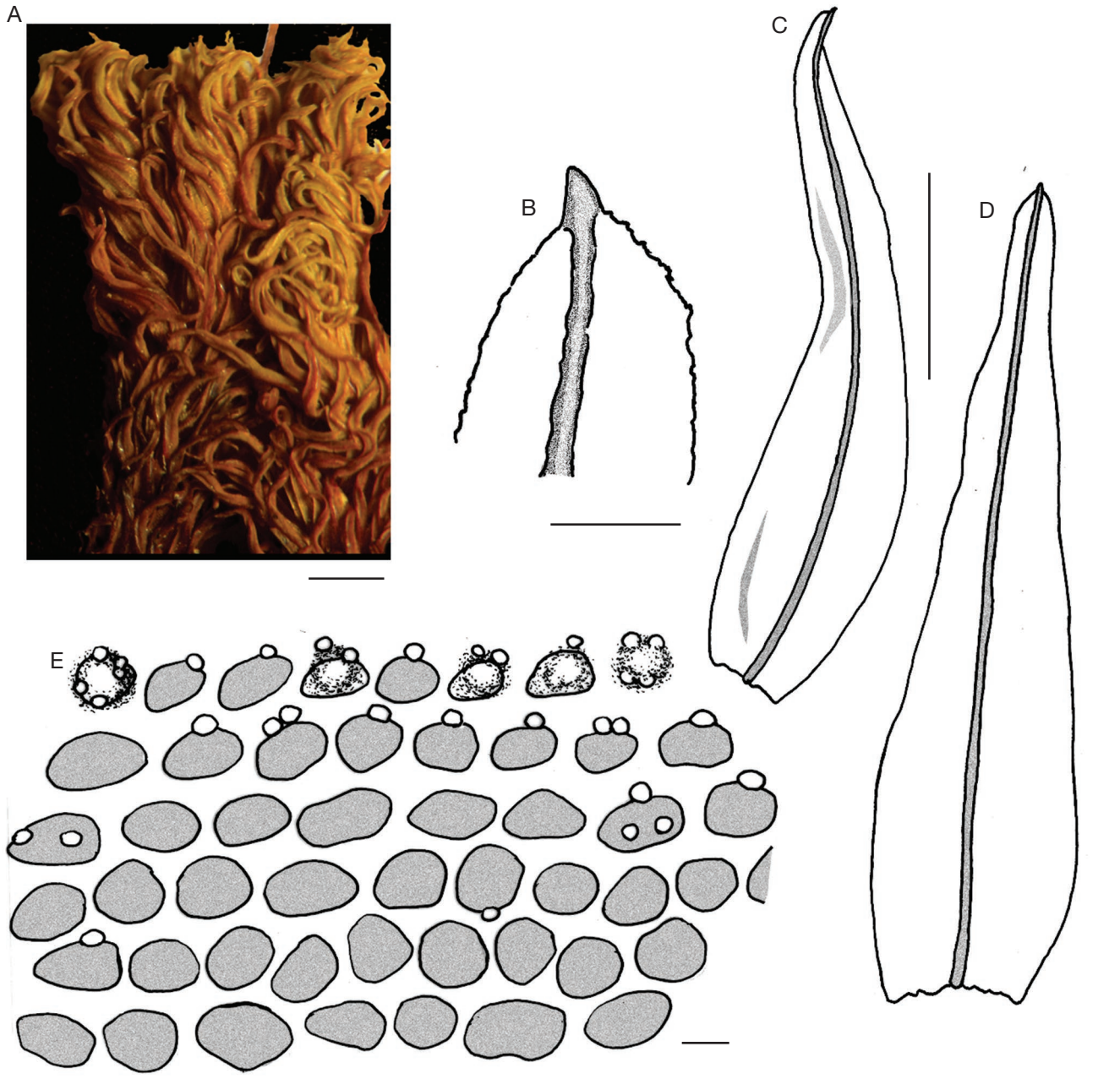

Fig. 18. — *Macromitrium pulchrum* var. *neocaledonicum* (Besch.) Thouvenot.: **A**, branches in dry condition; **B**, branch leaf apex; **C**, **D**, branch leaves; **E**, upper cells. All drawn from the isotype *PC0096506*. Scale bars: A, C, D, 1 mm; B, 100 µm; E, 10 µm.

Macromitrium pulchrum var. ***neocaledonicum***
(Besch.) Thouvenot, comb. nov.
(Fig. 18)

Basionym. — *Macromitrium neocaledonicum* Besch., *Annales des Sciences naturelles, Botanique*, sér. 5, 18: 211 (1873).

Type. — New Caledonia, "in monte Mou,1200 m, *Balansa 2980* cum M. pulchro socium" (lecto-, *fide* Vitt *in Sched.* [1983] BM[BM000982735]; isolecto-, PC[PC0137835, 0137836, 0096506]!).

Distribution in New Caledonia. — Rarely found in South Province.

Total range. — Endemic to New Caledonia.

Selected specimens. — **New Caledonia**. Province Sud, Païta, Dzumac massif, in mountain forest with understorey dominated by Cyperaceae, in ultramafic massif, 915 m, 18.IX.2008, *Thouvenot NC230*.

Remarks

Macromitrium neocaledonicum is very similar to *M. puchrum* whose it shares most traits except: 1) in dry condition, leaf apices less tightly enrolled; 2) in wet condition, leaves spreading recurved instead of erect-spreading; 3) branches usually longer with fastigiated branchlets, up to 20 mm

long, the perichaetia developing at apices of branchlets or single main branches; 4) upper leaf shape narrowly ligulate, rounded to obtuse and mucronate at apices instead of lanceolate acute; and 5) upper cells more evenly isodiametric, less thick-walled.

These typical features were used by Bescherelle to define *M. neocaledonicum* as a species since they are well expressed in the type specimen. However, we could observe among type specimens in PC or more recent collections some samples lacking one or more of these characters, e.g.: 1) samples with simple and shorter branches can be considered as included in intra-specific variability. Fastigiated branches are quite rare in New Caledonian *Macromitrium* and we are not aware of their value as a specific discriminating character; 2) samples may possess lanceolate leaves with narrowly obtuse to acute apices. In these cases, the plants are intermediate between *M. neocaledonicum* by their dry/wet habit and *M. pulchrum* by their size and leaf shapes; and 3) the type of *M. pulchrum* var. *densirete* has branches with fastigiate branchlets, smaller cells and narrowly rounded leaf apices, like *M. neocaledonicum*, but with the shape of *M. pulchrum* branches when moist. Due to these various patterns in the features used to discriminate these two taxa, we do not retain the specific status for *M. neocaledonicum*. However, it seems necessary to keep in mind this well characterized "form", especially because the type specimen of *M. neocaledonicum* was found mixed in a sample of *M. pulchrum.* It could hide different evolutionary processes that cannot be understood at this stage of knowledge and needs further studies involving more material and molecular studies. Besides, the difference in the wet habit of the leaves could be interesting regarding adaptation to ecological constraints (see above in the *Francii* group paragraph). Therefore, we provisionally propose a varietal status.

Macromitrium renauldii Thér.
(Fig. 19)

Bulletin de l'Académie internationale de Géographie botanique 17: 307 (1907).

Macromitrium gracilipes Cardot, *Bull. Herb. Boiss.* Sér2, 8: 168 (1908). — Type: New Caledonia, Balade, *Vieillard 1735* (lecto-, designated here *fide* Guo *in Sched.* [2007] PC[PC0083666]!; isolecto-, PC[PC083665]!) **syn. nov**.

Macromitrium leratioides Broth. & Paris, *Öfversigt af Finska Vetenskaps-Societetens Förhandlingar* 51A (17): 15 (1909). — Type: New Caledonia, Mt Dzumac, "ad arbores", *A. Le Rat s.n.* (lecto-, designated here *fide* Vitt *in Sched.* [1983]: H.BR[H.BR2618013]!; isolecto-, PC[PC0096518]! *pro parte*) **syn. nov**.

Type. — **New Caledonia**. "env. Nouméa", *Franc s.n.* (lecto-, designated here, *fide* Guo *in Sched.* [2007] PC[PC0083728]!).

Distribution in New Caledonia. — More frequent in South Province. In North Province known only from the type specimen.

Total range. — Endemic to New Caledonia.

Selected specimens. — *Macromitrium renauldii* **New Caledonia**. Province Sud, Païta, Dzumac, on bark in mountain forest with Cyperaceae, 915 m, 18.IX.2008, *Thouvenot NC196*; Boulouparis, Mt Do, on bark in mountain wet forest, 800m, 25.X.2012, *Thouvenot NC1017* (PC); Yaté, Madeleine waterfalls, epiphyt, 248 m, 4.IX.2003, *Frank Müller NC761* (DR); Plaine des Lacs, on bark of *Retrophyllum min*or on river bank, 245 m, 6.X.2016, *Thouvenot NC2367* (PC), Parc de la Rivière Bleue, on bark in wet forest on deep soil, 175 m, 5.X.2016, *Thouvenot NC2233*; Plaine des Lacs, Creek Amos, on bark in gallery forest inside shrubland, 270 m, 6.X.2016, *Thouvenot NC2377* (PC); Pic du Grand Kaori, on bark in shrubland, 490 m, 4.X.2016, *Thouvenot NC2263*. M. leratioides; Plaine des Lacs, 1904 (?), *Compton s.n.* (PC009650).

Description

Pseudautoicous
Dwarf male plants on leaf axis of female branches.

Plant
Small to medium sized, upper parts yellow-green, older lower parts brown or olive green, creeping stems densely branched.

Branches
Thin, short to medium, 2-8(-10) mm long, 0.8-1 mm wide, straight, simple or rarely shortly furcate, when dry loosely coiled, leaves loosely erect or obliquely to transversely oriented, individually twisted, carinate, the apex incurved to circinate, unevenly directed, when moist erect to patent, usually little recurved.

Branch leaves
Small to medium, 0.8-1.8(-2.3) mm long, 0.2-0.4 mm wide, lanceolate, more or less long acuminate, translucent thorough, basal part being 1/3 the leaf length, apex acute, apiculate to very short aristate, aristae less than 0.1 mm long, costae thick, ending just below the apex to excurrent, margins smooth, plane to slightly recurved on one side near base.

Upper cells
Single-layered, small, 7-10(-12) µm wide, very thick walled, quadrate with rounded to oval lumina, flat to little bulging, smooth or rarely with a few low papillae, the cells arranged in continuous longitudinal rows with the transverse limits usually inconspicuous, marginal cells sometimes smaller in 1-3 ranks, transitional part null to very short, with an inverted "v" shape, transitional cells short rectangular, thick walled, sometimes with single rounded papillae, lower cells rectangular elongate, 10-40 µm long, 7-10 µm wide, very thick walled, walls 2-5 µm wide, lumina straight to wavy, narrow, single papillae scarce to numerous, possibly displayed on plicae, low to high rounded.

Perichaetia
More or less obvious, loosely erect, not sheathing, perichaetial leaves usually distinct, larger than the vegetative ones, oblong to more widely lanceolate or triangulate.

Calyptrae
Hairy.

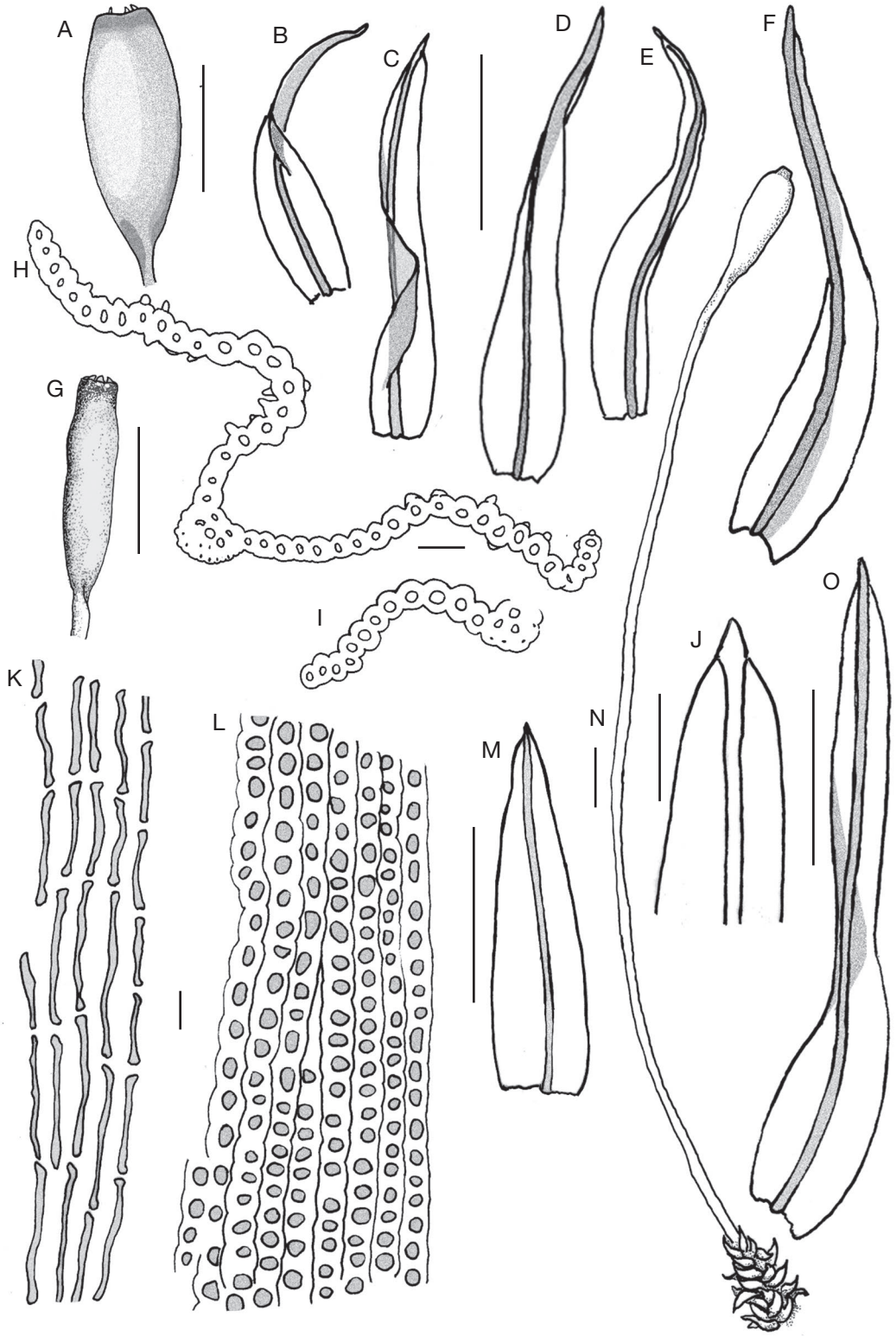

FIG. 19. — *Macromitrium renauldii* Thér.: **A**, **G**, capsules; **B**-**F**, **O**, branch leaves; **H**, transverse section in basal quarter of branch leaf; **I**, transverse section in top quarter; **J**, branch leaf apex; **K**, basal cells; **L**, upper cells; **M**, perichaetial leaf; **N**, sporophyte. Drawn from the lectotype (**C**-**E**, **J**-**L**), from the lectotype of *M. leratioides* Broth. & Paris (**A**, **F**), from the lectotype of *M. gracilipes* Cardot (**O**), from the specimens *Thouvenot NC2263* (**B**), *NC2229* (**G**), *NC2377* (**H**, **I**), *NC2233* (**M**), *NC1017* (**N**). Scale bars: A, G, 1 mm; B-F, M, O, 1 mm; H, I, 20 µm; J, 100 µm; K, L, 10 µm; N, 1 mm.

Setae
Medium to large, 12-25 mm long, thin, straight to flexuous, vaginulae with long hairs, usually conspicuous.

Capsules
1.5-2 mm long, narrowly elliptic to sub-cylindric, smooth, rims brown, small, erect, without plicae.

Peristomes
Present, single or little developed.

Remarks
The taxa brought together under the name of *M. renauldii* share: 1) the original arrangement of the smooth upper cells in very regular longitudinal rows, underlined by thicker walls; 2) short branches; 3) branch leaves when dry typically spirally coiled with apices incurved like crooks or circinate; 4) basal cells elongate with narrow lumina usually wavy and single papillae; 5) long setae; and 6) vaginulae and calyptrae hairy. In the upper cells, the border of contiguous transversal walls of cells are barely visible and the bands of cells appears in parallel files more or less transversally staggered, making the lamina rough. The lower cells are also arranged in longitudinal rows, underlined by thicker longitudinal walls and sinuous lumina which make a conspicuous wavy line. So that the entire leaves appear longitudinally striated. The ornamentation of the lower parts is variable, from nearly smooth thorough to locally strongly papillose. The variability concerns the branch length and shape or the costa excurrence. The characteristic features underlined in the diagnosis are incompletely recognized in the type specimens examined: in *M. gracilipes*, Cardot (1908) emphasises shorter branches, branch leaves patent-spreading when moist, less excurrent costae and smooth capsule rims versus squarrose leaves when moist with long excurrent costae and plicate capsule rims in *M. renauldii*. The type specimen checked exhibits less evidence because the leaf apices are varying in shape and costa excurrence. In the Brotherus' description of *M. leratioides* (1909), all the features are identical to those described by Thériot (1907) for *M. renauldii* and observed in the type. The type specimens of the three taxa and nine recently collected samples match our description with emphasis on branch leaf shapes, cell ornamentation and areolation, seta length, branch density, length range and shape in dry condition.

Macromitrium taoense shares the same areolation, setae and branch length and branch habit in dry condition but differs from by its naked calyptrae and vaginulae. However, it could be reduced to synonymy, but material of *M. taoense* is too scarce to conclude.

Thus defined, *M. renauldii* is found on barks of trees and treelets in riparian shrublands, lowland mesophilous forests or mountain wet forests with fairy open canopy, in the ultramafic massifs. It is a little frequent species growing in lowland up to medium elevation, usually collected between 100-1000 m a.s.l.

Macromitrium rufipilum Cardot, (Fig. 2H, 20)

Bulletin de l'Herbier Boissier, sér. 2, 8: 169 f. 4 (1908).

Type. — Balade, *Vieillard s.n.* ("typus in herb. Boissier et herb. Cardot"). *Vieillard 1735 p.p.* (lecto-, designated here PC[PC0096531]!; isolecto-, PC[PC0096534]!).

Distribution in New Caledonia. — Hitherto only collected in two localities of North Province.

Total range. — Endemic to New Caledonia.

Selected specimen. — **New Caledonia**. Province Nord, Canala, Mt Bogota, altitude 500 m, X.1911, *Sarasin 391*, PC[PC0737584 (PC)].

Description
Pseudautoicous
Dwarf male plants on leaf axis of female branches.

Plant
Medium sized, red brown in herbarium, stems creeping.

Branches
Thick, medium sized, 5-13 mm long, when dry loosely spiralled, spiky, leaves erect to oblique, flexuous, carinate, the incurved apex unevenly directed, when moist erect to patent, straight.

Branch leaves
Large, 3-4.5 mm long, 0.5-0.8 mm wide, ligulate, widening slightly downwards, the apices usually obtuse to truncate, some of them shortly acute on the same branch, long aristate, the aristae thin, flexuous, red with hyaline tip, 0.4-1.5 mm long, basal parts of leaves 1/4-1/5 leaf length, costae thin, red, long excurrent, margins papillose crenulate.

Upper cells
Single-layered, of varying size ranging 10-20 µm long, 10-12 µm wide, thick walled, rounded, ovate to oblong, strongly bulging, the external walls strongly protruding, rounded to high conical with small papillae simple to furcate, the cells roughly aligned, marginal cells smaller in one row, transitional part usually short, transitional cells rectangular, thick walled, walls irregular, porous nodulous, with rounded to high single papillae, lower cells rectangular, elongate to linear, 35-85 µm long, 7-10(-15) µm wide, very thick walled, lumina straight, irregularly narrow 1/3-1/4 cell width, papillae null in basal parts to numerous near transitional parts.

Perichaetia
Indistinct, perichaetial leaf size and cell ornamentation like the vegetative ones, shape lanceolate, acuminate or acute, long aristate.

Calyptrae
Naked.

Setae
Long, 20-25 mm long, thin, flexuous, vaginulae hairless but with a few short paraphyses.

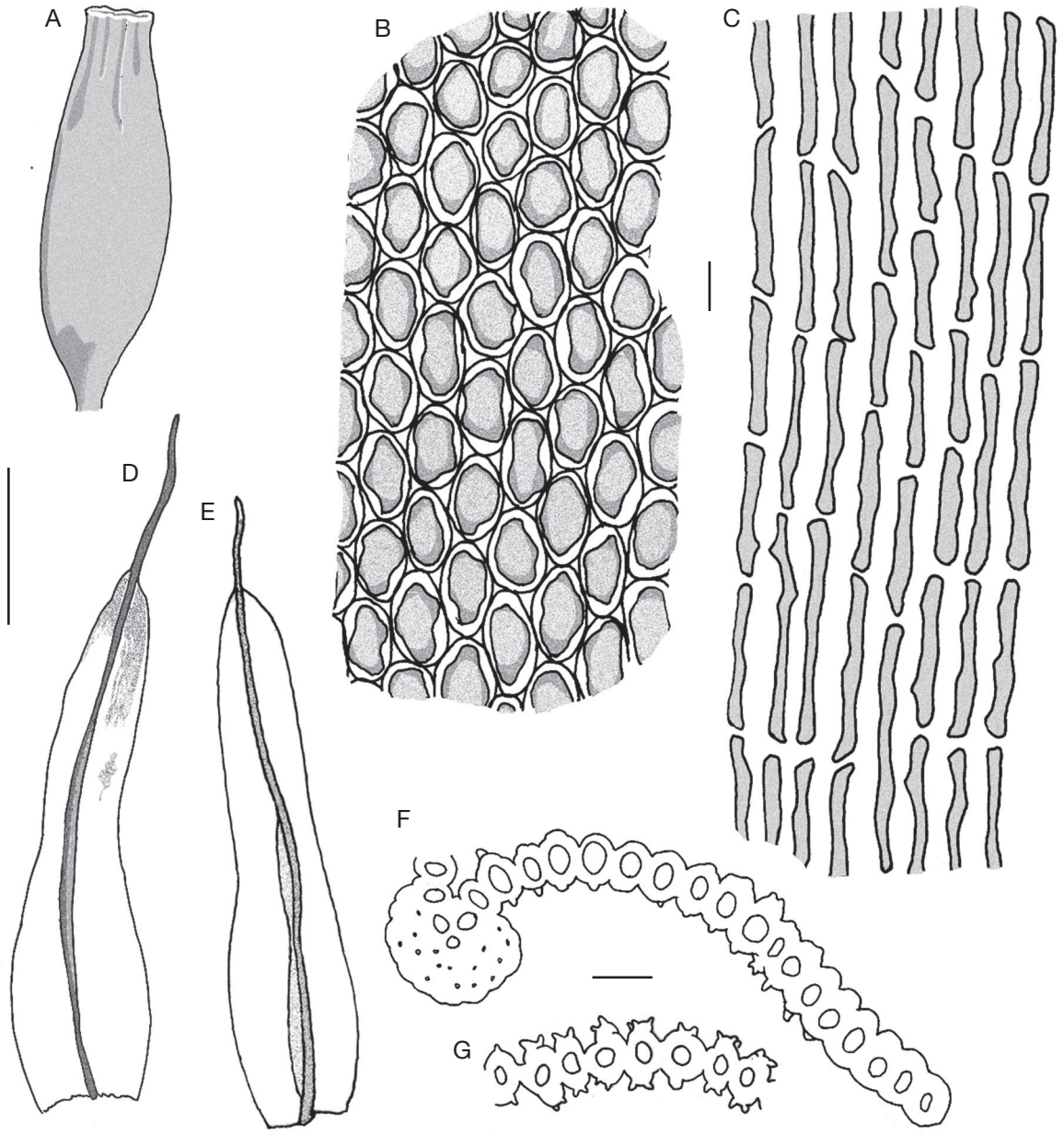

Fig. 20. — *Macromitrium rufipilum* Cardot.: **A**, capsule; **B**, upper cells; **C**, basal cells; **D**, **E**, branch leaves; **F**, half transverse section in transitional part of branch leaf; **G**, transverse section in top quarter of branch leaf (fragment). All drawn from the lectotype except for **E** from the specimen *Sarasin 391*. Scale bars: A, D, E, 1 mm; B, C, 10 µm; F, G, 20 µm.

Capsules
2-2.5 mm long, narrowly oblong, sub-cylindric, smooth, rims plicate, brown, erect.

Peristome
Absent or reduced to a white ridge.

Remarks
Macromitrium rufipilum is the most distinctive taxon in the *Pulchrum* group, essentially by the long reddish aristae and the conspicuous spiky and spiralled shape of the branches in dry condition. Other characters such as very long leaves, smooth basal cells, longer capsules allow to separate it from most of the specimens in the *Pulchrum* group, but they can also be observed in some *M. pulchrum* var. *pulchrum* specimens with short aristate and obtuse leaves.

Compared to other species with long aristae, *M. larrainii*, *M. humboldtense* and *M. panduraefolium*, *M. rufipilum* differs from by many significant features (see under these species). The lectotype selected here is included in a pocket coming from the Cardot's herbarium kept in PC. Ecological conditions are unknown.

Macromitrium salakanum Müll.Hal.

Synopsis Muscorum Frondosorum omnium hucusque Cognitorum 2: 646 (1851).

Illustrations and description. — Vitt *et al.* (1995).

Distribution in New Caledonia. — Rarely found but present in North Province.

Total range. — Indonesia, Philippines, Western Melanesia (Vitt *et al.* 1995).

Selected specimens. — **Java**. Tjibodas im Berggarten an Bäumen 1450 m, III.1900, Fleischer Musci Archipelagi Indici 128, PC0738562 (PC); **New Caledonia**. Province Nord, Poindimié, mountains south of Amoa River, in shrublands and low forests, 230 m, 11.X.2012, *Larraín 35929* (PC).

Remarks

Compared with *Macromitrium leratii*, the plants related to *M. salakanum* in New Caledonia are medium to large with branches reaching 22 mm long, thinner, 1-1.5 mm wide, branch leaves smaller, 2-2.6 mm long, lanceolate, with the same areolation. But they can be separated from more easily by: 1) the upper cells single-layered thorough; 2) the intermediate cells more progressively longer toward the leaf base; 3) branch leaves less narrowly acuminate; and 4) calyptrae somewhat hairy in upper part.

The differences between *Macromitrium leratii* and *M. salakanum* are not very robust in New Caledonia specimens and it would be necessary to look for molecular evidences in order to test that distinction. The bistratose upper cells observed in *M. leratii* must be linked to other features such as calyptra hairiness, long acuminate vegetative leaves and molecular data.

Macromitrium taoense Thér.
(Figs 1F, 21)

Diagnoses d'Espèces et de Variétés nouvelles de Mousses 8: 5 (1910).

Type. — **New Caledonia**. "Tao, forêt, sur l'écorce des arbres, alt. 0 à 100 m", *Franc s.n.* (lecto-, designated here: PC[PC0096517]!; isolecto-, PC[PC0695985, PC0695986]!).

Distribution in New Caledonia. — Rarely found in North (type locality) and South Provinces.

Total range. — Endemic to New Caledonia.

Selected specimen. — **New Caledonia**. Province Sud, Dumbéa, trail to Mt Dzumac, 900 m, 26.IX.2012, *Larraín 35357*.

Descpription

Pseudautoicous

Dwarf male plants on leaf axis of female branches.

Plant

Medium, creeping stems densely branched.

Branches

Thick, up to 10 mm long, simple to furcate, when dry loosely funiculate, not curly, with leaves erect to loosely spirally coiled, costae prominent on the back, the apices incurved and exposed by the margins in the upper parts of the branches, above directed inward and hidden between the leaves, when moist patent to spreading, incurved, spirally inserted.

Branch leaves

Small, 1.1-1.5 mm long, 0.25-0.4 mm wide, not carinate, ligulate above wider oblong bases, rarely lanceolate, upper parts translucent with a sharp transition, in inverted "v", towards the basal parts which take up *c.* 1/2 the total leaf length, apices abruptly acute, costae strong, ending below the apices or percurrent in apiculi or excurrent in mucrones that may be fairly long, margins entire.

Upper cells

Single-layered, in conspicuous longitudinal rows, small, 5-8 µm wide, uneven in size and shape, the lumina rounded to oblate, very thick walled, walls 2.5 µm thick, smooth, marginal cells oblate in one rank, lower cells rectangular elongate, 25-37 µm long, 5-8 µm wide, very thick walled, lumina narrow, straight to slightly wavy, single papillae numerous, rounded to long, sometimes curved.

Perichaetia

Erect sheathing the seta bases, not exceeding the vegetative leaves, perichaetial leaves wider than the vegetative ones, plicate, oblong to wide lanceolate.

Calyptrae

Naked.

Setae

Long, 10-15 mm long, thin.

Capsules

Oval, 1.2-1.5 mm long, smooth, with medium neck, brown rims small, plicate.

Peristomes

Single.

Male plants

Very small, stems 600 µm long with a few vegetative leaves, perigonia terminal.

Remarks

Macromitrium taoense is characterized by: 1) medium branches more or less funiculate when dry with leaf apices of upper leaves curved like crooks; 2) branch leaves ligulate, translucent; 3) abrupt transition between upper and basal parts; 4) upper cells smooth, lined up in conspicuous longitudinal rows, with very thick walls; 5) lower cells with strong single papillae, long rectangular; 6) perichaetia not exceeding vegetative leaves; and 7) setae long; 8) vaginula hairs not visible from

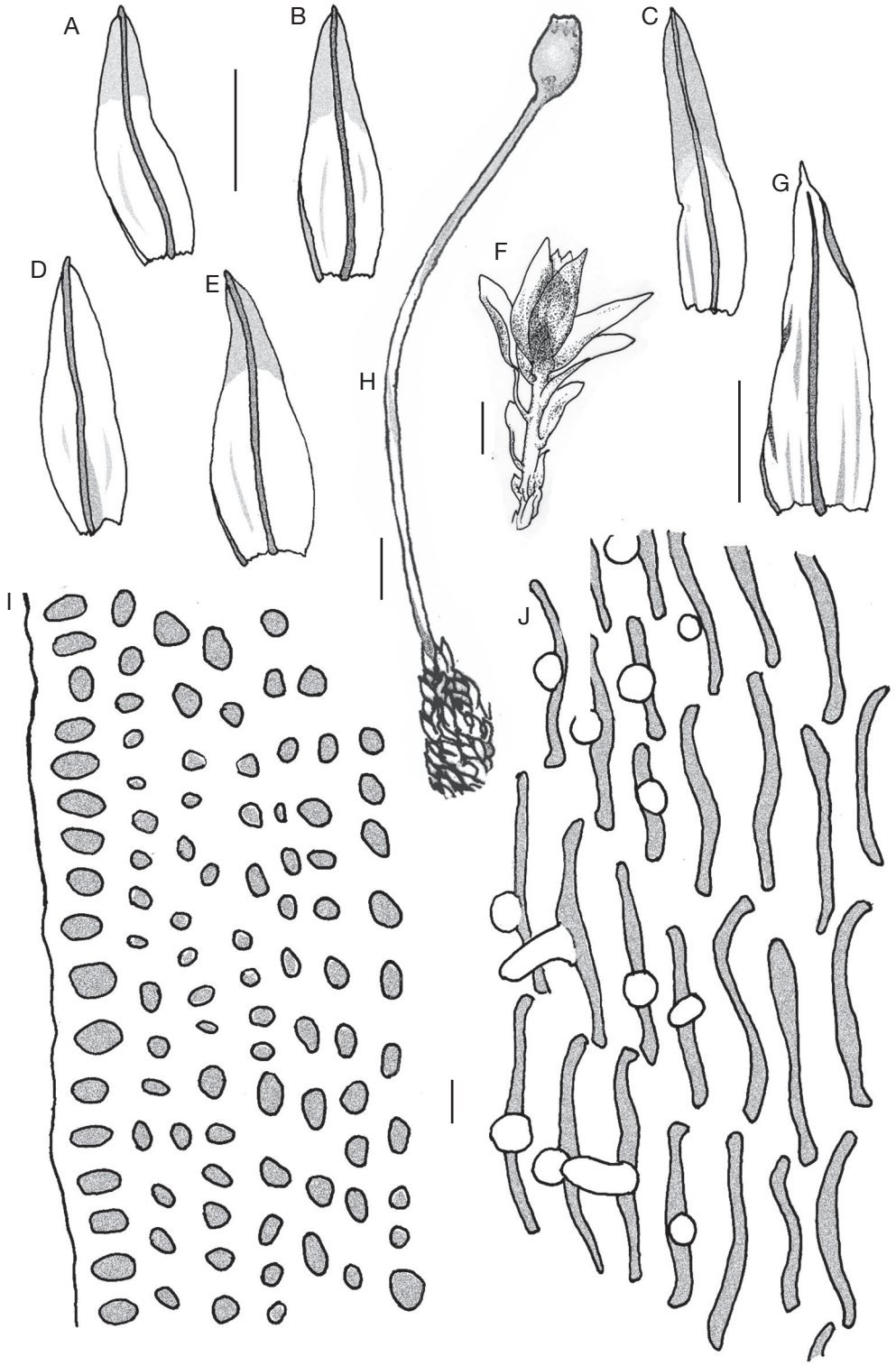

FIG. 21. — *Macromitrium taoense* Thér.: **A**-**E**, branch leaves; **F**, dwarf male plant; **G**, perichaetial leaves; **H**, dry branch top with sporophyte; **I**, upper cells; **J**, basal cells. All drawn from the lectotype, except for **C** from the specimen *Larraín 35357*. Scale bars: A-E, G, 500 µm; F, 100 µm; H, 1 mm; I, J, 10 µm.

the outside and calyptrae naked. In Thériot opinion, it would look like *M. microstomum* from which it eventually differs by the strong papillae on the basal cells, the upper cells lined up, the longer excurrent costae, the more robust branches which are less tightly funiculate when dry, the leaves not arranged in conspicuous spiral rows around the branches. More important are the similitude with *M. renauldii*, especially the striking areolation, the branch size and habit in dry condition, the seta

sizes. The main discriminant characters of *M. renauldii* are: 1) the hairiness of both vaginulae and calyptrae; 2) the shape of the leaves that are usually narrowly and long acuminate; and 3) the sub-cylindrical capsules. However, *Macromitrium taoense* is known from very few specimens unsufficient to assess with certainty that it is a good species.

The known *Macromitrium taoense* plants are epiphyte in wet forests.

Macromitrium tongense Sull.
(Figs 2E, 22, 23)

United States Exploring Expedition Wilkes Musci 7: table 5 (1859).

Macromitrium villosum (Besch.) Broth., *Naturlichen Pflanzenfamilien.* I (3): 486. 1903. — *Drummondia villosa* Besch., *Annales des Sciences naturelles, Botanique,* sér. 5, 18: 207. 1873. **syn. nov**. — Types: New Caledonia, "Île des Pins", *Pancher 578* "Sud de la Nouvelle Calédonie", *Pancher 574*; Mt Mou, *Balansa 2979*. (lecto-, designated here: *Balansa 2979,* [Ms CRY 2 p. 24, PC[PC0774037]! Bibliothèque de Botanique, MNHN, Paris]; isolecto-, PC[PC0695939, PC0695940, PC0695941]!; syn-, PC[PC0096505, PC0695938, PC0096513]! — *Dasymitrium villosum* (Besch.) A.Jaeger., *Bericht über die Thätigkeit der St. Gallischen Naturwissenschaftlichen Gesellschaft* 1877-1878: 423 1880).

M. villosum var. *longisetum* Thér., *Bulletin de l'Académie internationale de Géographie botanique* 17: 308. 1907. — Type: New Caledonia, 1906, *Franc s.n.* com. Renauld (lecto-, designated here: PC[PC0695934]!; isolecto-, PC[PC0096504]!) **syn. nov**.

M. villosum var. *elongatum* Thér., *Bulletin de l'Académie internationale de Géographie botanique* 17: 308. 1907. — Type: New Caledonia, 1906, *Franc s.n.* com. Renauld (lecto-, designated here: PC[PC0083740]!; isolecto-, PC[PC0096502]!) **syn. nov**.

M. villosum var. *intermedium* Thér., *Bulletin de l'Académie internationale de Géographie botanique* 17: 308. 1907. — Type: New Caledonia, 1906, *Franc s.n.* com. Renauld (lecto-, designated here *fide* Guo *in Sched.* [2007]: «env. Nouméa» PC[PC0083741]!; isolecto-, PC[PC96503]!) **syn. nov**.

M. ludoviciae Broth. & Paris, *Öfversigt af Finska Vetenskaps-Societetens Förhandlingar* 53A (11):17. 1911. — Type: New Caledonia, "Île des Pins, Watchia", *L. Le Rat s.n.* (lecto-, designated here *fide* Vitt *in Sched.* [1983]: H-BR[H-BR2563009]!; isolecto-, PC[PC137795]!, REN[REN000207]!) **syn. nov.**

M. densifolium Thér., *Bulletin de l'Académie internationale de Géographie botanique* 18: 253. 1908. — Type: New Caledonia, 1907, *Franc s.n*. (lecto-, designated here PC[PC0137661]!, isolecto-, PC[PC0096532]!) **syn. nov**.

M. chrysoneuron Müll.Hal. nom. herb. (C.M. *in Bescherelle's herbarium*), reference specimen: Wagap, *Vieillard s.n.* (PC: BESB1950!).

M. subvillosum Broth. & Paris *Öfversigt af Finska Vetenskaps-Societetens Förhandlingar* 51A (17): 16. 1909. — Type: New Caledonia, Mt Dzumac, *A. Le Rat s.n*. (lecto-, designated here *fide* Vitt *in Sched*. [1983] H-BR[H-BR2561008]!; isolecto, H-BR[H-BR2561005]!, PC[PC0096521]!) **syn. nov**.

Type. — **Tonga**. Tongatabu (Holotype: ?; iso, PC[PC0695994, PC0695995]!)

Distribution in New Caledonia. — Frequent at low to medium altitude in North and South Provinces.

Total range. — Western New Guinea, Polynesia (Pitcairn Isl.), Tonga, Fiji, New Caledonia.

Selected specimens. — *Macromitrium tongense*: **New Caledonia**. Province Nord, Pouembout, Tiéa dry forest, 40 m, on trunks, 26.IX.2008, *Thouvenot NC122* (PC); Forêt Plate near Ouendé waterfall, 300 m, epiphyt, 7.IX.2003, *F. Müller NC755* (DR); Province Sud, Nouméa, Tina, mangrove edge, 1 m, on dead stump, 24.IX.2012, *Thouvenot NC1451* (PC), on rock, 24.IX.2012, *Thouvenot NC1444* (PC); Mont-Dore, Demazures wet forest, 400 m, on trunks, 28.IX.2016, *Thouvenot NC2262* (PC); Farino, Grandes Fougères Nature Park, 400 m, 8.XII.2010, *K. Reichel NC767* (DR); Bourail, Gouaro-Déva, Nindouri, 105 m, on trunks, 25.IX.2008, *Thouvenot NC1124* (PC); Fiji, Malatta, 0-100 m, 29.III.1934, *A.C. Smith 1443*, det Bartram (PC0146832); *Macromitrium chrysoneuron*: **New Caledonia**. Île des Pins, *Pancher s.n.* (PC0137629); *Macromitrium ludoviciae*: **New Caledonia**. Île des Pins, Koumo, *McKee 33758* (PC0096537); *Macromitrium densifolium*: **New Caledonia**. Province Nord, Balade, *Vieillard 1733*, PC0096500 (PC); *Macromitrium subvillosum*: **New Caledonia**. Province Sud, Mt Humboldt, trail to the hut below the summit, on stone, 800 m, 30.VIII.2003, *F. Müller NC764* (DR); *Macromitrium villosum* var. *intermedium*: **New Caledonia**. Province Sud, Mont-Dore, Demazures forest, on trunks, 412 m, 28.IX.2016, *Thouvenot NC2360* (PC);
South Africa. *Macromitrium serpens*: Cape of Good Hope, *Burchell s.n.* type: E00007638 (E);
Tahiti. *Macromitrium tahitisecundum*: *Nadeaud 266* (type PC0695992).

Description

Pseudautoicous
Dwarf male plants on leaf axis of female branches.

Plant
Small, creeping stems with dense erect fusiform branches.

Branches
Short, 2-4(-10) mm long, simple, rarely innovating by fasciculate branchlets, when dry usually tightly funiculate, with leaves erect to obliquely appressed and spirally coiled, sometimes loosely so, stout costae prominent on the back, when moist patent to spreading, straight to slightly incurved, spirally inserted.

Branch leaves
Small, 1.1-1.6 mm long, (0.2-)0.3-0.4 mm wide, carinate, ligulate above the more or less oblong wider bases, rarely lanceolate, upper parts opaque with a sharp transition, in inverted "v", towards the basal parts which take up *c.* ½ the total leaf length, apices usually obtuse mucronate or apiculate, less frequently abruptly acute, costae strong, percurrent in apiculi or excurrent in stout mucrones, margins plane, subentire to crenulate, basal part plicate.

Upper cells
Small, (5-)8(-12) µm wide, irregularly multi-layered, the internal layers made of rounded-quadrate cells, thick walled, unevenly contiguous, in a slightly embossed surface, covered on both sides by more or less dense patches of spherical cells thick walled, bearing several small papillae, the internal cells with the same papillae when exposed. This pattern of

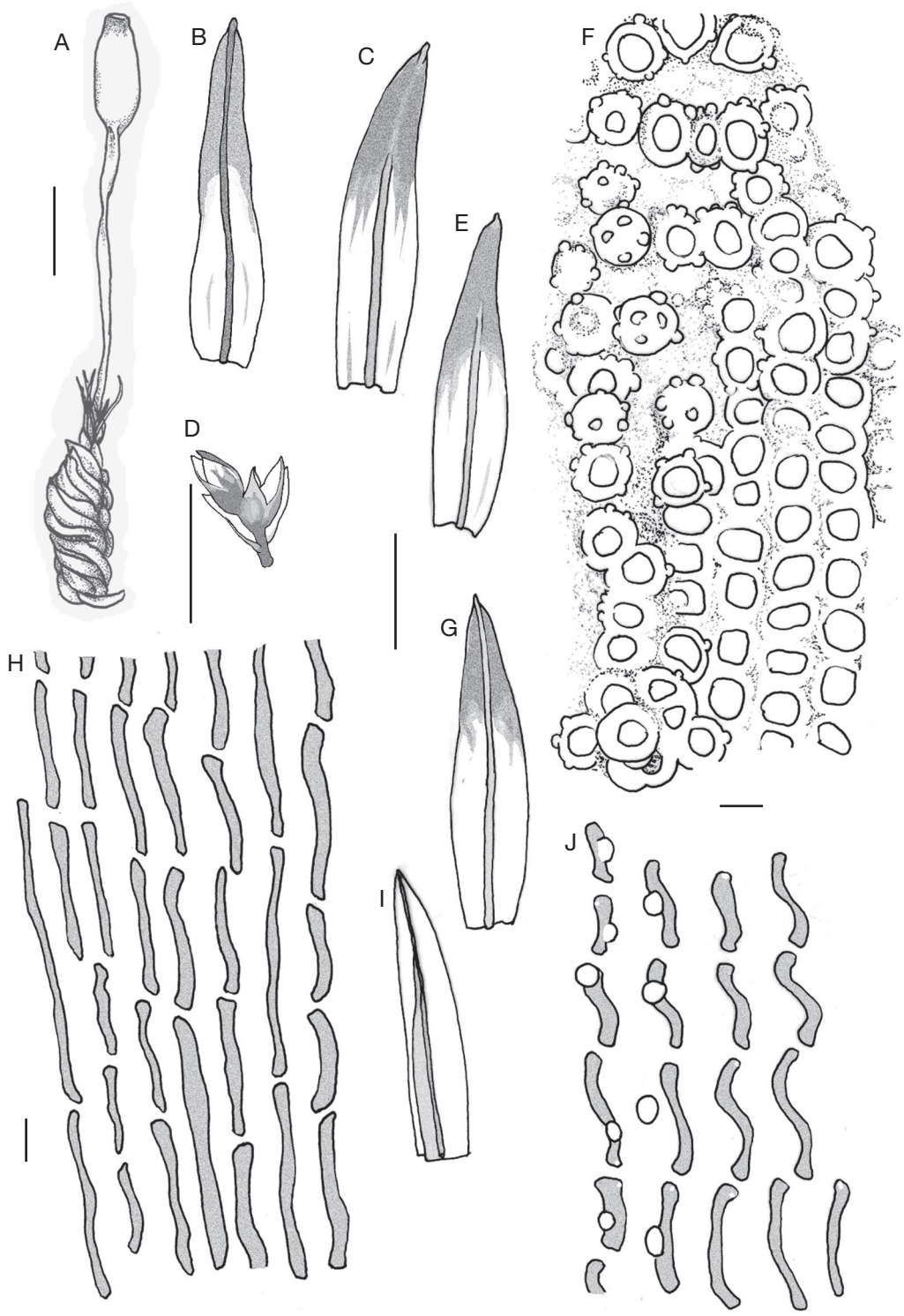

FIG. 22. — *Macromitrium tongense* Sull. **A**, Dry branch with sporophyte; **B**, **C**, **E**, **G**, Branch leaves; **D**, Dwarf male plant; **F**, Upper cells; **H**, Basal cells; **I**, Perichaetial leaf; **J**, Cells in upper half of basal par of branch leaf. All drawn from the *M. villosum* (Besch.) Broth. syntypes *Pancher 574* (**A**, **B**, **I**), *Pancher 578* (**D**), *Balansa 2979* (**C**, **E**, **F**-**H**, **J**). Scale bars: A, 1 mm; B-D, E, G, I, 500 µm; F, H, J, 10 µm.

cellular arrangement is variously developed on the upper half surfaces of the leaves, sometimes including the ventral side of the costae, but more often scattered, at least limited to the apices.

Lower cells

Rectangular elongate, 12-35 µm long, 7-10 µm wide, very thick walled, lumina narrow, variously wavy, single rounded papillae present, scattered or lined up on the plicae. Perichaetial

leaves erect along the seta bases, not or slightly exceeding the vegetative leaves, oblong to wide lanceolate, smooth.

Calyptrae
Hairy.

Setae
Short to medium, 4-6(-10) mm long, rigid.

Vaginulae
Hairy.

Capsules
Elliptical to short cylindrical, 1.2-1.5(-2) mm long, smooth, with rims brown, small and erect, slightly plicate or smooth.

Peristomes
Single.

Remarks
Macromitrium tongense is well characterized by: 1) small branches fusiform, acute, usually simple; 2) leaves obliquely appressed, spirally coiled in dry condition, usually tightly so; 3) upper cells multi-layered with the continuous internal layers being covered on both sides by patches of rounded papillose cells; in transverse section the internal cells are arranged in staggered row, with additional cells in a discontinuous row on one or both sides; 4) basal cells rectangular elongate with thicker walls and sinuous narrow lumina; 5) perichaetia inconspicuous; 6) vaginulae and calyptrae hairy; 7) setae short to medium; and 8) oblong elliptical urns, mouth narrowed and usually smooth. It is easily distinguished from the Indian-African *Macromitrium serpens* Burch. ex Hook. *et* Grev.) Brid., a species with longer lanceolate leaves, long acuminate, contorted in dry condition with fragile apices incurved so that the dry branches appear curly. *Macromitrium tahitisecundum* Margad. from Society Islands, should be a synonym of *M. tongense* as the distinguishing characters cited by Bescherelle (1898) and observed on types specimens are included within the variability observed in the later. Bescherelle himself stated that this species (first named *Dasymitrium nadeaudii* Besch.) was very similar to *Dasymitrium villosum*.

All the syntype samples of *Macromitrium villosum* in PC, kept in the general herbarium of bryophytes as well as in the Bescherelle's herbarium, have the characteristic features of *M. tongense* and the examination of many samples allows to evaluate the variability of the species, mainly varying in cover ratio of the upper laminae by patches of rounded cells which may cover nearly all the surface or be very scattered or limited to the apex (e.g. specimen *Pancher 578*). The lengths of the setae are evenly short, not exceeding 9 mm, but the var. *longisetum*, with setae 10-20 mm long, was isolated by Thériot on this single criterium. We do not consider here the single seta length as relevant, because it may be variable in some extant in many species of the genus. Thériot described *M. villosum* var. *elongatum* with longer branches, up to 7 mm, but a close examination reveals that this size regards branches innovating with fasciculate branchlets, while single branches do not exceed 4 mm. Branch innovations are rarely observed in the species. Since it is the single difference with the type, we include this variety within the species concept. Brotherus compared *M. ludoviciae* to *M. cucullatum*, synonym of *M. francii*, but the different type specimens actually match *M. villosum*, except for the branch dry habit that is variable, some specimens exhibiting very loosely spirally coiled branch leaves so that the typical fusiform spiralled habit of the branches is inconspicuous. In *M. densifolium*, Thériot emphasized the thick costae and mucrones, but it is a common feature in the species. *M. subvillosum* was isolated by Brotherus according to minor differences with *M. villosum*, namely the shape of the leaves, narrowly acuminate and acute, the rigid habit and larger cells. In the type specimens, we found no striking differences regardint to the two latter characters. However, leaves are variously spirally coiled in dry condition and the leaf upper parts are narrower and acute, upper cells are arranged as in *M. villosum* var. *intermedium*. The latter is distinguished from the other types brought together under the name *M. tongense* by the branch dry habit with very loosely spirally coiled leaves, branch leaves narrower, long ligulate, very obtuse to rounded, upper cells pluripapillose, single-layered except in the apices, setae 7-15 mm long. It represents a mix of extreme modes in the features of *M. villosum*. Recent samples matching to this variety have been collected at about 400 m, an elevation at the limit of the distribution range. Another sample matching with *M. subvillosum*, has been found at *c.* 800 m. Thus, these forms might represent extreme modes of variation in *M. tongense* characters and could be linked to ecological conditions.

Amongst the syntypes, the most accurate specimen, likely considered as typical of *Drummondia villosa* by Bescherelle, is the collection of Balansa n° 2979. Indeed, Bescherelle wrotes this reference in original documents found in his private herbarium: the part glued to his personnal sample book (Bescherelle 1873, Ms CRY 2) and the corresponding pencil sketches in a volume of plates (Bescherelle, s.d., Ms CRY 3-30, ined.), likely intended to illustrate the "Florule bryologique de la Nouvelle-Calédonie" (Bescherelle 1873). Therefore, we select this part of the Balansa specimen in the Bescherelle herbarium as the lectotype and the other parts in PC are isolectotypes.

Macromitrium tongense is a frequent species in coastal, lowland and foothill areas, growing mainly on tree trunks but it can also be found on deadwood and rocks in various lowland habitats: mangroves, dry forests, wet forests, from 0 to 450, rarely up to 800 m a.s.l. These small plants seem adapted to harsh environments.

Acknowledgements
The author thanks the authorities and environment managers of Province Nord and Province Sud of New Caledonia for collecting permissions and local support, the curators of the following herbariums: PC, Catherine Rausch and Lionel

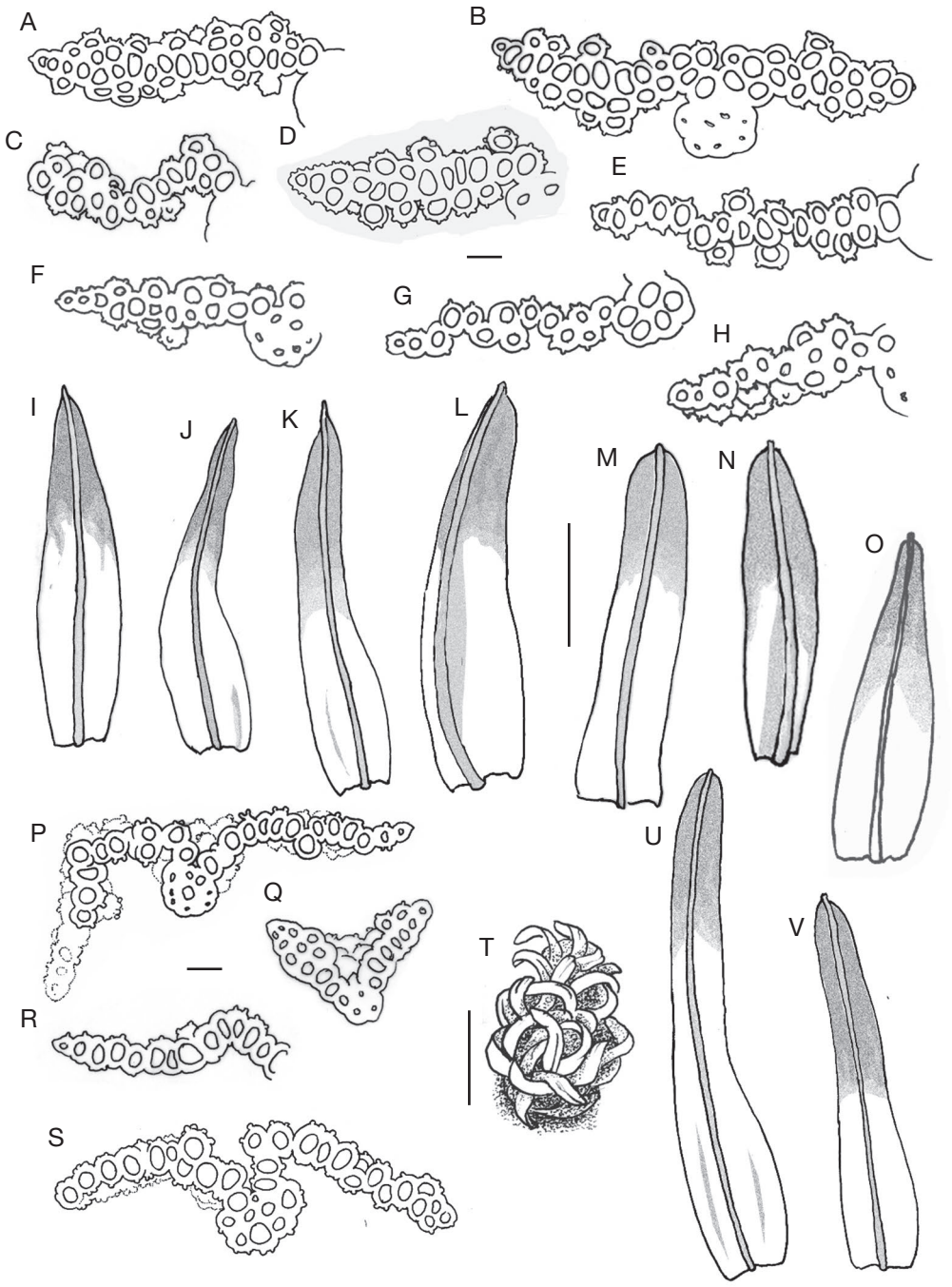

Fig. 23. — *Macromitrium tongense* Sull.: morphological diversity among the New Caledonian types with special emphasis on *M. villosum* var. *intermedium* (**P**-**V**). **A**-**H**, **P**, **R**, **S**, transverse sections in the top quarter of branch leaves; **Q**, transverse section at apex of branch leaf; **I**-**O**, **U**, **V**, branch leaves; **T**, dry branch. Drawn from the *M. tongense* isotype PC0695994 (**A**) and specimen of Smith 1443 (**C**), from the *M. villosum* (Besch.) Broth. syntypes Pancher 574 (**B**), Balansa 2979 (**D**, **I**), Pancher 578 (**E**-**G**), from the lectotype of *M. subvillosum* Broth. & Paris (**H**, **J**), lectotype of *M. villosum* var. *intermedium* Thér. (**Q**-**S**, **U**), lectotype of *M. villosum* var. *elongatum* Thér. (**K**), lectotype of *M. ludoviciae* Broth. & Paris (**L**, **M**), lectotype of *M. densifolium* Thér. (**N**, **O**), from the specimen *M. villosum* var. *intermedium* Thér. *Thouvenot NC2311* (**P**, **T**, **V**). Scale bars: A-H, P-S, 10 µm; T, 1 mm; I-O, U, V, 500 µm.

Kervran, REN, Audrey Chambet, H-BR, Xiaolan He and E, David Harry, Matt von Konrat for his kind invitation to participate in the 2012 Field Museum expedition to New Caledonia, Jacques Bardat, Denis Lamy and Sébastien Leblond for work facilities in Paris Museum, S.Robbert Gradstein for his friendly encouragement and help. Special thanks to the people and organisations who helped the author in many way on the field: Research & Development Institute (IRD), Endémia Association, Rivière Bleue and Grandes Fougères Natural Parks, SLN Company, Irène and Daniel Letocart, Christian Laudereau, Dominique Garnier, Jean-Jérôme Cassan, Vanessa Héquet, Edith Thouvenot, Pascale Menuteaux, Romain Fran-

quet, Thomas Duval, Denis Meandu Povéu, Morgan Farino, Francis Béalo, Patrick Moénou, Gaby Teipoueme, Maurice Wangueme, François Wangueme, Jacob Hiandodimat, Avis Dominique Popani, Abel Phalé. The author expresses his gratitude to Rui-Liang Zhu and anonymous reviewers for their helpful comments which contributed greatly to improve the final version of the manuscript.

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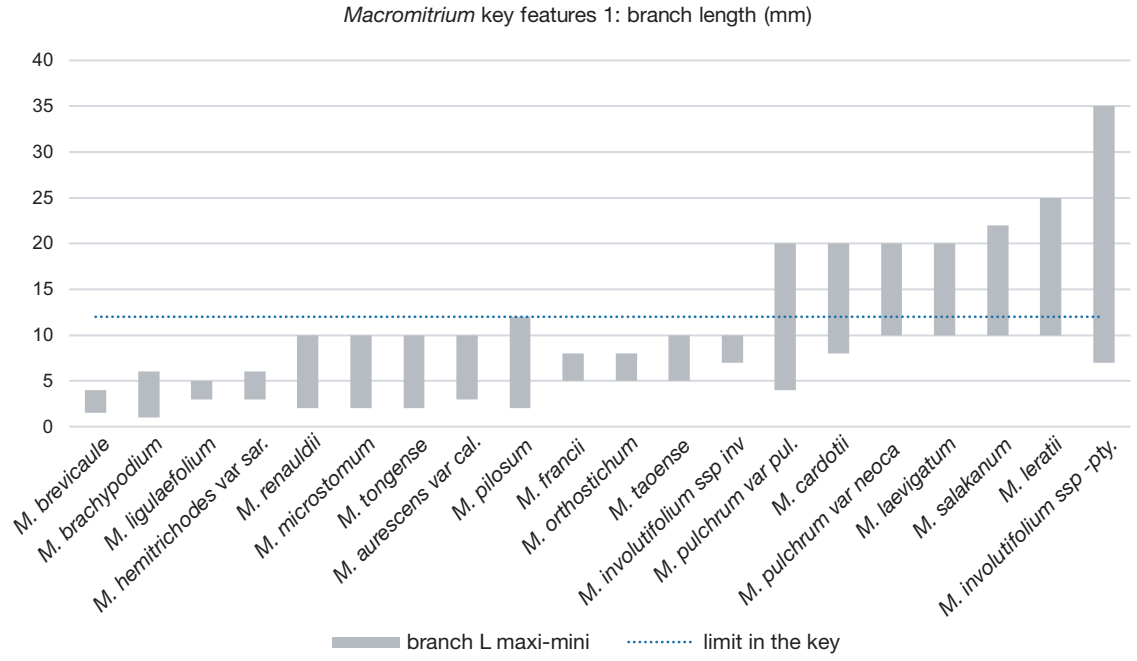
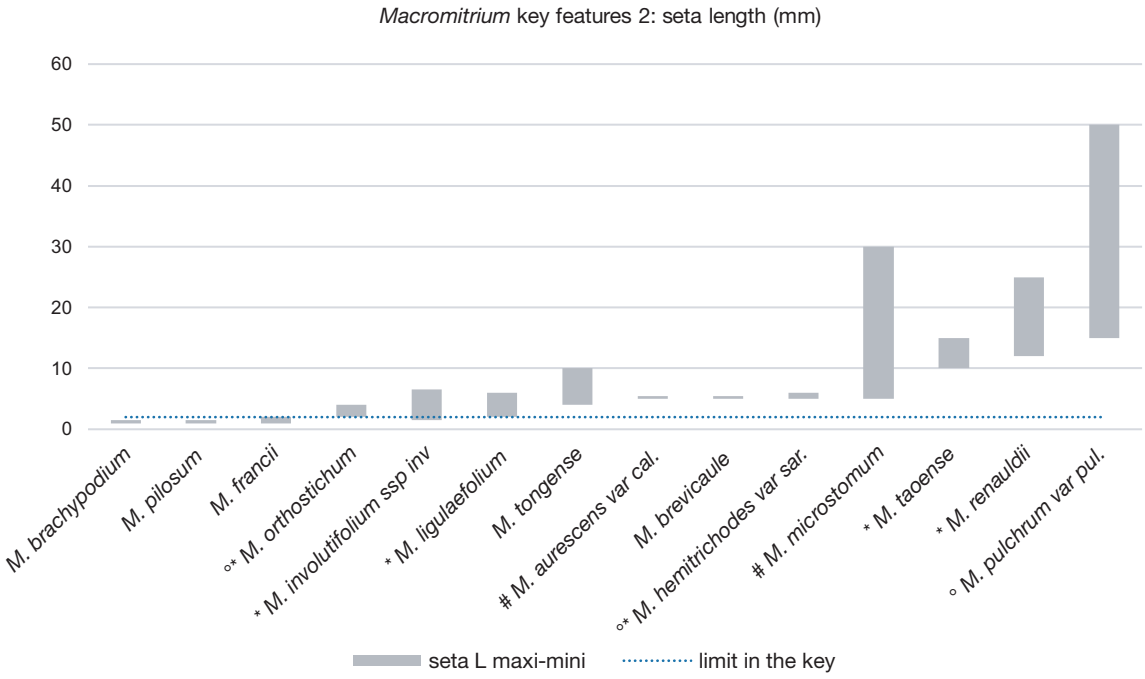
Submitted on 22 October 2018;
accepted on 28 February 2019;
published on 16 October 2019.

APPENDIX

Appendix 1. — Key features in New Caledonian species of *Macromitrium* Brid.: size ranges and limits in the key to species. Note 1: the 4 long-aristate species key out first and are not represented here (*M. humboldtense* Thouvenot & Frank Müll., *M. larrainii* Thouvenot & K.T.Yong, *M. panduraefolium* Thouvenot and *M. rufipilum* Cardot). Note 2: In the character "setae length" above, the limit first allows to isolate the group with the shortest setae. Then, as you continue to follow the key, you have to separate plants in relation to other values. The paired groups to compare are marked with the same symbol in the graph above.





Appendix 2. — Individual altitudinal distribution of *Macromitrium* Brid. species the most frequent in New Caledonia. Legend: Left Y axes and curves = number of survey points, right Y axes and bars = number of species specimens.