

# First bryophyte records from Diego Ramírez Archipelago: Changing lenses in long-term socio-ecological research at the southernmost island of the Americas

*Primer registro de briófitas en el archipiélago Diego Ramírez:  
Cambiando los lentes en estudios socio-ecológicos a  
largo plazo en la isla más austral de América*

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## Abstract

Long-term socio-ecological research requires comprehensive assessments of biodiversity that overcome historical taxonomic biases, such as the strong focus on the vascular flora. This is particularly relevant at high latitudes where the richness of non-vascular plant species exceeds that of vascular species. Additionally, with respect to geographical regions, there is also a marked bias towards ecological and conservation research in the northern hemisphere. In contrast, few studies have investigated patterns of non-vascular species richness in relation to conservation priorities at sub-Antarctic latitudes, particularly in the sub-Antarctic Magellanic ecoregion. In this work, we contribute to overcome such taxonomic, geographical and ecoregional biases by moving outside these limits, and therefore “changing the lenses” that are commonly used to assess and conserve biodiversity. We implemented these new “biocultural lenses” by including, for the first time, bryophytes in the floristic inventory of the southernmost island of the American continent: Gonzalo Island ( $56^{\circ}31'16.8''S$ ;  $68^{\circ}42'53.5''W$ ) in the Diego Ramírez Archipelago, Chile. The first bryological exploration of the Diego Ramírez archipelago, SW of Cape Horn, revealed a bryophyte flora composed of 14 species, eight liverworts and six mosses. This number of non-vascular plant species almost doubles the eight vascular plants present on the island. Consequently, with our study, we aim to fill a critical gap in the knowledge of the flora of the Diego Ramírez archipelago, and establish an integral floristic characterization

for the long-term socio-ecological research and conservation of the southernmost archipelago of South America. Based on the field material collected, the new nomenclatural combination *Chiloscyphus secundifolius* (Hook. f. & Taylor)

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J.J.Engel is proposed. The moss flora comprises *Amblystegium serpens*, a widespread moss, yet hitherto unknown for sub-Antarctic Chile. The bryoflora of Diego Ramírez has its greatest affinities with that of the sub-Antarctic Magellanic ecoregion and Maritime Antarctica. None of the liverworts present on Gonzalo Island occurs on continental Antarctica; in contrast, four of the six mosses are shared between these two areas.

### **Key words:**

Antarctica, conservation, liverworts, mosses, sub-Antarctic Magellanic ecoregion.

### **Resumen**

La investigación socio-ecológica a largo plazo requiere evaluaciones exhaustivas de la biodiversidad que eviten sesgos taxonómicos históricos, tales como la restricción del análisis a la flora vascular. Esto es particularmente relevante en latitudes altas donde la riqueza de especies de plantas no-vasculares supera la riqueza de especies vasculares. Otro marcado sesgo en la investigación ecológica y de conservación se refiere a las regiones geográficas, cuyo estudio se ha concentrado en el hemisferio norte. En contraste, existen pocas investigaciones de patrones de riqueza de especies y prioridades de conservación en relación con las latitudes subantárticas, particularmente en la ecorregión subantártica de Magallanes en el sur de Sudamérica. En este trabajo contribuimos a superar los sesgos taxonómicos, geográficos y ecorregionales, moviéndonos fuera de estos límites y, por lo tanto, “cambiando los lentes” que se utilizan usualmente para evaluar y conservar la biodiversidad. Implementamos estos nuevos “lentes bioculturales” al incluir por primera vez a las briófitas en el inventario florístico de la isla más austral del continente americano: la isla Gonzalo ( $56^{\circ}31'16,8''S$ ;  $68^{\circ}42'53,5''O$ ) del archipiélago Diego Ramírez, Chile. La primera exploración briológica del archipiélago Diego Ramírez, al suroeste de Cabo de Hornos, reveló una flora de briófitas compuesta por 14 especies, ocho hepáticas y seis musgos. Este número de especies no vasculares casi duplica las ocho plantas vasculares presentes en la isla. En consecuencia, con el presente estudio, contribuimos a llenar un vacío de conocimiento crítico sobre la flora del archipiélago

Diego Ramírez y establecemos una caracterización florística integral para la investigación socio-ecológica a largo plazo y la conservación en el archipiélago más austral de Sudamérica. Sobre la base del material recolectado, se propone la nueva combinación *Chiloscyphus secundifolius* (Hook. f. & Taylor) J.J.Engel. La flora de musgos incluye *Amblystegium serpens*, un musgo de distribución amplia, hasta ahora desconocido para Chile subantártico. Las afinidades de la brioflora de Diego Ramírez se concentran principalmente con aquella de la ecorregión subantártica de Magallanes y la Antártica marítima. Ninguna de las hepáticas presentes en la isla Gonzalo se encuentran en la Antártica continental; en cambio, cuatro de las seis especies de musgos están presentes en ambas áreas.

### **Palabras clave:**

Antártica, conservación, hepáticas, musgos., ecorregión subantártica de Magallanes,

### **INTRODUCTION**

The islands of the Southern Ocean are of considerable biological and conservation significance (Chown *et al.* 1998). We here provide the first-ever report on the bryophytes of Gonzalo Island (Fig. 1A, B) in the Diego Ramírez Archipelago, Chile. The Diego Ramírez archipelago is a group of sub-Antarctic islands (see synopsis of phytogeographical categories in Engel, 1990) situated at the southern end of the South American continental shelf in the Drake Passage, which separates South America from Antarctica (Rozzi *et al.* 2017). It is located 60 nautical miles (n.m.) south-west of the Cape Horn archipelago and 430 n.m. north-west of the Antarctic Peninsula, in close proximity to the Antarctic Polar Front. The Diego Ramírez Islands ( $56^{\circ}31'S$ ,  $68^{\circ}44'W$ ), in particular, and the sub-Antarctic Magellanic ecoregion of extreme southwestern Chile, in general, provide critical breeding habitats for marine mammals and avifauna of global conservation concern, such as the grey-headed albatross (Rozzi *et al.* 2017). The Diego Ramírez archipelago is the southernmost and one of eight known breeding sites for this species in the world (Fig. 1C). Because of its significance for the conservation of regional biodiversity, the



Fig. 1. A. Aerial view of Gonzalo Island, showing the flat summit area surrounded by steep slopes dominated by *Poa flabellata*. B. Slopes dominated by dense *Poa flabellata* communities. C. Nesting grey-headed albatross (*Thalassarche chrysostoma*) at the base of *Poa flabellata* tussock. D. *Cephalozia dusei*, terricolous. E. *Clasmatocolea vermicularis* at the base of *Poa* tussock in the slope. F. *Leptoscyphus antarcticus* in terricolous vegetation with *Colobanthus quitensis*. G. *Hennediella heimii*. H. Steep rock surface near summit colonized by cushion plants and *Orthotrichum crassifolium*. I. *Orthotrichum crassifolium* growing on fence post.

new Diego Ramírez-Drake Passage marine park was recently established (Rozzi *et al.* 2017). The archipelago was discovered by Europeans in the 17th century, and only permanently inhabited since mid 20th century by the Chilean Navy following the construction of the lighthouse built on Gonzalo Island.

The vascular vegetation and flora of the Diego Ramírez Islands was described by Pisano (1972) and Pisano & Schlatter (1981). They documented the

presence of eight vascular plants on the two largest islands of the archipelago, Gonzalo and Bartolomé islands. These species are *Callitriche antarctica* Engelm. ex Hegelm., *Cardamine glacialis* (Forst. f.) DC, *Colobanthus quitensis* (Kunth) Bartl., *Cotula scariosa* (Cass.) Franch., *Crassula moschata* Forst. f., *Plantago barbata* Forst. f., *Poa flabellata* (Lam.) Raspail, and *Ranunculus biternatus* Sm. The vegetation is largely dominated by *Poa flabellata* on the slopes (Fig. 1B), whereas

the rather flat area of the summit is covered by dense communities of *Colobanthus quitensis* and *Plantago barbata* (Fig. 1A). Woody plants are entirely absent, and no exotic species have been recorded in the archipelago (see Mackenzie *et al.* 2020 in this volume). Its floristic affinities are with other Sub-Antarctic islands such as South Georgia, and particularly with the Cape Horn Archipelago (*cfr.* Pisano, 1980). Additionally, the flora has an affinity with Antarctica since *C. quitensis* is one of the only two native vascular plants in Antarctica (Komárková *et al.* 1985). While the vascular flora has been previously studied, the bryophyte flora of Diego Ramírez has remained undescribed until this date, except for the mention of the occurrence of two (unnamed) species of bryophytes in the *Colobantho-Plantaginetum* vegetation by Pisano and Schlatter (1981).

In past decades, influential assessments of global priorities for conservation have relied on geographic differences in the concentration of diversity and endemism of vertebrates and vascular plants (Myers *et al.* 2000; Rodrigues *et al.* 2004; Lamoreux *et al.* 2006). The majority of publications on plant conservation have focused on vascular flora, and non-vascular plants have remained marginal even at high latitudes where they are the dominant floristic component (Rozzi *et al.* 2008). Regarding geographical and ecological regions, conservation research is markedly biased to and strongly concentrated in the northern hemisphere (Lawler *et al.* 2006). In contrast, few studies have investigated patterns of species richness in relation to conservation priorities in sub-Antarctic latitudes, particularly in the sub-Antarctic Magellanic ecoregion of southern South America (Arroyo *et al.* 2005; Lawler *et al.* 2006; Rozzi *et al.* 2012a).

We have attempted to overcome these taxonomic, geographical, and ecoregional biases by moving outside these boundaries, and thereby “change the lenses” that are commonly used to assess regional patterns and conserve biodiversity (Rozzi *et al.* 2008). In this article, we use these novel “biocultural lenses” (*sensu* Rozzi *et al.* 2012b) to include bryophytes for the first-time in the floristic inventory of the southernmost island of the American Continent: Gonzalo Island ( $56^{\circ}31'16.8''S$ ;  $68^{\circ}42'53.5''W$ ) in the Diego Ramírez Archipelago, Chile.

## METHODS

We examined the specimens of bryophytes collected by Goffinet and Mackenzie on Gonzalo Island during the austral reproductive season, from November 29 to December 1, 2016. For each identified species, we briefly describe the habitat, and provide a summary of its broader geographic distribution.

All vouchers or their duplicates are deposited in the herbarium of the Universidad de Concepción (CONC), which works in partnership with the Institute of Ecology and Biodiversity and the Sub-Antarctic Cape Horn Research Center in Chile, and the herbaria of the University of Connecticut (CONN) or The Field Museum in Chicago (F), in the United States of America. Among the collections, were specimens whose morphological study led to the re-evaluation of the name *Lophocolea secundifolia* (Hook. f. & Taylor) Gottsche, Lindenb. & Nees, for which a new nomenclatural combination is proposed below.

## RESULTS

We identified 14 species of bryophytes on Gonzalo Island, which comprise eight species of liverworts and six species of mosses. Below we provide a concise description for each of the identified species first of (I) liverworts (Division Marchantiophyta), and then of (II) mosses (Division Bryophyta).

### I. Marchantiophyta (liverworts)

#### I.1. *Cephaloziella dusenii* Steph. (Fig. 1D)

**Notes.** The status of this species is not unambiguously settled and in particular whether it is distinct from *Cephaloziella varians*, a bipolar species that occurs in Antarctica (Bednarek-Ochyra *et al.* 2000), or from the circum-subantarctic *C. exiliflora* (Tayl.) Douin (Engel, 1978).

**Ecology.** Typically growing among *Poa* tussocks, also on top of mounds in *Colobanthus/Poa* community behind the Navy Station on Gonzalo Island, on abandoned nests.

**Distribution.** Southern South America, Falkland Islands, and South Georgia; in Chile, it is known from the Valdivian and Magellanic regions (Engel, 1990).

*Specimens seen.* B. Goffinet with R. Mackenzie 13605 (CONC, F), 13621A (CONC, F), 13624 (F), 13627 (F), 13638 (CONN), 13648 (CONN, F) & 13661 (CONN, F), Nov. 29-30, 2016.

I.2. *Chiloscyphus secundifolius* (Hook. f. & Taylor) J.J.Engel, comb. nov. (Fig. 2 A-D)

*Jungermannia secundifolia* Hook. f. & Taylor, London J. Bot. 3:471. 1844. *Lophocolea secundifolia* (Hook. f. & Taylor) Gottsche, Lindenb.

& Nees, Syn. Hep. 693. 1847. Lectotype (*fide* Engel, 1978): Falkland Islands, Hooker (FH!).

*Notes.* Several authors previously recognized this taxon as a distinct species (Gottsche *et al.* 1847; Stephani, 1900, 1906 [1898-1924], 1911; Arnell, 1955), whereas others (*e.g.* Engel, 1978, 1990; Bednarek-Ochyra *et al.* 2000; Hässel de Menéndez & Rubies, 2009) considered it conspecific with *Chiloscyphus latus*, which then had an amphipacific distribution, being rather widespread in sub-Antarctic and south temperate areas (*e.g.* Engel, 1978, 1990). After morphological study of

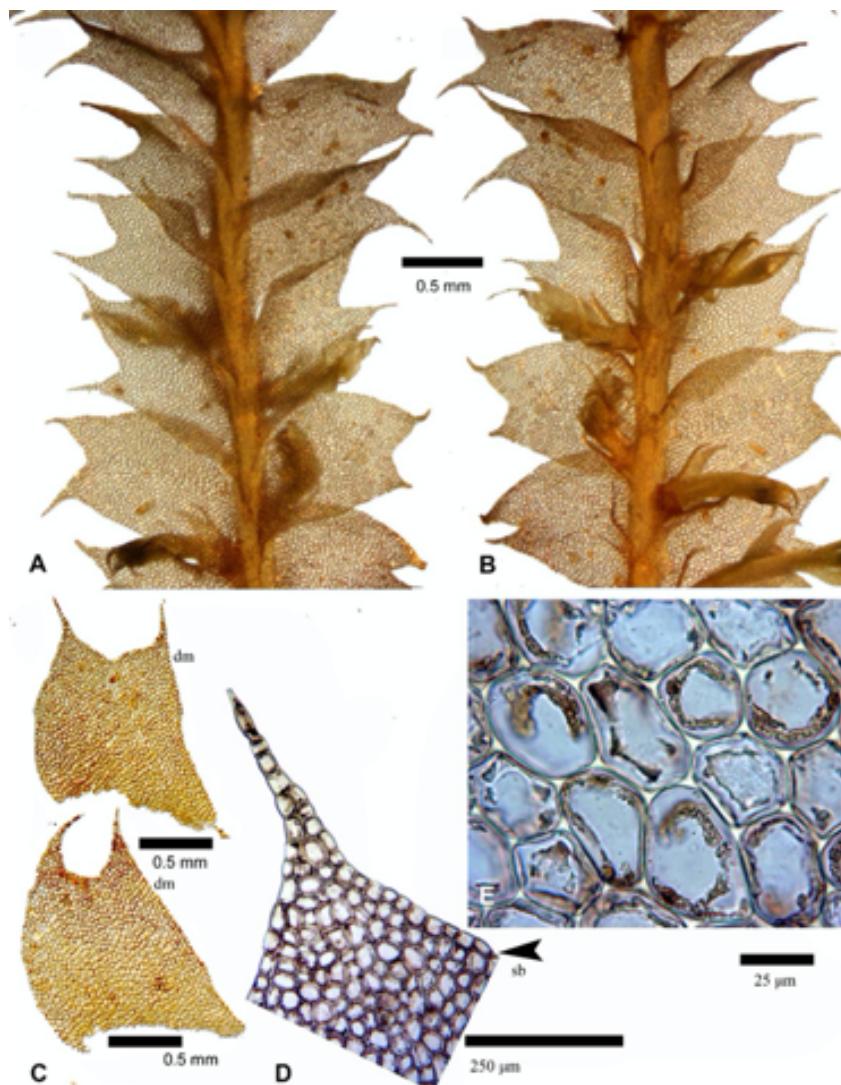


Fig. 2. *Chiloscyphus secundifolius* (Hook. f. & Taylor) J.J.Engel. A. Dorsal view, sector of leading shoot (note leaf-free strip of stem cells). B. Ventral view, sector of leading shoot (note free underleaves and lateral-intercalary branches). C. Leaves (dm = dorsal margin). D. Leaf lobe (sb = sinus base). E. Median cells of leaf. From Goffinet 13658-F.

the Australasian members of *Chiloscyphus* (Engel, 2010), including the type of *C. latus*, the two taxa are now treated as distinct species. The range of *C. latus* is now confined to New Zealand (Stewart Is., South Island, North Island) and its offshore islands (Campbell, Auckland and Snares Is.), whereas *C. secundifolius* is restricted to southern South America and the Falkland Islands.

The species can be distinguished as follows:

**Key to *Chiloscyphus secundifolius* and *C. latus***

1. Leaf insertions extending to the stem dorsal midline, no leaf-free strip; underleaves free from leaves but very closely juxtaposed to ventral leaf base on 1 side; plants monoecious; plants terricolous (?always). Southern South America + Falkland Islands ..... *C. secundifolius*
1. Leaf insertions not extending to the stem dorsal midline, delimiting a leaf-free strip of 1 cell; underleaves connate with leaves on 1 side; plants dioecious; plants commonly corticolous. New Zealand (incl. Campbell, Auckland and Snares Islands) ..... *C. latus*

**Ecology.** Growing on *Poa* tussocks as well as on mounds in *Colobanthus/Poa* community behind the Navy station; at times on tussocks used as bird nests; also on rock of cliff near flagpole.

**Distribution.** Restricted to southern South America; in the Valdivian and Magellanic regions, Chile, extending eastward to the Falkland Islands, South Sandwich Islands and South Georgia (Grolle, 1972; Longton & Holdgate, 1979). The report of *Lophocolea lenta* (Hook. f. & Taylor) Gottsche, Lindenb. & Nees from Antarctica in Bednarek-Ochyra *et al.* (2000) needs confirmation. *Lophocolea lenta* in the sense of these authors may actually be *Chiloscyphus subviridis* (e.g. presence of gemmae, leaves sometimes with a tooth, see Bednarek-Ochyra *et al.*, loc. cit. Fig. 74: 1, 6, 8). Without such confirmation, we did not include Antarctica in the distribution of *C. subviridis*.

**Specimens seen.** B. Goffinet with R. Mackenzie 13621B (CONC, F), 13623 (F) & 13658 (CONC, CONN, F), Nov. 29-30, 2016.

**I.3. *Chiloscyphus subviridis* (Hook. f. & Taylor)**  
J.J.Engel & R.M.Schust.

**Notes.** *Chiloscyphus subviridis* produces abundant one- to pluricellular gemmae from the lobes (particularly the tips), the margins, as well as the surface, of leaves. With continued formation of gemmae, the distal sector of the leaf becomes erose and ragged in aspect. Plants also produce regenerants, but to a lesser degree. These modes of asexual reproduction appear to be very efficient; for example, the population of Goffinet 13653 has abundant gemmae and intimately intermixed with mature shoots are copious juvenile shoots in various stages of development. Asexual reproduction by both gemmae and regeneration also occurs in *C. perpusillus* (Hook.f. & Tayl.) J.J.Engel of New Zealand and Tasmania (see Engel, 1993, 2010). We are unaware of any other species from southern South America with this combination of asexual reproduction.

**Ecology.** In wet depressions and on mounds in *Colobanthus/Poa* community behind the Navy station.

**Distribution.** Southern South America, Falkland Islands; Tristan da Cunha (see Váña & Engel, 2013); in Chile, from central Chile, and Valdivian regions to the sub-Antarctic Magellanic ecoregion, and westward to Juan Fernández Islands.

**Specimens seen.** B. Goffinet with R. Mackenzie 13653 (CONN, F) & 13656 (CONN, F), Nov. 29-30, 2016.

**I.4. *Chiloscyphus divaricatus* (Hook. f. & Taylor)**  
J.J.Engel & R.M.Schust.

**Ecology.** On base of *Poa* tussock.

**Distribution.** Falkland Islands; Magellanic region (Tierra del Fuego, Patagonian Channels in Brunswick Peninsula); Valdivian region (45°17'S, 73°43'W).

**Specimen seen.** B. Goffinet with R. Mackenzie 13608 (CONC, F), Nov. 29-30, 2016.

**I.5. *Clasmatocolea vermicularis* (Lehm.) Grolle**  
(Fig. 1E)

**Notes.** The Diego Ramírez Archipelago populations on Gonzalo Island differ from typical

phases of *C. vermicularis* in the abundant *Frullania*- and (both lateral- and ventral-) intercalary type branches, as well as the bright yellow green or bright green color when dry. Most tufts are compact and comprised of small plants with shoots possessing only a few to several gyres of leaves.

*Ecology.* On organic material (soil, etc.) on path to Navy station; also on dead *Poa* tussock.

*Distribution.* Pan-south-temperate (Engel, 1990).

*Specimens seen.* B. Goffinet with R. Mackenzie 13604 (CONC, F), 13607 (CONC, F), 13635 (CONN, F), 13636 (CONN, F) & 13643 (CONN, F), Nov. 29-30, 2016.

#### I.6. *Leptoscyphus antarcticus* (C. Massal.) Solari (Fig. 1F)

*Notes.* This is the sole species of the genus represented on Diego Ramírez. Since *Leptoscyphus expansus* (Lehm.) Grolle is very common in southern South America (Engel, 1978) and the Falkland Islands (Engel, 1990), one would expect presence of this species, too. Because *L. antarcticus* may be confused with other species of the genus, including *L. expansus*, a brief description of *L. antarcticus* follows; the description is based solely on material collected on Gonzalo Island.

Plants brittle, green or greyish green or red brown, at times reddish brown in older sectors but lacking pigments distally. Branches of the lateral-intercalary and *Frullania* types. Leaves with insertion lines not extending to stem midline dorsally, a leaf-free gutter present; leaves usually strongly dorsally assurgent, the adaxial faces of opposing leaves often facing one another, the orientation in some populations variable: some shoots with leaves dorsally assurgent but intermixed are leaves only weakly assurgent, while other shoots have leaves all widely spreading, the leaves weakly convex throughout or slightly concave at the ventral base. Cells with trigones minute. Underleaves ca. 0.75-0.8X stem width, very narrowly connate on 1 side (by 1 cell), the connation via the underleaf decurrent strip and the extreme base of the leaf margin or by the underleaf decurrent strip and the adaxial face of the leaf base; underleaves widely spreading to reflexed, bifid to ca. 0.5-

0.8; lamina on each side with a dentiform to ciliiform process.

*Ecology.* In somewhat lit niche at the base of *Poa* tussock, also in *Colobanthus/Poa* community behind the Navy station.

*Distribution.* South Georgia; southern South America, Magellanic region (Tierra del Fuego); thus, despite the specific epithet *antarcticus*, the species is not known from the Antarctic continent (Bednarek-Ochyra *et al.* 2000).

*Specimens seen.* B. Goffinet with R. Mackenzie 13637 (CONN, F), 13654 (CONN, F), 13657 (CONN, F) & 13659 (CONN, F), Nov. 29-30, 2016.

#### I.7. *Telaranea plumulosa* (Lehm. & Llindenb.) Fulf.

*Ecology.* At the base of *Poa* tussocks.

*Distribution.* Falkland Islands; southern South America, Valdivian and Magellanic regions, Juan Fernández Islands (Engel & Smith Merrill, 2004).

*Specimen seen.* B. Goffinet with R. Mackenzie 13609 (CONC, F), Nov. 29-30, 2016.

#### I.8. *Telaranea pseudozoopsis* (Herzog) Fulf.

*Ecology.* Growing among tussocks of *Poa* as well as on the side of living and dead *Poa* tussocks.

*Distribution.* Southern South America, Valdivian and Magellanic regions, Falkland Islands (Engel & Smith Merrill, 2004).

*Specimens seen.* B. Goffinet with R. Mackenzie 13626 (F), 13645 (CONN, F) & 13660 (CONC, CONN, F, NY), Nov. 29-30, 2016.

### II. Bryophyta (mosses)

#### II.1. *Amblystegium serpens* (Hedw.) Schimp.

*Ecology.* In cushion plant community; elsewhere known from a variety of habitats, such as decaying wood, rocks, in wet to xeric habitats (Vanderpoorten, 2014).

*Distribution.* Virtually cosmopolitan (Vanderpoorten, 2014); in Chile, primarily known from central regions (*i.e.*, Coquimbo to Bío-Bío; He, 1998), but also found in Juan Fernández

Islands (Robinson, 1975); not yet known from the Magellanic region, including the well explored, Navarino Island (Buck & Goffinet, 2010), but reported from the Falkland Islands (Robinson, 1975). New to sub-Antarctic Chile.

*Specimen examined.* B. Goffinet with R. Mackenzie 13641 (CONC, CONN, NY).

## II.2. *Bryum orbiculatifolium* Cardot & Broth.

*Notes.* This species is distinguished by its small size, deeply concave and imbricate leaves that are typically rounded obtuse (Ochyra *et al.* 2008, also treated as *Plagiobryoides orbiculatifolia* (Cardot & Broth.) Ochyra & Bedn.-Ochyra; see Ochyra & Bednarek-Ochyra, 2017). It has been confused with forms of the rather highly variable *Bryum pseudotriquetrum*, whose leaves are, however, reddish at the base, and typically decurrent. The material attributed here to *B. orbiculatifolium*, lacks decurrencies and the lamina is green throughout. The leaves are strongly concave, densely imbricate especially toward to the apex, and the leaf apex is rather obtuse and apiculate, similar to some Antarctic plants (Ochyra *et al.* 2008).

*Ecology.* On compact soil with *Hennediella* in summit vegetation, and along path near Navy station.

*Distribution.* Southern temperate amphi-Atlantic (Ochyra *et al.* 2008); Diego Ramírez Islands may mark the western limit of its distribution.

*Specimens examined.* B. Goffinet with R. Mackenzie 13684 (CONN), s.n. releve 2 (CONC), Nov. 29-30, 2016.

## II.3. *Bryum pseudotriquetrum* (Hedw.) G. Gaertn., B. Mey. & Scherb.

*Ecology.* Base of seepage, on outcrop close to Navy station; overall rather ubiquitous, typically terricolous, but also on rocks and gravel, and rarely aquatic (Ochyra *et al.* 2008).

*Distribution.* Transequatorial, with occurrences at high altitudes in tropical latitudes; widespread in both northern and southern hemispheres, including across all sub-Antarctic islands (Ochyra *et al.* 2008).

*Specimen examined.* B. Goffinet with R. Mackenzie 13664 (CONN), Nov. 29-30, 2016.

## II.4. *Calyptrochaeta apiculata* (Hook. f. & Wilson) Vitt

*Ecology.* On soil, in wet, community behind the Navy station; elsewhere on soil along creeks, low epiphyte on shrubs and tree ferns, decaying logs, and on wet rocks (Pokorny *et al.* 2011).

*Distribution.* Austral (Pokorny *et al.* 2011), with disjunct occurrences in Southern South America, including Falkland Islands and Navarino Island (Buck & Goffinet, 2010), SE Australasia and Marion Island (South Africa); in Chile known from the Valdivian region southward.

*Specimens examined.* B. Goffinet with R. Mackenzie 13647 (CONC, CONN), 13650 (CONC, CONN) & 13652 (CONN, NY), Nov. 29-30, 2016.

## II.5. *Hennediella heimii* (Hedw.) Zander (Fig. 1G)

*Ecology.* On soil, along path, or in cushion plant vegetation at summit; elsewhere also terricolous, considered a halophyte, although not restricted to salt enriched substrates.

*Distribution.* Strictly bipolar, widespread in the Northern Hemisphere and with an austral distribution in the Southern Hemisphere (Ochyra *et al.* 2008).

*Specimen examined.* B. Goffinet with R. Mackenzie 13642a (CONN), Nov. 29-30, 2016.

## II.6. *Orthotrichum crassifolium* Hook. f. & Wilson (Fig. 1H, I)

*Notes.* This species was formerly accommodated in the genus *Muelleriella* Dusén (Vitt, 1976) until phylogenetic evidence revealed that this clade of austral species was nested within the cosmopolitan genus *Orthotrichum* (Goffinet *et al.* 2004). *Orthotrichum crassifolium* and its close relatives (*i.e.* *Muelleriella sensu* Vitt) are in part characterized by their multicellular spores (Vitt, 1976).

*Ecology.* Halophyte or at least halotolerant, typically growing on rocks from sea-level to the summit, with cushion plants and occasionally with the lichen *Ramalina terebrata* Hook. f. & Taylor (Goffinet with Mackenzie 13632, CONC); recorded once from a fence post (Goffinet with

Mackenzie 13674); elsewhere also on rocks mostly at sea level.

**Distribution.** Circumsubantarctic, including southernmost South America, and New Zealand (Ochyra *et al.* 2008; Vitt, 1976; as *Muelleriella crassifolia* (Hook. f. & Wilson) Dusén).

**Specimens examined.** B. Goffinet with R. Mackenzie 13663 (CONN), 13674 (CONN), 13687 (CAS, CONC, CONN, NY) & 13688 (CONC, CONN), Nov. 29-30, 2016.

## DISCUSSION

The bryophyte flora of Gonzalo Island in the Diego Ramírez archipelago comprises 14 species, eight liverworts and six mosses. This number of non-vascular species nearly doubles the number of vascular plants present on the island (Mackenzie *et al.* 2020, in this volume). The non-vascular/vascular (NV/V) plant species ratio is 1.75. This value is seven times higher than the average NV/V ratio of 0.25 for Chile, and even 66% higher than the NV/V ratio of 1.05 for the rest of the sub-Antarctic Magellanic ecoregion in southern Chile (see Rozzi *et al.* 2008). Consequently, our study contributes to fill a critical knowledge gap regarding the flora of the Diego Ramírez archipelago, and establishes a comprehensive floristic characterization of this deep southern ocean archipelago for long-term socio-ecological research and biocultural conservation (*sensu* Rozzi *et al.* 2006).

The small size of Gonzalo Island combined with its low altitude exposes much of the surface to intense salt spray that may limit the colonization of the island by additional bryophytes. The flora most conspicuously lacks thalloid liverworts (such as *Marchantia berteroana* Lehm. & Lindenb.), and any *Sphagnum* species, which are both abundant in coastal vegetation on Horn Island and other islands of the archipelago (Goffinet & Rozzi, pers. obs.). None of the liverwort species showed signs of sexual reproduction (*i.e.* no gametangia or sporophyte seen; the only exception being young gynoecia in *Leptoscyphus antarcticus*), whereas at least two mosses (*i.e.* *Hennediella heimii* and *Orthotrichum crassifolium*) develop numerous sporophytes. As for specialized asexual reproductive structures, only *Chiloscyphus subviridis* produces gemmae.

All species, except *Amblystegium serpens*, are known to occur in the sub-Antarctic Magellanic ecoregion (Buck pers. com.), and only four, all mosses, occur also on the Antarctic continent (Ochyra *et al.* 2008). Although *A. serpens* is here newly recorded for the sub-Antarctic Magellanic ecoregion from where it is so far unknown (William Buck pers. com. 12 April 2018), it was known from the Falkland Islands, central Chile, and the Juan Fernández Islands (Robinson, 1975), and hence its presence in the Magellanic region is to be expected.

The dominant part of the bryophyte flora of the Diego Ramírez archipelago, and in particular its liverwort component, exhibits strong affinities with the flora of continental and maritime (sub) Antarctic (*e.g.* Bednarek-Ochyra *et al.* 2000; Ochyra *et al.* 2008) and oceanic islands such as the south temperate Falkland Islands, subtropical Tristan da Cunha, and the cool-temperate Gough Island and New Zealand's shelf islands (Vitt, 1976; Engel, 1990; Engel & Glenny, 2008, 2019a, 2019b; Váña & Engel, 2013).

Patterns of floristic similarities based on seedless plants among austral regions of the world may be shaped by geographic distance between areas, but also by the positions of these areas relative to the path of major ocean surface wind currents (Muñoz *et al.* 2004). Current wind connectivity, as well as geographic distances, would suggest that the flora of Diego Ramírez islands should share much (or all) of its flora with the nearby Cape Horn Archipelago, and perhaps with the Antarctic Peninsula, except that the islands are located west of these areas and hence implied dispersal would be against the predominant westerly winds (*i.e.* west to east). The island hosts an extensive breeding colony of the grey-headed albatross (*Thalassarche chrysostoma* (Forster, 1785; Robertson *et al.* 2007), a bird that moves freely across the austral region. Although this bird could theoretically act as a dispersal vector between islands, its feeding behavior, which consists of diving for marine prey (Arata *et al.* 2004), makes this unlikely. Phylogeographic analyses of the species occurring on Diego Ramírez based on extensive population sampling from across their range in austral regions, may be the sole approach to determine the source of dispersal to Diego Ramírez, and perhaps the

role and potential of the island as a source for the colonization of Antarctica.

Finally, none of the bryophyte species recorded on Gonzalo Island is exotic, but *Calyptrochaeta apiculata* was only found in a small wet herbaceous community immediately behind the meteorological station. Our study provides a critical baseline for the southernmost Long-Term Socio-Ecological Research (LT SER) site of the Chilean LT SER network (see Rozzi *et al.* 2020, in this volume).

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