






Description of plant communities on Half Moon Island, Antarctica

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ABSTRACT

During February–March of the austral summers of 2013/14 and 2014/2015, fieldwork was performed on Half Moon Island, South Shetland Archipelago, Antarctica, to evaluate the distribution and abundance of mosses and lichens, as well as to describe and map the plant communities there. The quadrat (20 × 20 cm) sampling method was employed in a phytosociological study that aimed to describe these communities. The area was mapped using an Astech Promark II® DGPS, yielding sub-metric precision after post-processing with software. The number of species totalled 38 bryophytes, 59 lichens, only one flowering plant (*Deschampsia antarctica* Desv.), and two macroscopic terrestrial algae. Five types of plant communities were identified on the island, as follows: (1) fruticose lichen and moss cushion, (2) moss carpet, (3) muscicolous lichen, (4) crustose lichen and (5) moss turf.

KEYWORDS

Phytosociology; Antarctic plant distribution; bryophytes; lichens; plant community mapping

ABBREVIATION

IES: index of ecological significance

Introduction

Half Moon Island (62°35'S and 59°55'W) is one of the smallest islands in the South Shetland Archipelago, Antarctica. This island is visited daily by tourists, who are mainly attracted by its penguin colonies and by the fact that, apart from the giant petrel, all birds that reproduce in the Antarctic can be found on this island (Olrog 1958; Favero & Silva 1991; Esponda et al. 2000). Teniente Camara Base (Argentina) is located on this island.

The Antarctic flora is composed mainly of bryophyte and lichen species adapted to harsh conditions and low temperatures, with 111 moss species described and 360 lichen species accepted by taxonomists occurring in the region, although recent studies indicate that the number of lichen species could actually be as high as 500 species. Regarding angiosperms, only two species of native flowering plants have been described from Antarctica, which are *Deschampsia antarctica* (Desv.) and *Colobanthus quitensis* (Kunth) Bartl. (Pereira & Putzke 1994; Øvstedal & Lewis-Smith 2001, 2004; Putzke & Pereira 2001; Chwedorzewska et al. 2008; Ochyra et al. 2008; Øvstedal & Schaefer 2013).


The vegetation of Half Moon Island was first reported by Lindsay (1971) after a short-term excursion (6 h) in the area, but no reference has been made to any specific species. There are colonies of almost all representative Antarctic birds breeding on the island, in addition to colonies of seals resting in the area, which

could suggest an association between the presence of these animals with the occurrence of plants there. Birds were counted on this island in some previous studies (Olrog 1958; Favero & Silva 1991; Esponda et al. 2000). According to Esponda et al. (2000), there were 10 breeding species on this island in the Antarctic summer of 1995/96: chinstrap penguins (*Pygoscelis antarctica*; 3342 pairs), Cape petrels (*Daption capense*; eight), Wilson's storm petrels (*Oceanites oceanicus*; 377), black-bellied storm petrels (*Fregetta tropica*; seven), Antarctic cormorants (*Phalacrocorax atriceps bransfieldensis*; 29), Subantarctic skuas (*Catharacta antarctica*; three), South Polar skuas (*C. maccormicki*; 103), kelp gulls (*Larus dominicanus*; 39), Antarctic terns (*Sterna vittata*; 125) and greater sheathbills (*Chionis alba*; 11).

Tourism is on the rise in Antarctica, and Half Moon Island is one of the areas most visited by tourists. According to the Association of Antarctic Tourism Operators, tourism on this island has increased nearly eightfold from 1999 to 2014 (Bender et al. 2016). This has likely had an impact on the vegetation, which is a drawback for a plant community study. However, it also provides an opportunity to monitor environmental impacts and diminish future damage from anthropic activities (Esponda et al. 2000).

This study aimed to describe and map the distribution of plant communities on Half Moon Island in order to contribute to efforts to monitor the impact on plant communities of touristic activities there in the future.

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 Supplementary data for this article can be accessed [here](#)

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Materials and methods

Half Moon Island is located in the South Shetland Archipelago, on the west side of the Antarctic Peninsula. It was visited during the 32nd Brazilian Antarctic Operation, carried out in two fieldwork seasons, both in February–March of the austral summers of 2013/14 and 2014/15. The Operation used the facilities of Argentina's Camara Base, which was established in 1952/53, and laboratories and equipment were installed in the proximity of La Morenita Hill. Shaped like a crescent moon, the island is located between latitudes of 62°34'50.57"S and 62°35'54.04"S and longitudes of 59°53'24.44"W and 59°56'04.16"W. Its east–west and north–south dimensions are both approximately 2 km. With a total area of 152 ha, it is one of the smallest islands of the archipelago.

There are three main hills on the island, among which Gabriel Hill is the highest point on the island, reaching 101 m a.s.l. Penguin rookeries are concentrated on Baliza Point and are frequently visited by tourists during the summer.

The study of vegetal communities on the island started with a survey to locate the vegetated areas, and the collection and identification of the plant species occurring in the area. Species not identified in the field were sampled and identified later in the laboratory at Camara Base. Species identification was performed according to guides by Ochyra (1998), Ochyra et al. (2008) and Putzke & Pereira (2001) for mosses, Ochyra et al. (2008) for liverworts, and Redon (1985), Øvstedal & Lewis-Smith (2001) and Olech (2004) for lichens, using the usual procedures for each group.

A phytosociological survey was carried out using the methods of Braun-Blanquet (1964), adapted to the Antarctic situation (Victoria & Pereira 2007). South–north lines were placed over each plant community formation, 5 m apart, with the total number of lines placed depending on the size of the vegetation formation, and sampling was maintained until no new species was found in five consecutive samples. Along each line, within each 5 × 5 m plot, the abundance and coverage of each plant species was counted by using a 20 × 20 cm quadrat subdivided with a grid into 100 sub-quadrats 2 cm² in size. A total of 358 quadrats were sampled across the island, including all the observed patches of vegetation. Samples of vegetation were taken for subsequent identification if needed. The phytosociological data obtained were then used in the calculation of the IES. The IES combines the parameters of abundance (coverage and frequency, represented as C and F, respectively), as follows: $IES = F(1 + C)$ (Lara & Mazimpaka 1998; Marques et al. 2005; Victoria & Pereira 2007). The Shannon-Wiener's diversity index (Pitkanen 1998), Pielou's evenness index (Peet 1974) were used in order to describe the plant species diversity in each community formation (Ludwig & Reynolds 1988).

The vegetal communities were mapped using an Ashtech Promark II® DGPS (Ashtech OEM), with data processed with the Astech Solutions® software. Vegetation spots on the maps produced were then circled and subsequently classified according to the IES.

The samples were dried at 40 °C (±5 °C) in a kiln in the field, and deposited at the Bruno Edgar Irgang Herbarium in the Universidade Federal do Pampa in southern Brazil.

Results

The phytosociological analysis used data from 358 20 × 20 cm quadrats sampled in the field. The plants found included 37 bryophyte species (35 mosses and two liverworts), representing 33% of the bryophyte species described for Antarctica, and 59 lichen species that comprise 15% of those described for the Antarctic (Supplementary Table S1). Only one flowering plant (*Deschampsia antarctica*) and the macroscopic terrestrial algae *Prasiola crispera* (Lightfoot) Kützing and *Prasiola calophylla* (Carmichael ex Greville) Kützing were found on the island. The most species-rich family of mosses on the island was Bryaceae, followed by Pottiaceae, while the most speciose lichen families were Physciaceae and Teloschistaceae. These results demonstrate that, in spite of its small size, Half Moon Island has a great diversity of plant species compared to the amount of species existing around the Antarctic continent (Pereira & Putzke 1994; Victoria et al. 2009; Victoria et al. 2013).

From the data obtained by phytosociological sampling of all the vegetation on Half Moon Island, the mosses *Sanionia uncinata* (Hedw.) Loeske and *Sanionia georgico-uncinata* (Müll. Hal.) Ochyra & Hedenäs, combined herein as *Sanionia* spp., were the most frequently found species, followed by the lichen *Usnea aurantiaco-atra* (Jacq.) Bory (Table 1).

According to this phytosociological study on the vegetation of Half Moon Island, five types of plant communities were identified (Table 2, Fig. 1) covering approximately 19.17 ha of the island's surface, which represents 12.5% of the total island area. These communities were mapped (Fig. 2) and were characterized according to Lindsay (1971), as presented in Table 2.

Fruticose lichen community

This community was found to consist mainly of fruticose lichens, such as *Usnea aurantiaco-atra* and *Sphaerophorus globosus* (Huds.) Vain., on slopes facing the north side of the island, as well as mosses like *Sanionia uncinata* and *Polytrichastrum alpinum* (Hedw.) G.L. Smith on the most stable surfaces of these slopes. This is the second largest community on the island. However, the difficulties in reaching its locations

Table 1. List of the most frequently sampled representative species found in the phytosociological survey on Half Moon Island, Antarctica.

Species	Group	Number of quadrats ^a	F ^b (%)	IES ^c
<i>Sanionia</i> spp.	Moss	257	71.78	234.81
<i>Usnea aurantiaco-atra</i> (Jacq.) Bory	Lichen	124	34.63	63.17
<i>Polytrichastrum alpinum</i> (Hedw.) G.L. Smith	Moss	114	31.84	49.63
<i>Ochrolechia frigida</i> (Sw.) Lynge	Lichen	110	30.62	40.85
<i>Verrucaria</i> sp.	Lichen	83	23.18	29.27
<i>Lecidea sciatrapha</i> Hue	Lichen	79	22.06	27.86
<i>Sphaerophorus globosus</i> (Huds.) Vain.	Lichen	70	19.55	25.67

^aNumber of quadrats in which the species was recorded. ^bSpecies frequency in 358 quadrats. ^cIES of specie considering all samples.

Table 2. Diversity analyses of the plant communities found on Half Moon Island, Antarctica. The number of species (S), specific diversity observed (H'), expected species diversity (H_{max}), and Pielou evenness (J) are presented.

Community	S	H'	H _{max}	J	Area (ha)
Fruticulose lichen	37	1.3817	1.5682	0.8811	5.08
Moss carpet	51	1.3640	1.7075	0.7988	4.30
Muscicolous lichen	35	1.3327	1.5440	0.8631	0.64
Crustose lichen	39	1.4700	1.5910	0.9239	8.46
Moss turf	30	1.3330	1.4771	0.9024	0.70

on slopes limited the number of phytosociological quadrat samples that could be taken to 36, at which point new species stopped appearing in the samples. Thirty-seven plant species were identified ($E = 0.8811$, $H' = 1.3817$) comprising mosses, lichens and the grass *Deschampsia antarctica* (Table 3) that appears sparsely in both of the hillsides of La Morenita and Xenia hills.

Some areas are transitional between the moss *Andreaea* spp. and true fruticulose lichen associations, and these are dominated by *Usnea aurantiaco-atra*

among the saxicolous species and *Sphaerophorus globosus*, *Cladonia borealis* S. Stenroos, *C. rangiferina* (L.) Weber ex F.H.Wigg. and *Stereocaulon glabrum* (Müll. Arg.) Vain. among the muscicolous species. The confluence of these communities generates a well-defined complex, aggregating characteristic species of these communities and other important ones, which are mostly muscicolous lichens growing on *Andreaea* spp., such as *Psoroma hypnorum* (Vahl) Gray, *P. cinammomeum* Malme, *Parmelia saxatilis* (L.) Ach. and, most commonly, *Ochrolechia frigida* (Sw.) Lynge.

One formation almost exclusively inhabited by fruticulose lichens (saxicolous *Usnea aurantiaco-atra*) is that found on a slope of high declivity that starts near the access to the beach north of Xenia Hill and then rises up to approximately 250 m a.s.l. from east to west. The small rock fragments in this formation are almost entirely covered by *Usnea aurantiaco-atra*, giving it a very high IES (reaching 425.00) here, followed by crustose saxicolous lichens, which together reached an IES of 266.43. Among the moss carpet species, only *Sanionia* spp. were registered here (IES = 115.43), covering areas where a small amount of fine soil particles was found. Among the cushion-forming mosses, *Andreaea gainii* Card., *A. depressinervis* Card. and *Himantormia lugubris* (Hue) I.M. Lamb were found sparsely, usually associated with other communities.

Moss carpet community

Moss carpet communities are mostly composed of the species *Sanionia* spp. (Table 4), which has the highest index of biomass in the Antarctic islands (Putzke & Pereira 2001). This community is usually found on soft slopes or on slopes near drainage lines, forming

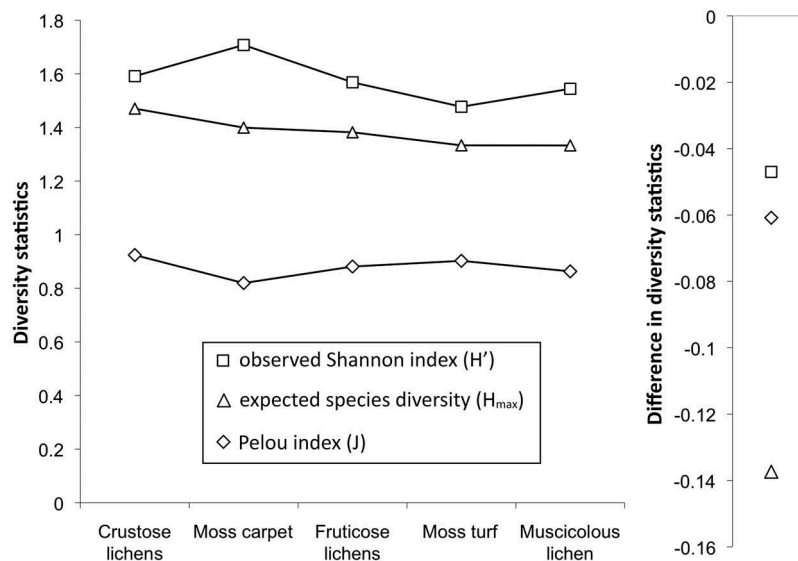


Figure 1. Diversity statistics of plant communities found in each community formation observed on Half Moon Island, maritime Antarctica. The differences in measurements means the significance of each index at the number of samples in each community formation.

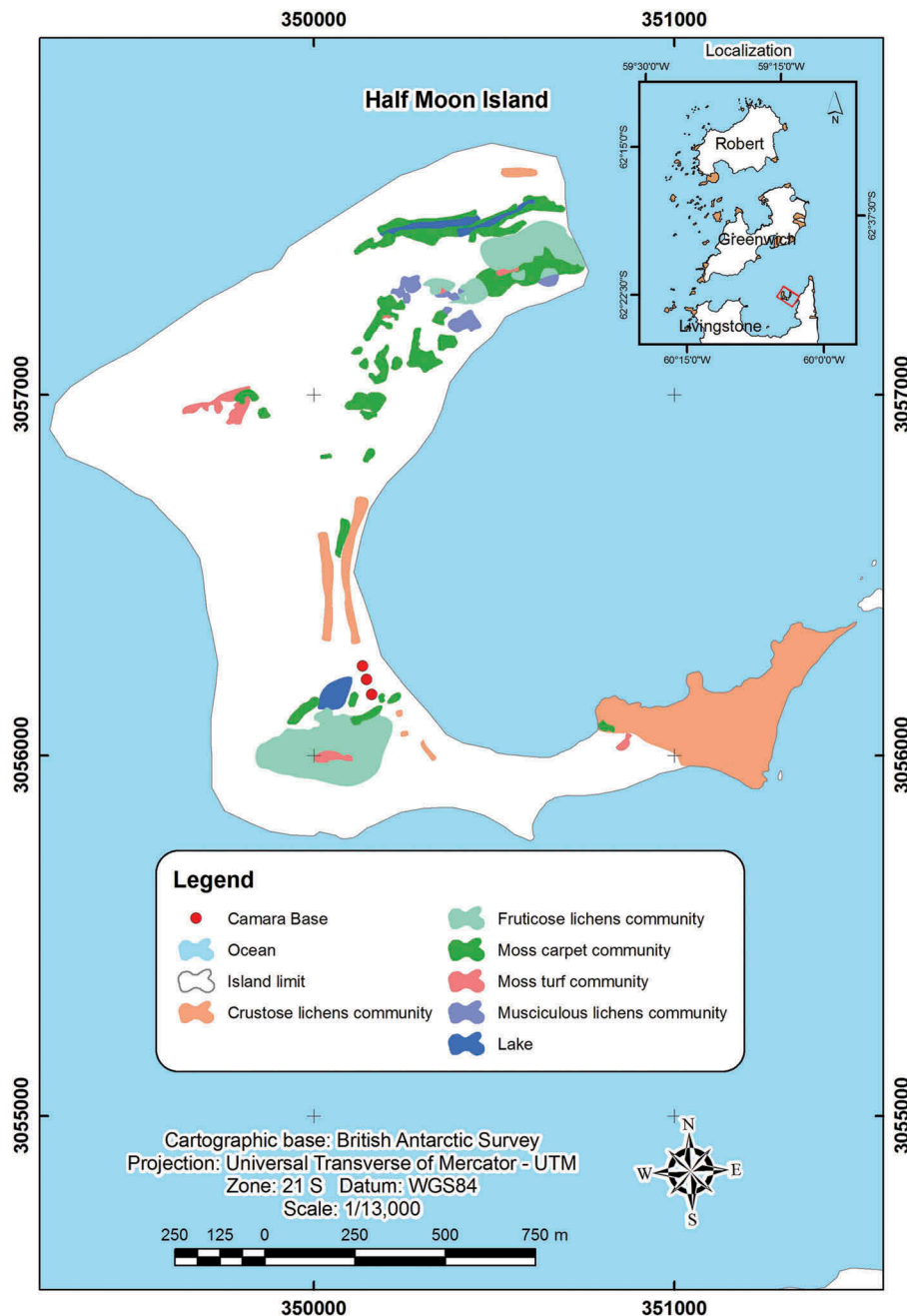


Figure 2. Distribution map of the plant communities on Half Moon Island, Antarctica.

extensive carpets both on the tops of hills and on areas adjacent to the beach level. Its occurrence is restricted to areas with a stable substrate. In this study, 51 species were identified from 191 quadrat samples of this community ($E = 0.7988$; $H' = 1.3640$), making it the most species-rich community at the study site.

The most extensive carpets are found along the northern beaches, at almost the level of the seashore, and also sparsely on the top of Xenia Hill, at the northern site of La Morenita Hill, and in the elevated areas between them. The carpets are formed mostly by *Sanionia uncinata*, along with some tufts of *Brachythecium austrosalebrosus* (Müll. Hal.) Kindb. at least 1 m in size, and sparsely some *Warnstorfia fontinaliopsis* (Müll. Hal.) Ochyra. There is still

competition, especially with *Bryum argenteum* Hedw., *B. cf nivale* Müll. Hal. and *B. pseudotriquetrum* (Hedw.) Schwaegr., which are found together with the carpets of *Sanionia uncinata* or as completely isolated cushions. There are a few musciculous lichens, but ring fungi are more frequent. In areas with small guano deposits, such as La Morenita in the south and Xenia and Gabriel hills in the north, the carpets are small and also furrowing among small rocks. Sometimes the carpets form large groups, which are frequently colonized by musciculous lichens such as *Ochrolechia frigida*, *Psoroma* spp., *Cladonia* spp., *Sphaerophorus globosus* and *Stereocaulon glabrum*.

It is interesting to note that three different carpets are found in the northern portion of the island, almost at

Table 3. Phytosociological data for the fruticose lichen communities on Half Moon Island, including the frequency (F), coverage (C) and IES for each species.

Species	Group	F	C	IES
<i>Usnea aurantiaco-atra</i> (Jacq.) Bory	Lichen	100	3.25	425.00
<i>Sanionia</i> spp.	Moss	61.11	0.888	115.43
<i>Sphaerophorus globosus</i> (Huds.) Vain.	Lichen	47.22	0.666	78.70
<i>Ochrolechia frigida</i> (Sw.) Lynge	Lichen	44.44	0.444	64.19
<i>Lecidea sciatrapha</i> Hue	Lichen	38.88	0.444	56.17
<i>Polytrichastrum alpinum</i> (Hedw.) G.L. Smith	Moss	36.11	0.5	54.16
<i>Verrucaria</i> sp.	Lichen	33.33	0.388	46.29
<i>Cladonia metacorallifera</i> Asahina	Lichen	33.33	0.361	45.37
<i>Lecidea</i> sp.	Lichen	30.55	0.416	43.28
<i>Andreaea depressinervis</i> Card.	Moss	27.77	0.527	42.43
<i>Stereocaulon glabrum</i> (Müll. Arg.) Vain.	Lichen	22.22	0.472	32.71
<i>Rhizoplaca aspidophora</i> (Vain.) Redón	Lichen	25	0.25	31.25
<i>Andreaea gainii</i> Card.	Moss	19.44	0.222	23.76
<i>Andreaea regularis</i> Muell.	Moss	16.66	0.222	20.37
<i>Schistidium steerii</i> Ochyra	Moss	13.88	0.166	16.20
<i>Dicranoweisia grimmiaecae</i> (Müll. Hal.) Broth.	Moss	13.88	0.138	15.81
<i>Microglaena antarctica</i> I.M. Lamb	Lichen	13.88	0.138	15.81
<i>Rhizocarpon polycarpum</i> (Hepp) Th. Fr.	Lichen	13.88	0.138	15.81
<i>Psoroma cinammomeum</i> Malme	Lichen	11.11	0.166	12.96
<i>Cladonia rangiferina</i> (L.) Weber ex F.H. Wigg.	Lichen	11.11	0.138	12.65
<i>Buellia latemarginata</i> Darb.	Lichen	11.11	0.111	12.34
<i>Ceratodon purpureus</i> (Hedw.) Brid.	Moss	11.11	0.111	12.34
<i>Rhizocarpon geographicum</i> (L.) DC.	Lichen	11.11	0.111	12.34
<i>Cystocoleus niger</i> (Huds.) Har.	Lichen	8.33	0.111	9.25
<i>Polytrichum piliferum</i> Hedw.	Moss	8.33	0.083	9.02
<i>Caloplaca athallina</i> Darb.	Lichen	5.55	0.055	5.86
<i>Cladonia furcata</i> (Huds.) Schrad.	Lichen	5.55	0.055	5.86
<i>Ochrolechia parella</i> (L.) A. Massal.	Lichen	5.55	0.055	5.86
<i>Parmelia saxatilis</i> (L.) Ach.	Lichen	5.55	0.055	5.86
<i>Bartramia patens</i> Brid.	Moss	2.77	0.027	2.85
<i>Buellia russa</i> (Hue) Darb.	Lichen	2.77	0.027	2.85
<i>Caloplaca cinericola</i> (Hue) Darb.	Lichen	2.77	0.027	2.85
<i>Deschampsia antarctica</i> Desv.	Grass	2.77	0.027	2.85
<i>Cephalozia</i> sp.	Liverworth	2.77	0.027	2.85
<i>Leptogium puberulum</i> Hue	Lichen	2.77	0.027	2.85
<i>Psoroma hypnorum</i> (Vahl) Gray	Lichen	2.77	0.027	2.85
<i>Schistidium urnulaceum</i> (Müll. Hal.) B.G. Sino	Moss	2.77	0.027	2.85

sea level, forming a 500-m long group, alongside two linear shallow lakes. The northernmost one contains only *Sanionia uncinata*, the middle one has *S. uncinata* together with some cushions of *Bryum cf nivale*, and the southernmost one has *S. uncinata* colonized by *Cystocoleus niger* (Huds.) Har. and *Psoroma hypnorum* with some small tufts of *Polytrichastrum alpinum*.

At the top of Xenia Hill, there is a carpet formed by *Sanionia uncinata* (exclusively associated with *Bryum argenteum*), and a small amount of muscicolous lichens associated with a water pond. No other place has this association on the island.

On the southern face of Xenia Hill, near its top, another carpet can be found, which is composed of *S. uncinata* partially covered by muscicolous lichens, such as *Stereocaulon glabrum*, *Sphaerophorus globosus* and *Psoroma hypnorum*, as well as *Ochrolechia frigida* and *Cladonia* spp. Some of these muscicolous lichens are associated with *Andreaea*, which is scarce in this association. This formation indicates that a muscicolous community probably occupies the area, and could replace the moss carpet formation in the future; however, further evaluations will be necessary to appraise this succession hypothesis.

On the flat area of Xenia Hill there are two other types of carpets, one of which is *S. uncinata* that is

slightly colonized, but not enough to justify its characterization as muscicolous.

Another carpet is found high at the top of Gabriel Hill, formed by *S. uncinata* with patches of *Andreaea* spp. covering the rocks. This association is noteworthy because it is difficult to identify to which assemblage type it exactly belongs, but in fact there are two carpets here isolated by an *Andreaea* association.

A carpet was found ca. 20 m south of Camara Base, of which *S. uncinata* is the main component. In this area, the *Sanionia* coverage and frequency becomes larger towards the west. There are other components here, such as *Andreaea* spp. and *Polytrichastrum alpinum* among the mosses, but they are less representative towards the west, and the same trend occurs with saxicolous and muscicolous lichens here.

Muscicolous lichen community

This community represents the vast majority of the moss formations on the island. Thirty-five species were identified in this formation (Table 5), of which a total of 46 quadrats were evaluated ($E = 0.8631$, $H' = 1.3327$). There is a mix of many moss species, among which *S. uncinata* is the most abundant. The mosses are colonized by

Table 4. Phytosociological data for the moss carpet communities on Half Moon Island, including the frequency (F), coverage (C) and IES for each species.

Species	Group	F	C	IES
<i>Sanionia uncinata</i> (Hedw.) Loeske	Moss	91.09	3.350	396.35
<i>Polytrichastrum alpinum</i> (Hedw.) G.L. Smith	Moss	31.41	0.565	49.17
<i>Usnea aurantiaco-atra</i> (Jacq.) Bory	Lichen	25.13	0.544	38.81
<i>Lecidea sciatrapha</i> Hue	Lichen	27.74	0.335	37.04
<i>Ochrolechia frigida</i> (Sw.) Lynge	Lichen	27.22	0.277	34.77
<i>Verrucaria</i> sp.	Lichen	22.51	0.246	28.05
<i>Psoroma hypnorum</i> (Vahl) Gray	Lichen	14.65	0.214	17.80
<i>Rhizocarpon polycarpum</i> (Hepp) Th. Fr.	Lichen	15.18	0.172	17.80
<i>Sphaerophorus globosus</i> (Huds.) Vain.	Lichen	14.13	0.230	17.39
<i>Andreaea regularis</i> Muell.	Moss	14.13	0.146	16.20
<i>Rhizoplaca aspidophora</i> (Vain.) Redón	Lichen	12.56	0.125	14.14
<i>Andreaea gainii</i> Card.	Moss	12.04	0.136	13.68
<i>Cladonia rangiferina</i> (L.) Weber ex F.H. Wigg.	Lichen	10.47	0.120	11.73
<i>Cladonia metacorallifera</i> Asahina	Lichen	9.94	0.099	10.93
<i>Bryum cf. nivale</i> Müll. Hal.	Moss	8.89	0.146	9.82
<i>Rhizocarpon geographicum</i> (L.) DC.	Lichen	8.37	0.083	9.07
<i>Acarospora macrocyclos</i> Vain.	Lichen	7.85	0.078	8.47
<i>Stereocaulon glabrum</i> (Müll. Arg.) Vain.	Lichen	7.32	0.104	8.09
<i>Usnea antarctica</i> Du Rietz	Lichen	6.80	0.104	7.51
<i>Prasiola crispa</i> (Lightfoot) Kützing	Chlorophyta	6.28	0.068	6.71
<i>Cystocoleus niger</i> (Huds.) Har.	Lichen	6.28	0.062	6.67
<i>Cladonia borealis</i> S. Stenroos	Lichen	5.75	0.083	6.24
<i>Prasiola calophylla</i> (Carmichael ex Greville) Kützing	Chlorophyta	5.75	0.078	6.21
<i>Bryum argenteum</i> Hedw.	Moss	5.23	0.151	6.03
<i>Hennediella heimii</i> (Hedw.) Zand.	Moss	5.23	0.052	5.50
<i>Andreaea depressinervis</i> Card.	Moss	3.66	0.062	3.89
<i>Himantormia lugubris</i> (Hue) I.M. Lamb	Lichen	3.14	0.036	3.25
<i>Rhizoplaca melanophthalma</i> (DC.) Leuckert & Poelt	Lichen	2.61	0.026	2.68
<i>Polytrichum piliferum</i> Hedw.	Moss	2.09	0.031	2.16
<i>Buellia latemarginata</i> Darb.	Lichen	2.09	0.026	2.14
<i>Bryum pallescens</i> Schleich. ex Schwägr.	Moss	1.57	0.015	1.59
<i>Huea austroschetalanica</i> (Zahlbr.) C.W. Dodge	Lichen	1.57	0.015	1.59
<i>Microglaena antarctica</i> I.M. Lamb	Lichen	1.57	0.015	1.59
<i>Pannaria hookeri</i> (Borrer) Nyl.	Lichen	1.57	0.015	1.59
<i>Psoroma cinnamomeum</i> Malme	Lichen	1.57	0.015	1.59
<i>Bartramia patens</i> Brid.	Moss	1.04	0.010	1.05
<i>Buellia anisomera</i> Vain.	Lichen	1.04	0.010	1.05
<i>Pohlia cruda</i> (Hedw.) Lindb.	Moss	1.04	0.010	1.05
<i>Bryum pseudotriquetrum</i> (Hedw.) Schwaegr.	Moss	0.52	0.010	0.52
<i>Buellia racovitzae</i> C.W. Dodge	Lichen	0.52	0.010	0.52
<i>Bacidia tuberculata</i> Darb.	Lichen	0.52	0.005	0.52
<i>Brachythecium austrosalebrosus</i> (Müll. Hal.) Kindb.	Moss	0.52	0.005	0.52
<i>Bryum dichotomum</i> Hedw.	Moss	0.52	0.005	0.52
<i>Buellia russa</i> (Hue) Darb.	Lichen	0.52	0.005	0.52
<i>Caloplaca athallina</i> Darb.	Lichen	0.52	0.005	0.52
<i>Ceratodon grossiretis</i> Card.	Moss	0.52	0.005	0.52
<i>Haematomma erythromma</i> (Nyl.) Zahlbr.	Lichen	0.52	0.005	0.52
<i>Lecanora skottsbergii</i> Darb.	Lichen	0.52	0.005	0.52
<i>Pohlia nutans</i> (Hedw.) Lindb.	Moss	0.52	0.005	0.52

lichens at different degrees of coverage, depending on the environmental conditions. These formations are usually found in the upper part of the hills, at sites of transitional communities like those between carpets of mosses and fruticose lichens.

The pure *Andreaea* spp. formations are generally colonized by *Ochrolechia frigida*. The carpets are colonized by crustose, foliose and fruticulose lichens. This is the case on the third plateau on the way to Xenia Hill's summit, at which a community of mosses formed by *Polytrichastrum alpinum*, *Sanionia uncinata* and *Andreaea* spp. occurs. These mosses are almost completely colonized by the lichens *Cladonia* spp., *Ochrolechia frigida*, *Psoroma hypnorum*, *Sphaerophorus globosus* and *Stereocaulon glabrum*.

Another muscicolous field is found near the edge of a cliff at the east point of the Xenia plateau, which is basically composed of *Andreaea regularis* Muell. and

Sanionia uncinata almost entirely covered by lichens such as *Ochrolechia frigida*, *Cladonia* spp. and *Psoroma hypnorum*.

Crustose lichen community

This community is composed of crustose lichens that develop on gravel, generally in low-altitude and plain areas close to the beach level where there is probably a strong maritime influence (wind and salinity) and plants remain covered by snow for long periods. These sites have strong nitrophilous influences due to the nearby penguin colonies, favouring ornithophilous species. Taking into account the island's entire area, this community comprises a total of 39 plant species (Table 6) sampled in 67 quadrats ($E = 0.9239$, $H' = 1.4700$). These communities include sparse appearances by representative mosses and

Table 5. Phytosociological data for the muscicolous lichen communities on Half Moon Island, including the frequency (F), coverage (C) and IES for each species.

Species	Group	F	C	IES
<i>Sanionia uncinata</i> (Hedw.) Loeske	Moss	82.60	2.021	249.62
<i>Usnea aurantiaco-atra</i> (Jacq.) Bory	Lichen	65.21	1.956	192.81
<i>Ochrolechia frigida</i> (Sw.) Lynge	Lichen	67.39	0.760	118.66
<i>Sphaerophorus globosus</i> (Huds.) Vain.	Lichen	54.34	0.956	106.33
<i>Polytrichastrum alpinum</i> G.L. Smith	Moss	54.34	0.760	95.69
<i>Psoroma hypnorum</i> (Vahl) Gray	Lichen	50	0.782	89.13
<i>Cladonia rangiferina</i> (L.) Weber ex F.H. Wigg.	Lichen	47.82	0.608	76.93
<i>Cladonia metacorallifera</i> Asahina	Lichen	32.60	0.326	43.24
<i>Verrucaria</i> sp.	Lichen	28.26	0.326	37.47
<i>Stereocaulon glabrum</i> (Müll. Arg.) Vain.	Lichen	26.08	0.434	37.42
<i>Andreaea regularis</i> Muell.	Moss	23.91	0.478	35.34
<i>Rhizocarpon polycarpum</i> (Hepp) Th. Fr.	Lichen	23.91	0.239	29.63
<i>Andreaea depressinervis</i> Card.	Moss	17.39	0.413	24.57
<i>Lecidea sciatrappa</i> Hue	Lichen	19.56	0.239	24.24
<i>Andreaea gainii</i> Card.	Moss	19.56	0.217	23.81
<i>Rhizoplaca aspidophora</i> (Vain.) Redón	Lichen	13.04	0.173	15.31
<i>Cladonia borealis</i> S. Stenroos	Lichen	10.86	0.195	12.99
<i>Usnea antarctica</i> Du Rietz	Lichen	10.86	0.195	12.99
<i>Physconia muscigena</i> (Ach.) Poelt	Lichen	10.86	0.152	12.52
<i>Umbilicaria antarctica</i> Frey & I.M. Lamb	Lichen	10.86	0.152	12.52
<i>Microglaena antarctica</i> I.M. Lamb	Lichen	8.69	0.086	9.45
<i>Prasiola crispa</i> (Lightfoot) Kützing	Chlorophyta	8.69	0.086	9.45
<i>Acarospora macrocyclos</i> Vain.	Lichen	6.52	0.086	7.08
<i>Psoroma cinnamomeum</i> Malme	Lichen	6.52	0.065	6.94
<i>Rhizoplaca melanophthalma</i> (DC.) Leuckert & Poelt	Lichen	6.52	0.065	6.94
<i>Pohlia cruda</i> (Hedw.) Lindb.	Moss	4.34	0.086	4.72
<i>Rhizocarpon geographicum</i> (L.) DC.	Lichen	4.34	0.043	4.53
<i>Schistidium antarctici</i> (Card.) L.I. Savicz & Smirnova	Moss	2.17	0.065	2.31
<i>Buellia latemarginata</i> Darb.	Lichen	2.17	0.043	2.26
<i>Huea austroshetlandica</i> (Zahlbr.) C.W. Dodge	Lichen	2.17	0.043	2.26
<i>Cystocoleus niger</i> (Huds.) Har.	Lichen	2.17	0.021	2.22
<i>Hennediella heimii</i> (Hedw.) Zand	Moss	2.17	0.021	2.22
<i>Himantormia lugubris</i> (Hue) I.M. Lamb	Lichen	2.17	0.021	2.22
<i>Verrucaria tessellata</i> (C.W. Dodge) Øvstedal	Lichen	2.17	0.021	2.22
<i>Pohlia nutans</i> (Hedw.) Lindb.	Moss	2.17	0.011	2.17

fruticose lichens, which, in the future, could develop in other locations with favourable conditions..

The small peninsula that connects the hills at the north and middle–south of the island to the penguin rockery in the east are formed mainly of rounded rocks in deposits with plateau shapes. Each plateau has a distinct level of stability. In general, they have greater firmness in the centre of the island than at sites close to the sea. Apparently, erosion of the central plateaus is only affected anthropically. Amphibious vehicles used in 2008/09, for example, left tracks still visible in those sectors.

Depending on their altitudinal range and the depressions between each other, these areas are differently affected by wind and snow deposits. The higher sites are generally free from ice accumulation, while the depressions are generally covered by snow. However, the general geological structure does not allow for the formation or retention of soil, which allows only a saxicolous community to become established on the peninsula, except for a small part at the north and between each of the two straight-line formations found. The pebbles and rocks here are generally colonized by crustose lichens. Skuas use the area for nesting, generating some accumulation of finer particles, and such particulate pebbles and waste from the nests of birds allows the mosses to colonize these places, especially *Sanionia uncinata* and *Polytrichastrum alpinum*. An identical

community is found on the east side of La Morenita Hill, at the plateau formed by the same kind of stones. *Verrucaria* spp., *Buellia* spp. and *Lecidea* spp. are the main crustose lichens in this community. *Sanionia uncinata* and *Andreaea* spp. are the main mosses represented, and are sometimes colonized by the lichen *Ochrolechia frigida*.

This community is present as three characteristic groups on the island. One of them is restricted to the penguin rockeries in the south, where the amount of guano is large. The second is found at the north and centre of the island, where the guano supply is smaller and comes from skuas and Cape petrels (*Daption capense*) nesting in the area. The third is very peculiar, since it is linked to the rounded small rocks exposed near the beach with the regression of the sea. Some animals (birds and pinnipeds) use these places as resting or molting points, depositing feathers and faeces on the rocks and generating an coprophilous community mainly composed of *Acarospora macrocyclos*. On the cliffs of Xenia Hill, there are also some examples of this community type, stimulated by the presence of guano deposited by Cape petrels at their nesting points. The main species in the areas are *Haematomma erythromma* and *Xanthoria elegans* (*Polycauliona candelaria*), covering the higher parts of the cliffs.

Table 6. Phytosociological data for the crustose lichen communities on Half Moon Island, including the frequency (F), coverage (C) and IES for each species.

Species	Group	F	C	IES
<i>Lecania brialmontii</i> (Vain.) Zahlbr.	Lichen	37.31	0.985	74.06
<i>Buellia latemarginata</i> Darb.	Lichen	38.80	0.671	64.86
<i>Sanionia uncinata</i> (Hedw.) Loeske	Moss	22.38	0.417	31.74
<i>Acarospora macrocyclos</i> Vain.	Lichen	20.89	0.283	26.82
<i>Turgidosculum complicatulum</i> (Nyl.) Kohlm. & E. Kohlm.	Lichen	19.40	0.373	26.64
<i>Haematomma erythromma</i> (Nyl.) Zahlbr.	Lichen	17.91	0.373	24.59
<i>Rinodina petermannii</i> (Hue) Darb.	Lichen	16.41	0.477	24.25
<i>Verrucaria</i> sp.	Lichen	17.91	0.238	22.18
<i>Prasiola crispa</i> (Lightfoot) Kützing	Chlorophyta	17.91	0.194	21.38
<i>Caloplaca regalis</i> (Vain.) Zahlbr.	Lichen	14.92	0.313	19.60
<i>Xanthoria candelaria</i> (L.) Th. Fr.	Lichen	14.92	0.238	18.48
<i>Candelaria murrayi</i> Poelt	Lichen	13.43	0.238	16.64
<i>Lecidea sciatrapha</i> Hue	Lichen	13.43	0.223	16.44
<i>Pannaria hookeri</i> (Borrer) Nyl.	Lichen	13.43	0.194	16.03
<i>Bacidia tuberculata</i> Darb.	Lichen	11.94	0.238	14.79
<i>Usnea aurantiacoatra</i> (Jacq.) Bory	Lichen	11.94	0.149	13.72
<i>Rhizoplaca aspidophora</i> (Vain.) Redón	Lichen	11.94	0.119	13.36
<i>Parmelia saxatilis</i> (L.) Ach.	Lichen	8.95	0.253	11.22
<i>Xanthoria elegans</i> (Link) Th. Fr.	Lichen	7.46	0.149	8.57
<i>Buellia anisomera</i> Vain.	Lichen	7.46	0.134	8.46
<i>Ramalina terebrata</i> Hook. f. & Taylor	Lichen	7.46	0.134	8.46
<i>Andreaea regularis</i> Muell.	Moss	7.46	0.074	8.01
<i>Hennediella antarctica</i> (Angstr.) Ochyra & Matteri	Moss	7.46	0.074	8.01
<i>Syntrichia magellanica</i> (Mont.) R.H. Zander	Moss	7.46	0.074	8.01
<i>Mastodia tessellata</i> (Hook. f. & Harv.) Hook. f. & Harv.	Lichen	5.97	0.104	6.59
<i>Rhizocarpon geographicum</i> (L.) DC.	Lichen	5.97	0.059	6.32
<i>Rhizocarpon polycarpum</i> (Hepp) Th. Fr.	Lichen	5.97	0.059	6.32
<i>Polytrichastrum alpinum</i> G.L. Smith	Moss	4.47	0.059	4.74
<i>Psoroma cinnamomeum</i> Malme	Lichen	4.47	0.044	4.67
<i>Usnea antarctica</i> Du Rietz	Lichen	4.47	0.044	4.67
<i>Microglaena antarctica</i> I.M. Lamb	Lichen	2.98	0.044	3.11
<i>Andreaea gainii</i> Card.	Moss	2.98	0.029	3.07
<i>Caloplaca cinericola</i> (Hue) Darb.	Lichen	2.98	0.029	3.07
<i>Ochrolechia frigida</i> (Sw.) Lynge	Lichen	2.98	0.029	3.07
<i>Umbilicaria decussata</i> (Vill.) Zahlbr.	Lichen	2.98	0.029	3.07
<i>Physconia muscigena</i> (Ach.) Poelt	Lichen	1.49	0.014	1.51
<i>Rhizoplaca melanoptalma</i> (DC.) Leuckert & Poelt	Lichen	1.49	0.014	1.51
<i>Usnea acromelana</i> Stirt.	Lichen	1.49	0.014	1.51
<i>Verrucaria tessellata</i> (C.W. Dodge) Øvstedal	Lichen	1.49	0.014	1.51
<i>Bartramia patens</i> Brid.	Moss	0.14	0.007	0.15

Table 7. Phytosociological data for the moss turf communities on Half Moon Island, including the frequency (F), coverage (C) and IES for each species.

Species	Group	F	C	IES
<i>Polytrichastrum alpinum</i> G.L. Smith	Moss	72.22	2.055	220.67
<i>Sanionia uncinata</i> (Hedw.) Loeske	Moss	50	1.166	108.33
<i>Polytrichum piliferum</i> Hedw.	Moss	38.88	1.166	84.25
<i>Ochrolechia frigida</i> (Sw.) Lynge	Lichen	50	0.666	83.33
<i>Hennediella heimii</i> (Hedw.) Zand.	Moss	38.88	0.888	73.45
<i>Rhizoplaca aspidophora</i> (Vain.) Redón	Lichen	38.88	0.388	54.01
<i>Cladonia metacoralifera</i> Asahina	Lichen	33.33	0.333	44.44
<i>Verrucaria</i> sp.	Lichen	27.77	0.277	35.49
<i>Bryum argenteum</i> Hedw.	Moss	22.22	0.388	30.86
<i>Cladonia rangiferina</i> (L.) Weber ex F.H. Wigg.	Lichen	22.22	0.333	29.62
<i>Lecidea sciatrapha</i> Hue	Lichen	22.22	0.222	27.16
<i>Pohlia cruda</i> (Hedw.) Lindb.	Moss	22.22	0.222	27.16
<i>Ceratodon purpureus</i> (Hedw.) Brid.	Moss	22.22	0.166	25.92
<i>Cystocoleus niger</i> (Huds.) Har.	Lichen	16.66	0.222	20.37
<i>Andreaea regularis</i> Muell.	Moss	16.66	0.166	19.44
<i>Psoroma cinnamomeum</i> Malme	Lichen	16.66	0.166	19.44
<i>Usnea aurantiacoatra</i> (Jacq.) Bory	Lichen	11.11	0.111	12.34
<i>Andreaea depressinervis</i> Card.	Moss	5.55	0.277	7.09
<i>Acarospora macrocyclos</i> Vain.	Lichen	5.55	0.055	5.86
<i>Andreaea depressinervis</i> Card.	Moss	5.55	0.055	5.86
<i>Bartramia patens</i> Brid.	Moss	5.55	0.055	5.86
<i>Buellia anisomera</i> Vain.	Lichen	5.55	0.055	5.86
<i>Buellia latemarginata</i> Darb.	Lichen	5.55	0.055	5.86
<i>Chorisodontium acyphyllum</i> (Hook. f. & Wills.) Broth.	Moss	5.55	0.055	5.86
<i>Prasiola crispa</i> (Lightfoot) Kützing	Chlorophyta	5.55	0.055	5.86
<i>Psoroma hypnorum</i> (Vahl) Gray	Lichen	5.55	0.055	5.86
<i>Rhizocarpon geographicum</i> (L.) DC.	Lichen	5.55	0.055	5.86
<i>Rhizocarpon polycarpum</i> (Hepp) Th. Fr.	Lichen	5.55	0.055	5.86
<i>Rhizoplaca melanoptalma</i> (DC.) Leuckert & Poelt	Lichen	5.55	0.055	5.86
<i>Sphaerophorus globosus</i> (Huds.) Vain.	Lichen	5.55	0.055	5.86

Significant ornithocoprophilous communities are found in seven areas of the island. One is located at the extreme north of the island, on a shallow cliff near the seashore that is almost completely covered by *Nacella concina* shells in some places. The area is covered mainly by foliose/fruticose lichens such as *Rinodina pettermanii* and *Haematoma erythromma*, and also by crustose ones, for example *Buellia* spp. This place was the only one on the island where we found *Usnea acromelana*.

At two sites near Camara Base two giant rock fragments sometimes used by kelp gulls and skuas are covered by nitrophilous communities. Other hills used by gulls are situated inside the penguin colonies and, therefore, are influenced by them. The two isolated rocks are mainly covered by crustose lichens, such as *Acarospora macrocyclus*, *Bacidia* sp. and *Rhizoplaca aspidophora*.

Moss turf community

Eighteen quadrats were sampled and 30 plant species were identified in this formation ($E = 0.9024$, $H' = 1.3330$), which includes species of mosses, lichens and algae. This community is found at four sites of the island, three of which are located at higher altitudes on the tops of La Morenita, Gabriel and Xenia hills. The other formation is at the entrance of the penguin colony at Baliza Point, located in a transition area composed of pebbles, ornithocoprophilous plant communities and sparse carpets of *S. uncinata*. There is a constant presence of fur seals at this site. The moss species with high ecological significance in this community were *Pohlia* sp., *Polytrichastrum alpinum* and *S. uncinata* (Table 7). Crustose lichens have also been identified in association with the moss species, totalling six distinct species.

Discussion

Estimating of the extent and coverage of plant communities is important to assess their ecological relationships with different attributes of the physical environment, such as soil, rocks and the landscape, in greater detail (Simas et al. 2008). Our results indicated that *Sanionia uncinata* has the highest IES value on Half Moon Island (234.81), followed by *Usnea aurantiacoatra* (63.17) and *Polytrichastrum alpinum* (49.63). On Half Moon Island, the grass *Deschampsia antarctica* had an IES of only 0.28 because its frequency was very low (0.28%), which was probably due to the small size of seabird colonies, as the association of this grass species with ornithogenic soils has been observed in other areas of maritime Antarctica (Emslie et al. 2014). In the vicinity of Arctowski Station (Poland) in Admiralty Bay, King George Island, Victoria et al. (2009) and Pinto et al. (2013) found that the maximum IES was observed for *Deschampsia antarctica* (245 and 358,

respectively), followed by *Sanionia uncinata* (215 and 269, respectively) and *Polytrichastrum alpinum* (153 and 81, respectively). In this study, we found that the area with grass is not generally used by bird colonies, being used mostly by a few skuas as a nesting point. In two areas with grass on Half Moon Island, Esponda et al. (2000) counted only five and two skua nesting pairs, respectively. The opposite occurred at Arctowski, as the areas colonized by *D. antarctica* there have large nutrient input rates due to the presence of penguin colonies. The occurrence of Antarctic hair-grass is important to landscape changes since the presence of the grass in plant communities generates changes in several factors in the Antarctic soil. The grasses increase the carbon input to the soil, which modifies exudate input and rhizosphere microbial diversity (Teixeira 2010; Teixeira et al. 2013), as well as soil genesis. The adaptive success of this plant in Antarctica is related to its efficient nitrogen acquisition from guano sources (Hill et al. 2011).

Analysing the diversity indices presented in Table 2 and Fig. 3, it can be observed that the crustose lichen community is the most diverse on Half Moon Island as indicated by the highest Shannon diversity index (H') and even greater evenness (J); despite it not being the most species-rich it is a more homogeneous community in which no species stands out as being dominant over all others. The moss carpet community, in turn, has the highest species richness (51), although it does not have the greatest diversity and even has the lowest evenness. This is due to the fact that *S. uncinata* stands out as the dominant species in this community.

A previous study conducted at Hennequin Point on King George Island in the austral summer of 2004/05 (Victoria et al. 2013) showed some similar communities to those found herein on Half Moon Island, but with different indices. The moss carpet community of Hennequin Point was also the most species-rich one there, but the number of species was lower (28) and it was also the most homogeneous community in that study. Fruticose and crustose lichens were also found; however, these were classified as being within the same community, featuring only 28 species. The number of species of both fruticose and crustose lichens at Hennequin was relatively lower than that observed on Half Moon Island (Table 2), where fruticose and crustose lichens are not found in the same communities.

The fruticose lichen community on Half Moon Island is similar to that reported by Lindsay (1971), but with the *Andreaea* moss cushion presence only in isolated spots, forming associations similar to those described by that author. Accordingly, there is only one association (*Andreaea-Usnea*) in this community, and five associations. The associations found on Half Moon Island in this community are *Usnea-Lecidea-Andreaea* and *Andreaea-Ochrolechia frigida*.

The other three associations with *Himantormia lugubris* described by Lindsay (1971) in the South Shetlands were not found in this study; although some small patches of this species were observed, very sparsely distributed, they were not abundant enough to be described as an association. The exposure to high salinity is probably hampering their growth, since the island is too small to protect them from maritime influences.

The formations of the moss carpet community, in which *S. uncinata* appeared most often, were found near drainage lines or sites under the influence of water originating from melting glaciers or lakes, as observed in Admiralty Bay, King George Island (Victoria et al. 2009; Victoria et al. 2013). Spots in which several species have developed in association with *S. uncinata* were also found. Therefore, the same conditions that favour *S. uncinata* appear to promote adequate conditions for other species of both mosses and muscicolous lichens in these places, even in the absence of glaciers in the area studied in this work.

The crustose lichen community has the greatest area of vegetation cover on the island and, in addition, is the most diverse. Generally, this community is located in areas where the island birds and penguin colonies are concentrated. Important conditions for some species are developed there. The direct relationship between the vegetation and the presence of nests is linked to the fact that birds provide the majority of nutrients for the initial development of plants, since the emergence of plant communities is subsequent to the establishment of nests (Allen et al. 1967; Leishman & Wilde 2001; Smykla et al. 2007).

In the study by Lindsay (1971), the lichen community was composed mainly of crustose lichens, although fruticose lichens could attain appreciable cover and occur on rock surfaces, particularly those subjected to wind and salt spray. At the location of this study, a high coverage by the crustose lichen *Verrucaria* spp. can be observed, which is specifically associated with fresh or salt water (Olech 2004) and exposure to wind.

At Hennequin Point, King George Island, Victoria et al. (2013) found that there was a community association with fruticulose lichens, where they described *Usnea aurantiaco-atra*, *Mastodea tessellata* (Hook. f. & Harv.) Hook. f. & Harv., and *Lecania brialmontii* (Vain.) Zahlbr. as the most common species. The last two, which are usually associated with colonies of birds and occur along with other ornitocoprophilous species, were not found at comparable locations on Half Moon Island.

The formation located on the top of La Morenita Hill resembles the sociation of *Polytrichastrum alpinum*–*Polytrichum piliferum* Hedw. described by Lindsay (1971), in which these two mosses did

not form extensive turfs but occurred in small colonies that formed low piles and irregular loafs. The flat top of the hill allows the development of mosses such as *S. uncinata* and representatives of the family Polytrichaceae. There are other mosses on the hill formation, such as *Bryum argenteum* and *Ceratodon* sp., which develop among the same conditions as those preferred by the species referred to above. Fruticose and crustose lichen assemblages are also developed on the rocks nearby.

Verrucaria species (except *V. tessalata*) were found in all communities in most of the sites studied on Half Moon Island, except at the top of La Morenita and Xenia hills and on the slope and beach on the north side of Xenia Hill, i.e., areas that are probably protected from the east–west winds acting on the island. The only plant community in which *Verrucaria* spp. were not present is that predominated by fruticose lichens, which occurs mainly on the north slope of Xenia Hill. According to Olech (2004), *Verrucaria* species spp. were found on rocks in the spray zone above high-tide level. This indicates that the area is constantly sprayed by marine salt, especially because it is a very small island, which explains the frequent presence of these halophilous species.

Colobanthus quitensis (Caryophyllaceae) was not found on Half Moon Island. This species and the grass *Deschampsia antarctica* are the only native angiosperms found in the South Shetlands Islands and the maritime Antarctic, reaching as far south as 68°42'S along the Antarctic Peninsula (Moore 1970; Edwards & Lewis-Smith 1988; Putzke & Pereira 2001; Olech 2004; Parnikoza et al. 2007). *Colobanthus quitensis* is abundant in lower coastal regions, where it forms dense communities and occupies large areas associated with *D. antarctica* in all the South Shetland Islands. Vera (2011) reported the occurrence of *C. quitensis* at Livingston Island (located south-east of Half Moon Island) and proposed that its distribution there is related to the island's geomorphology, suggesting that it only grows in more interior areas and at higher altitudes, where the types of other vegetation that can persist become more restricted. Its dispersion is favoured by skuas for nesting, but can also occur with strong winds. These environmental factors are also found on Half Moon Island: it is a small island, with different altitudinal ranges, strong winds, and the presence of nesting skuas. However, no *C. quitensis* was found in our survey, suggesting that the soil condition, the size of bird colonies or the maritime influence on Half Moon Island might have affected its development or establishment there.

Conclusions

Comparing the plant communities of the ice-free areas on Half Moon Island with those described at Stinker Point, Elephant Island, by Pereira & Putzke (1994), Rip Point, Nelson Island, by Putzke et al. (1998), the region of Arctowski, Admiralty Bay, King George Island by Victoria et al. (2009), Hennequin Point, King George Island, by Victoria et al. (2013), Demay Point, King George Island, by Pereira et al. (2010) and Keller Peninsula, King George Island, by Pereira et al. (2007), it was possible to make the following conclusions.

Moss turf communities were found only in a small area and were difficult to clarify on account of the absence of key species in these communities. For example, *Chorisodontium aciphyllum* (Hook. f. & Wills.) Broth and *Polytrichum juniperinum* Hedw. are considered the moss tuft species most observed in this type of formation, but they were not found on Half Moon Island. We found only *Polytrichastrum alpinum* Hedw., but its low coverage and frequency made it extremely difficult to define this community based on this species in this study. However, the physiognomy observed in these small sites allow us to suggest the occurrence of this formation on the island.

Among the flowering plants, only *Deschampsia antarctica* was found on Half Moon Island, while *Colobanthus quitensis* (Caryophyllaceae) was absent, in spite of its occurrence in the surrounding islands. Because of the scarcity of soil on the island, the grass *D. antarctica* presented low coverage and low ecological importance indices.

Ornithocrophobous species are rare on Half Moon Island on account of guano inputs, as is the case on almost all islands in this region. *Polytrichum juniperinum* and *Placopsis antarctica* D.J. Galloway, Lewis-Sm. & Quilhot. were absent. The ornithocrophilous lichen community is restricted to the eastern extremity of the island, the penguin rookeries are, and to the north-east cliffs, where Cape petrels are found. The crustose lichen community is well represented on Half Moon Island, since there are many areas where these lichens completely cover rock fragments.

Disclosure statement



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