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Short Note

New *Folsomotoma* species (Collembola) found on Byers Peninsula, Livingston Island, South Shetland Islands

Stef Bokhorst[1], Janine Marien[2] and Peter Convey[3,4,5,6,7]

[1]Amsterdam Institute for Life and Environment (A-LIFE), Section Systems Ecology, Vrije Universiteit Amsterdam, Amsterdam, The Netherlands; [2]Amsterdam Institute for Life and Environment (A-LIFE), Section Ecology and Evolution, Vrije Universiteit Amsterdam, Amsterdam, The Netherlands; [3]British Antarctic Survey, Natural Environment Research Council, Cambridge, UK; [4]Department of Zoology, University of Johannesburg, Auckland Park, South Africa; [5]Millennium Institute – Biodiversity of Antarctic and Sub-Antarctic Ecosystems (BASE), Santiago, Chile; [6]Cape Horn International Center (CHIC), Puerto Williams, Chile and [7]School of Biosciences, University of Birmingham, Birmingham, UK

Abstract

Here we describe a new springtail species found on Byers Peninsula, Livingston Island. The new species, Folsomotoma punctata, is known from sub-Antarctic South Georgia, but this is a first occurrence of this species for the South Shetland Islands and the Maritime Antarctic, increasing the total species number to 15. Considering the widespread distribution of F. punctata across Byers Peninsula, it seems most likely that this species has been present for a long time. That it was only now reported reflects the limited arthropod surveys conducted in this region of the South Shetland Islands, and highlights the need for more thorough and high spatial resolution systematic surveys across different vegetation and habitats to better understand the terrestrial biodiversity patterns in Antarctica.

Keywords: Byers Peninsula; Collembola; *Folsomotoma*; habitat; Maritime Antarctic; springtail

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Introduction

Antarctica supports a low diversity of arthropod species compared to the rest of the world (Convey & Biersma 2024), and its highest species richness is typically found at sites in the relatively mild and wet Maritime Antarctic region. The South Shetland Islands host 14 springtail species (Collembola), including 8 native species and 6 exotics (Greenslade 2010, Greenslade *et al.* 2012). During a biological survey on Byers Peninsula, Livingston Island as part of a wider study of the impact of penguin-derived nutrients on arthropod diversity patterns during February 2017 (Bokhorst *et al.* 2019), where vegetation samples were heat extracted, we noticed an unusual springtail species (Fig. 1) to be present in 18 of the 240 vegetation samples (n = 64 individuals, 1–11 individuals/sample) obtained in that campaign. The springtail's morphology resembles that of the known Maritime Antarctic-native species *Folsomotoma octooculata* (Willem, 1901), but it clearly differed from this species by having 1+1 ocelli instead of the 4+4 ocelli configuration of *F. octooculata* (Convey *et al.* 1999, Fanciulli *et al.* 2018), and in most cases individuals are shorter than *F. octooculata*. Following the taxonomic key of Heckman (2001) for South American aquatic insects, this springtail was identified as *Isotoma punctata* (Wahlgren 1906). The genus *Isotoma* contains many subgenera, amongst which *Folsomotoma* was raised to full genus by Greenslade (1986). There are currently four recognized *Folsomotoma* species with 1+1 ocelli: *Folsomotoma boerneri*, *Folsomotoma subflava*, *Folsomotoma marionensis* and *Folsomotoma punctata* (Fanciulli *et al.* 2018), of which *F. punctata* has the closest geographical distribution to the South Shetland Islands, being native in southern South America (Heckman 2001) and also being recorded as native from sub-Antarctic South Georgia and other sub-Antarctic islands (Convey *et al.* 1999).

Results

We were unable to quantify the setae on the corpus of the retinacle, a distinguishing factor within *F. boerneri*, *F. subflava*, *F. marionensis* and *F. punctata*, but there appear to be 1+1 ampoule setae on the manubrium (Fig. 2), reducing the possibilities to *F. marionensis* and *F. punctata*. DNA was extracted from two springtail individuals using the Qiagen tissue protocol, followed by polymerase chain reaction (PCR) with universal cytochrome oxidase I (COI) primers COI-LCO1490F and COI-HCO2198R, and also a custom 18S rRNA primer based on *F. punctata* (GenBank DQ365777). No amplification products were obtained, probably due to low or absent DNA yield, primer mismatch or insufficient sequence similarity.

Specimens of *F. punctata* were obtained on Byers Peninsula from the mosses *Sanionia uncinata* (number of samples with *F. punctata*: n = 5) and *Andreaea regularis* (n = 10), the lichen *Sphaerophorus globosus*, the grass *Deschampsia antarctica* and an unidentified lichen (Fig. 3). All springtail communities were dominated by *Cryptopygus antarcticus*, and *F. punctata* was, in

Corresponding author: Stef Bokhorst; Email: s.f.bokhorst@vu.nl
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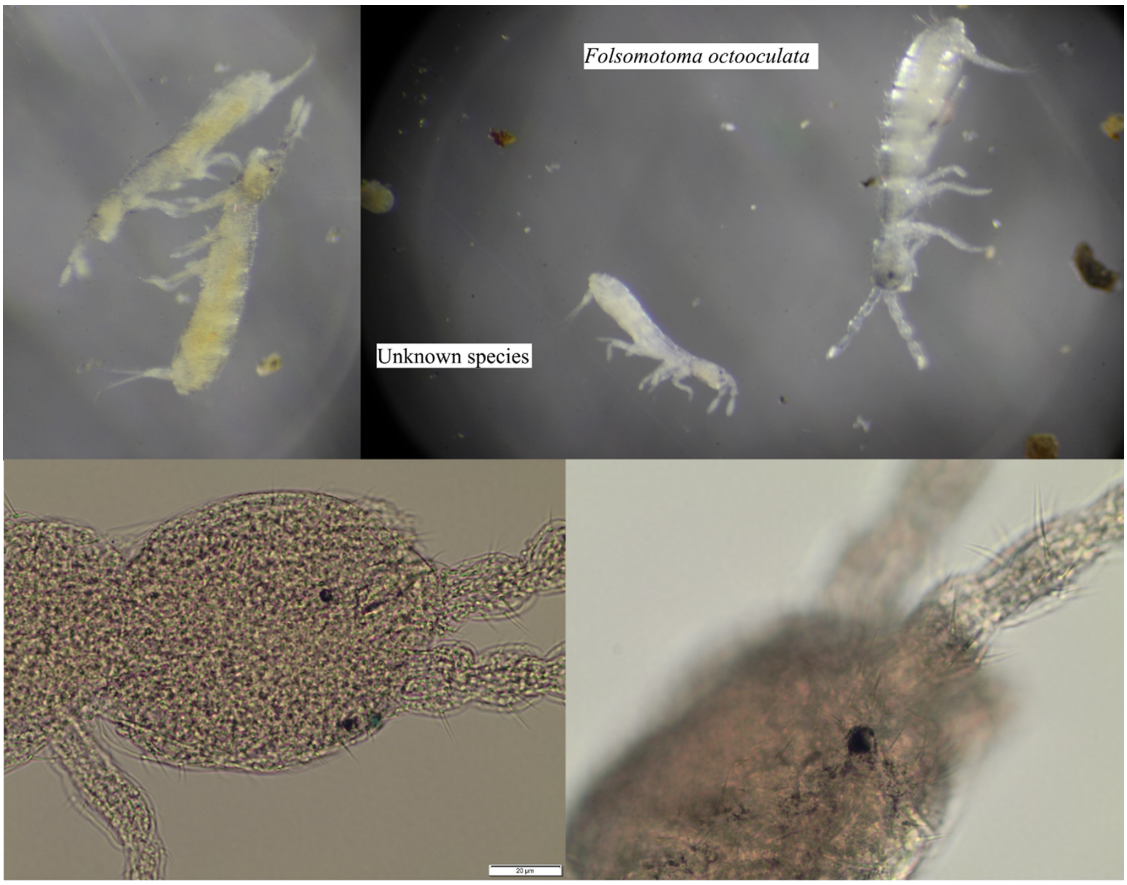

Figure 1. Stereomicroscope image of previously unrecorded springtail species found in vegetation samples obtained on Byers Peninsula, Livingston Island. The springtail on the far right is the native *Folsomotoma octooculata*, which is commonly found in this region. The middle springtail is most probably a juvenile, whereas the two on the left represent adults. The size of the new species is smaller than that of *F. octooculata*, but the overall appearance is similar with the exception of the number of ocelli. The lower images show close-up magnifications (×400) of the head and 1+1 ocelli of the unrecorded species.

Figure 2. Close-up image of the manubrium of the putative *Folsomotoma punctata* found on Byers Peninsula, Livingston Island. The arrow indicates the presence of an ampoule setae, of which *F. punctata* has 1+1 on the manubrium according to Fanciulli *et al.* (2018). We were unable to bring both ampoule setae into focus within one picture.

almost all instances, found together with *F. octooculata*, indicating preference for the same habitat (Fig. 4 & Table I). Other dominant microarthropod species were present across Byers Peninsula, except for the oribatid mites *Alaskozetes antarctica* and *Halozetes belgicae*, which are generally coastal species and were absent from the interior of the peninsula (Fig. 4). Species abundances across the different habitat types sampled are shown in Table I. Overall, there were no significant species abundance differences between moss, lichen and grass habitats, except for *Globoppia loxolineata*, which was 3.5 times more abundant ($F_{1,24} = 8.0$, $P = 0.009$) amongst lichen (2.6 ± 0.7 ind. g^{-1}) compared to moss (0.7 ± 0.2 ind. g^{-1}) habitats.

Discussion and conclusion

The most recent survey of the arthropod community on Byers Peninsula dates back to the early 1990s (Richard *et al.* 1994), with five springtail species being identified in that survey (Convey *et al.* 1996). The observation of a new species most probably reflects a more extensive sampling regime across both the northern and southern beaches of the peninsula as well as inland sampling (Fig. 3), whereas Richard *et al.* (1994) mainly collected along the western beaches. *F. punctata* was recorded on Deception Island, but this observation remained unpublished in a thesis (Enriquez 2017), and we thank the reviewers for bringing this to our attention. The morphology and description of setae match with the specimens

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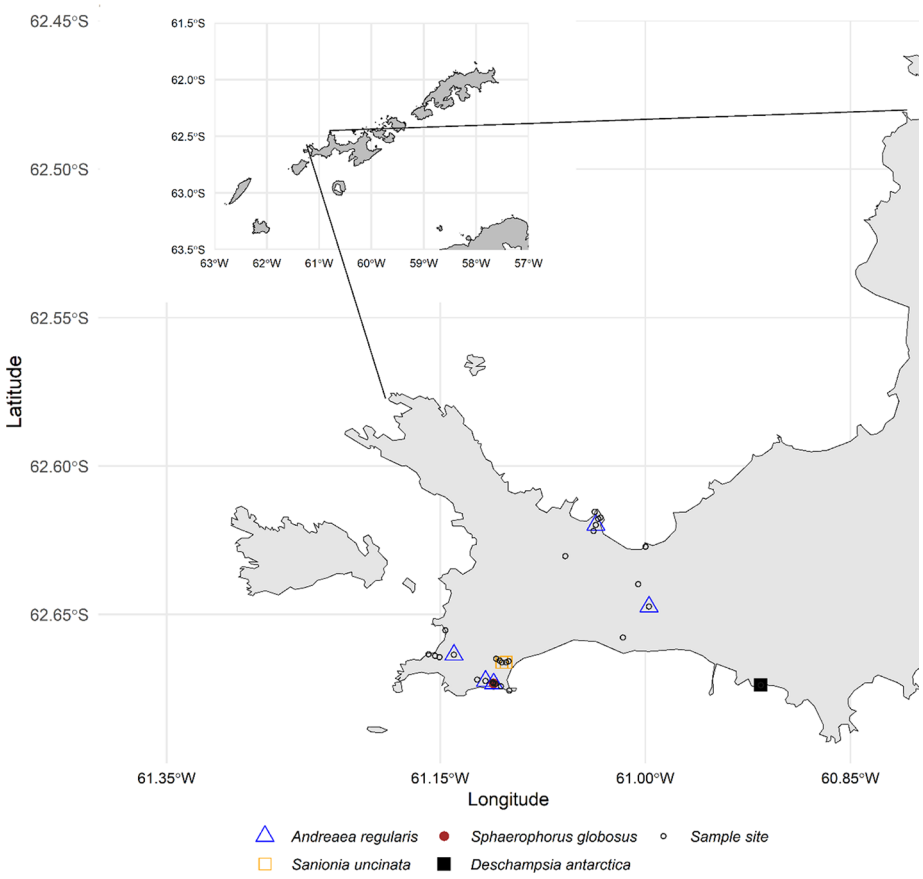

Figure 3. Sampling locations where *Folsomotoma punctata* was found on Byers Peninsula, Livingston Island, during February 2017. Different symbol types and colours represent different habitat types. *F. punctata* (64 individuals in total) was also found in an unidentified lichen sample at the same location as that of *Sphaerophorus globosus*. Open circles represent sample sites (n = 29) at which multiple vegetation samples were collected. The inset shows the location of the South Shetland Islands relative to the north-west coast of the Antarctic Peninsula.

from Byers Peninsula, and *F. punctata* was consistently observed together with *F. octooculata* and *C. antarcticus* on Deception Island, as was also found here. It is possible that *F. punctata* is a more recent arrival from South America, perhaps via geothermally heated sites on nearby Deception Island, where other springtails have been introduced to the region (Greenslade *et al.* 2012). The South Shetland Islands provides some of the mildest conditions anywhere in the Maritime Antarctic and so are particularly vulnerable to the establishment of non-native springtails (Hughes *et al.* 2020). It is also possible that the springtail may have been transported by migratory birds, or vagrant birds from southern South America that might have been blown off course. However, given the wide distribution of *F. punctata* across Byers Peninsula (Fig. 3) and the typically slow geographical dispersal of small soil-dwelling organisms (Ojala & Huhta 2001), it seems improbable that this springtail species is a recent arrival that has already migrated several kilometres from the vegetated southern beaches, across mostly unvegetated habitats of the centre of Byers Peninsula to the northern beaches. Regardless of its origin, this finding represents a new species for the South Shetland Islands and the Maritime Antarctic region, highlighting the need for more thorough and high-spatial-resolution systematic surveys across different vegetation types and habitats in order to better understand terrestrial biodiversity patterns in Antarctica.

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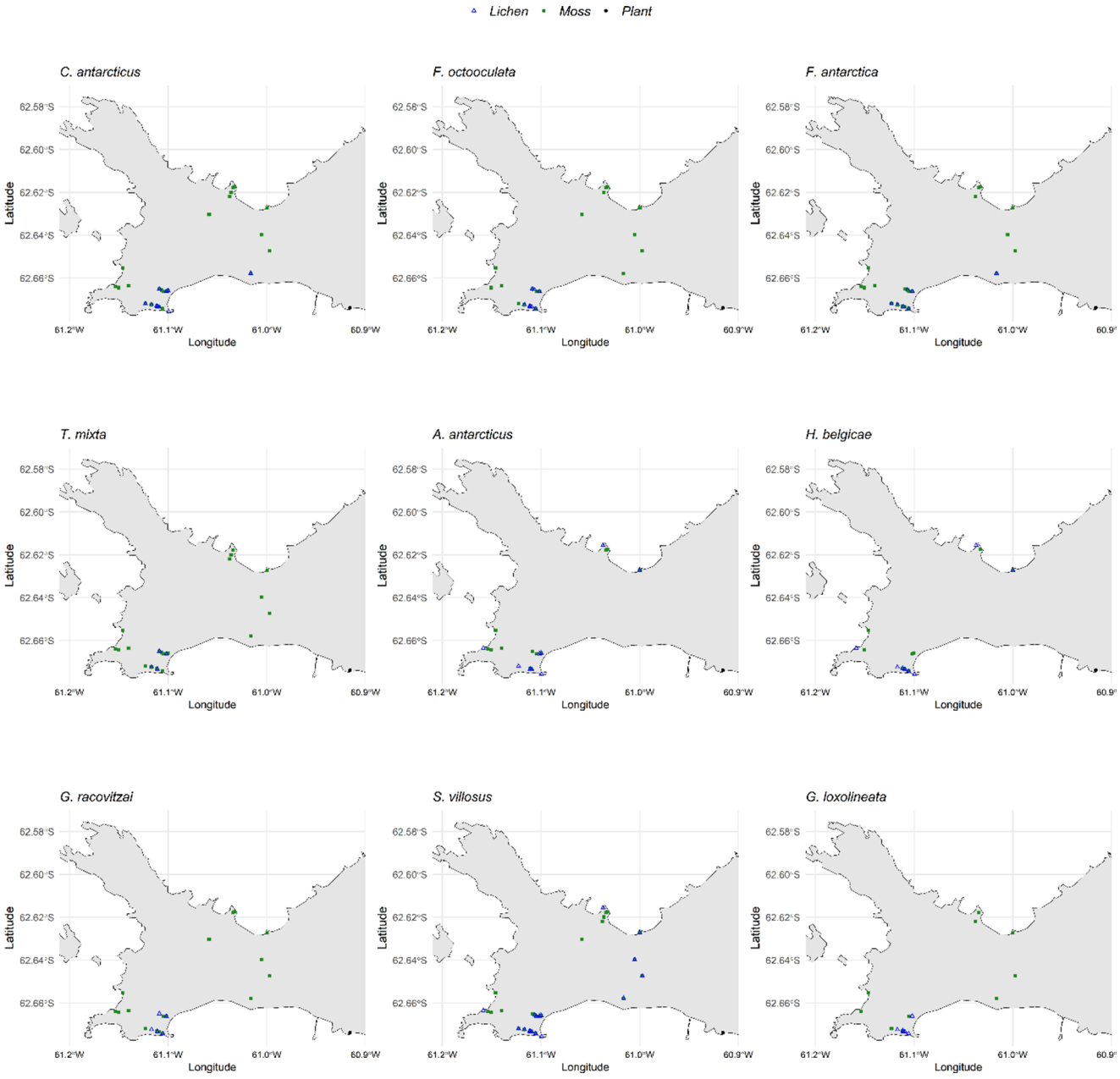

Figure 4. Arthropod species presence across Byers Peninsula, Livingston Island. Each symbol represents a location where lichens, mosses or plants were sampled and microarthropod species were extracted. All sampling locations are shown in Fig. 3. Total individuals collected from 240 samples: *Cryptopygus antarcticus* = 30 112; *Folsomotoma octooculata* = 1703; *Friesea antarctica* = 491; *Tullbergia mixta* = 705; *Alaskozetes antarcticus* = 3307; *Halozetes belgicae* = 1064; *Gamasellus racovitzai* = 217; *Stereotydeus villosus* = 6316; *Globoppia loxolineata* = 120; and 3244 unidentified very small prostigmatid and astigmatid mites, which may also include juveniles of various mite species.

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Table I. Arthropod abundances across vegetation habitats on Byers Peninsula, Livingston Island. Arthropod species abundances (individuals per gram dry substrate) across different lichen and moss species and those associated with the grass *Deschampsia antarctica* are shown. Vegetation samples were obtained across Byers Peninsula as part of transect sampling from the coast to inland sites (Fig. 3), with a focus on dominant moss and lichen species.

	Habitat species	Arthropod species	Abundance (ind. g^{-1})	SE	*n*
Lichen	Lichen sp.	*Alaskozetes antarcticus*	108.8	19.2	6
Moss	*Andreaea regularis*	*Alaskozetes antarcticus*	9.4	7.2	14
Moss	*Syntrichia saxicola*	*Alaskozetes antarcticus*	5.1	1.8	6
Plant	*Deschampsia antarctica*	*Alaskozetes antarcticus*	4.6	2.4	5
Lichen	*Ramalina terebrata*	*Alaskozetes antarcticus*	3.7	1.4	7
Lichen	*Usnea antarctica*	*Alaskozetes antarcticus*	1.9	0.9	5
Lichen	*Umbilicaria antarctica*	*Alaskozetes antarcticus*	1.1	NA	1
Lichen	*Sphaerophorus globosus*	*Alaskozetes antarcticus*	0.2	NA	1
Moss	*Sanionia uncinata*	*Alaskozetes antarcticus*	0.2	0.0	4
Moss	*Andreaea regularis*	*Cryptopygus antarcticus*	67.2	19.0	76
Moss	*Sanionia uncinata*	*Cryptopygus antarcticus*	27.5	10.0	30
Lichen	*Stereocaulon alpinum*	*Cryptopygus antarcticus*	12.6	4.6	3
Plant	*Deschampsia antarctica*	*Cryptopygus antarcticus*	1.0	0.9	2
Lichen	*Usnea antarctica*	*Cryptopygus antarcticus*	0.8	0.2	12
Lichen	*Sphaerophorus globosus*	*Cryptopygus antarcticus*	0.8	0.4	3
Lichen	Lichen sp.	*Cryptopygus antarcticus*	0.7	0.2	4
Moss	*Syntrichia saxicola*	*Cryptopygus antarcticus*	0.5	0.1	5
Moss	*Schistidium lewis-smithii*	*Cryptopygus antarcticus*	0.4	NA	1
Lichen	*Stereocaulon alpinum*	*Folsomotoma octooculata*	7.5	5.1	3
Lichen	*Sphaerophorus globosus*	*Folsomotoma octooculata*	7.4	2.1	4
Lichen	Lichen sp.	*Folsomotoma octooculata*	6.9	2.1	4
Moss	*Andreaea regularis*	*Folsomotoma octooculata*	5.2	1.6	42
Moss	*Sanionia uncinata*	*Folsomotoma octooculata*	3.0	1.1	10
Moss	*Syntrichia saxicola*	*Folsomotoma octooculata*	3.0	2.1	5
Plant	*Deschampsia antarctica*	*Folsomotoma octooculata*	2.3	1.0	5
Moss	*Schistidium lewis-smithii*	*Folsomotoma octooculata*	1.5	NA	1
Lichen	*Usnea antarctica*	*Folsomotoma octooculata*	1.3	0.4	8
Moss	*Sanionia uncinata*	*Folsomotoma punctata*	1.1	0.5	5
Moss	*Andreaea regularis*	*Folsomotoma punctata*	1.0	0.3	10
Plant	*Deschampsia antarctica*	*Folsomotoma punctata*	0.7	NA	1
Lichen	*Sphaerophorus globosus*	*Folsomotoma punctata*	0.4	NA	1
Lichen	Lichen sp.	*Folsomotoma punctata*	0.4	NA	1
Lichen	*Stereocaulon alpinum*	*Friesea antarctica*	3.1	2.7	3
Plant	*Deschampsia antarctica*	*Friesea antarctica*	2.7	1.7	5
Moss	*Syntrichia saxicola*	*Friesea antarctica*	1.8	1.2	7
Moss	*Andreaea regularis*	*Friesea antarctica*	1.4	0.4	47
Lichen	*Umbilicaria antarctica*	*Friesea antarctica*	1.1	NA	1
Lichen	Lichen sp.	*Friesea antarctica*	0.8	0.4	4
Lichen	*Sphaerophorus globosus*	*Friesea antarctica*	0.6	0.2	3
Moss	*Schistidium lewis-smithii*	*Friesea antarctica*	0.4	NA	1
Lichen	*Usnea antarctica*	*Friesea antarctica*	0.3	0.0	4
Moss	*Sanionia uncinata*	*Friesea antarctica*	0.3	0.1	12

(Continued)

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Table I. Continued.

	Habitat species	Arthropod species	Abundance (ind. g^{-1})	SE	*n*
Plant	*Deschampsia antarctica*	*Gamasellus racovitzai*	1.1	0.5	6
Moss	*Syntrichia saxicola*	*Gamasellus racovitzai*	0.8	0.2	7
Moss	*Andreaea regularis*	*Gamasellus racovitzai*	0.8	0.1	41
Lichen	*Usnea antarctica*	*Gamasellus racovitzai*	0.5	0.2	5
Lichen	*Stereocaulon alpinum*	*Gamasellus racovitzai*	0.5	0.0	2
Moss	*Sanionia uncinata*	*Gamasellus racovitzai*	0.4	0.2	5
Lichen	Lichen sp.	*Gamasellus racovitzai*	0.4	0.1	4
Moss	*Schistidium lewis-smithii*	*Gamasellus racovitzai*	0.2	NA	1
Lichen	*Sphaerophorus globosus*	*Gamasellus racovitzai*	0.1	NA	1
Lichen	Lichen sp.	*Halozetes belgicae*	28.1	11.0	7
Plant	*Deschampsia antarctica*	*Halozetes belgicae*	5.0	4.2	5
Moss	*Andreaea regularis*	*Halozetes belgicae*	4.1	2.3	16
Lichen	*Ramalina terebrata*	*Halozetes belgicae*	3.5	1.7	6
Moss	*Syntrichia saxicola*	*Halozetes belgicae*	1.1	0.5	5
Lichen	*Usnea antarctica*	*Halozetes belgicae*	0.7	0.1	6
Moss	*Sanionia uncinata*	*Halozetes belgicae*	0.4	0.1	2
Lichen	*Usnea antarctica*	*Globoppia loxolineata*	4.5	2.0	3
Lichen	*Stereocaulon alpinum*	*Globoppia loxolineata*	4.0	0.3	3
Lichen	*Sphaerophorus globosus*	*Globoppia loxolineata*	0.9	0.4	3
Moss	*Andreaea regularis*	*Globoppia loxolineata*	0.9	0.3	12
Lichen	Lichen sp.	*Globoppia loxolineata*	0.5	0.1	2
Moss	*Sanionia uncinata*	*Globoppia loxolineata*	0.3	NA	1
Moss	*Syntrichia saxicola*	*Globoppia loxolineata*	0.2	NA	1
Moss	*Schistidium lewis-smithii*	*Globoppia loxolineata*	0.1	NA	1
Lichen	Lichen sp.	*Stereotydeus villosus*	54.6	18.7	10
Lichen	*Ramalina terebrata*	*Stereotydeus villosus*	46.0	9.9	10
Moss	*Syntrichia saxicola*	*Stereotydeus villosus*	11.2	2.6	9
Lichen	*Usnea antarctica*	*Stereotydeus villosus*	10.2	2.7	48
Lichen	*Umbilicaria antarctica*	*Stereotydeus villosus*	5.8	3.3	5
Lichen	*Stereocaulon alpinum*	*Stereotydeus villosus*	4.4	3.4	3
Moss	*Andreaea regularis*	*Stereotydeus villosus*	3.7	0.8	69
Lichen	*Sphaerophorus globosus*	*Stereotydeus villosus*	2.5	0.7	4
Moss	*Sanionia uncinata*	*Stereotydeus villosus*	1.3	0.3	22
Moss	*Schistidium lewis-smithii*	*Stereotydeus villosus*	0.7	NA	1
Plant	*Deschampsia antarctica*	*Stereotydeus villosus*	0.1	0.1	2
Lichen	*Stereocaulon alpinum*	*Tullbergia mixta*	10.3	6.3	3
Moss	*Sanionia uncinata*	*Tullbergia mixta*	3.7	2.4	23
Moss	*Syntrichia saxicola*	*Tullbergia mixta*	2.7	1.1	2
Lichen	Lichen sp.	*Tullbergia mixta*	1.2	NA	1
Moss	*Andreaea regularis*	*Tullbergia mixta*	0.9	0.2	28
Lichen	*Usnea antarctica*	*Tullbergia mixta*	0.9	NA	1
Plant	*Deschampsia antarctica*	*Tullbergia mixta*	0.7	0.5	2
Lichen	*Sphaerophorus globosus*	*Tullbergia mixta*	0.4	0.2	2
Moss	*Schistidium lewis-smithii*	*Tullbergia mixta*	0.1	NA	1

n = number of samples; NA = not applicable; SE = standard error.

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Author contributions. SB: fieldwork, species identification and writing. JM: molecular approaches and review. PC: review and writing.

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Competing interests. The authors declare none.

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