CONSERVATION STATUS OF MOSS SPECIES IN NORTHERN MARITIME ANTARCTIC BASED ON THE INDEX OF ECOLOGICAL SIGNIFICANCE

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Abstract: The aim of this work was to verify moss conservation status on ice-free areas of northern Maritime Antarctic, including data of Elephant Island, King George Island and Deception Island. The study started with the classification and description of the plant communities based primarily on phytosociological and biodiversity data. All records were obtained from 1991-1992 to 2003-2004 austral summers. The coverage degree and frequency of each species found was used to calculate the index of ecological significance. 22 most frequent species based on all island records were found. The most important species in both studied areas were *Sanionia uncinata* (Hedw.) Loeske, *Polytrichastrum alpinum* (Hedw.) G. L. Smith, *Bartramia patens* Brid., respectively, occurring in all the studied islands. These results demonstrate the fragility of plant communities in Maritime Antarctic, based on the low frequency and coverage of most species known to this area.

Keyword: Bryophyta, ice-free areas, plant communities

Introduction

Since 1940 there has been evidence through monitoring and observation of the global warming effect on the plant species of Maritime Antarctic, mainly related to the oscillations in the percentages of plant coverage (Lewis-Smith, 2001). An important tool to study these fluctuations in bryophytes populations was idealized by Lara & Mazimpaka (1998). These authors developed the Index of Ecological Significance (IES), which compares the frequency and abundance of data to determine the importance of the species in a studied area. The index can be applied for moss conservation and phytosociological studies and for the classification of threatened species (Hallingbäck & Hodgetts, 2000), proposed by the International Union for Conservation of Nature (IUCN). Furthermore to reflect the importance of the particular species in plant formation, which also shows the degree of association within species in the sample, such is the degree of importance of maintaining this formation. If many species are associated with the dominant species of a formation, thus invariably they reflect the dependence of the

associated species, and if the dominant species is threatened, their dependents also will be (Lewis-Smith, 2001).

In order to complement the knowledge of plant communities in the ice-free areas of Admiralty Bay, are presented the conservation status of mosses based in several phytosociological studies developed in the Maritime Antarctic.

Materials and Methods

The data obtained in the phytosociological approaches since 1991/1992 up to 2003/2004 austral summers, were compiled to verify the most frequent species found in the plant communities from northern Maritime Antarctic. Data was analyzed from some four islands from the South Shetland Islands, as follows: Elephant Island (1991/1992 summer); King George Island (2003/2004, 2004/2005 summers) and Deception Island (1993/1994). High coverage moss species or dominant lichen species were sampled using the usual collection methods. The identification of the species was

based on specialized literature, such as Ochyra *et al.* (2008), Pereira & Putzke (1994) and Putzke & Pereira (2001). The index of ecological significance (IES) was calculated based on the Lara & Marzimpaka (1998), subsequently Victoria & Pereira (2007).

Results

Of the 102 moss species confirmed by Ochyra *et al.* (2008) for Antarctica, 22 of the most important moss species to northern Maritime Antarctic were found. From our data it was possible to verify the occurrence of *Sanionia uncinata* (Hedw.) Loske as the most frequent species in the three island communities is analyzed in (Tables 1 to 3). However with the IES of each species it was possible verify the other dominant species varieties of both islands (Figure 1). *Polytrichastrum alpinum* (Hedw.) G.L. Smith was observed as the second most important species in the ice-free areas of King George and Deception Islands.

The IES also indicates the degree of colonization of a determined species in the sample (Lara & Mazimpaka, 1998) which can also suggest the effect of variations of species occurrences related to the available substrata. Thus, if a species depends on a rich matter substrata and those are unavailable in that region that species will decline due to the relevant substrata being missing (Victoria *et al.*, 2006). Probably, for the regions where the terrains are composed of a lower fraction of organic matter only a few species included in the most important species list were found. This is the case of Deception Island, where, due the predominant volcanic substrata, only four species with significant index values (Table 3) were found, most plant communities being

Table 1. The species have more and less IES in the phytosociological analyzes made in Elephant Island in the year 1992. F(%) = species frequency in 240 sampled quadrats; C = mean cover degree of each species on the samples. IES = species index of ecological importance in the total sampling.

Species	F	C	IES
<i>Sanionia uncinata</i> (Hedw.) Loeske	68.45	1.76	189.24
<i>Bartramia patens</i> Brid.	1.60	0.02	1.63
<i>Ceratodon purpureus</i> (Hedw.) Brid.	1.07	0.01	1.08
<i>Brachythecium austrosalebrosum</i> (Müll. Hal.) Paris	1.07	0.02	1.09
<i>Pohlia nutans</i> (Hedw.) Lindb	0.53	0.01	0.54
<i>Pohlia cruda</i> (Hedw.) Lindb.	1.60	0.02	1.63

Table 2. The species have more and less IES in the phytosociological analyzes made in King George Island in the austral summers 2003/2004 and 2004/2005. F(%) = species frequency in 560 sampled quadrats; C = mean cover degree of each species on the samples; IES = species index of ecological importance in the total sampling.

Species	F (%)	C	IES
<i>Sanionia uncinata</i> (Hedw.) Loeske	57,87	2,7	215,20
<i>Polytrichastrum alpinum</i> (Hedw.) G.L. Sm	31,86	3,8	153,54
<i>Ptychostomum pseudotriquetrum</i> (Hedw.) P. Gaertn., B. Mey. & Scherb.	27,9	0,9	53,3
<i>Polytrichum juniperinum</i> Hedw.	11,36	2,02	34,3
<i>Andreaea gainii</i> Cardot	14,96	0,6	24,54
<i>Syntrichia princeps</i> (De Not.) Mitt.	7,69	1,98	22,96
<i>Pohlia cruda</i> (Hedw.) Lindb.	2,28	0,15	2,03
<i>Bartramia patens</i> Brid.	1,71	0,6	2,03
<i>Bryum pallescens</i> Schleich. ex Schwägr.	1,47	0,38	2,03
<i>Schistidium antarctici</i> (Cardot) L.I. Savicz & Smirnova	1,33	0,36	1,87
<i>Chorisodontium aciphyllum</i> (Hook. f. & Wilson) Broth.	0,38	3,68	1,78
<i>Dicranoweisia brevipes</i> (Müll. Hal.) Cardot	0,38	3,68	1,78
<i>Bryum orbiculatifolium</i> Cardot & Broth.	0,95	0,74	1,66
<i>Brachythecium austrosalebrosum</i> (Müll. Hal.) Paris	0,38	3,36	1,66
<i>Pohlia drummondii</i> (Müll. Hal.) A.L. Andrews	0,20	3,32	0,84
<i>Schistidium falcatum</i> (Hook. f. & Wilson) B. Bremer	0,21	3,33	0,85
<i>Andreaea depressinerves</i> Cardot	0,19	3,31	0,83
<i>Bryum archangelicum</i> Bruch & Schimp.	0,19	3,31	0,83
<i>Ditrichum hyalinum</i> (Mitt.) Kuntze	0,19	3,31	0,83

Table 3. The species found in Deception Island in the phytosociological analyzes made in the year 1994. F(%) = species frequency in 284 sampled quadrats; C = mean cover degree of each species on the samples; IES = species index of ecological importance in the total sampling.

Species	F	C	IES
<i>Sanionia uncinata</i> (Hedw.) Loeske	71.83	1.84	203.90
<i>Polytrichastrum alpinum</i> (Hedw.) G.L. Sm	35.92	1.18	78.15
<i>Bartramia patens</i> Brid.	8.10	0.11	9.01
<i>Hennediella heimii</i> (Hedw.) R.H. Zander	5.99	0.09	6.49

Figure 1. The most frequent moss found in northern Maritime Antarctic and their frequencies in each island sampled.

restricted to the beaches (Putzke & Pereira, 2001) with a higher content of carbon and other nitrogen compounds. On the other hand at Elephant Island this relationship was not observed, for example, Stinker Point has higher nitrophilic soils related with the bird colonies (Pereira & Putzke, 1994) and the most important species of the list are also few. An explanation for the latter can be closely related to the effect of winds (Putzke & Pereira, 2001) such as in Admiralty Bay area, which is less exposed and thus shows a greater number of important species.

Discussion

Comparing the records obtained from the three islands, was observed such these corroborated with other initiatives. Most of the species are easily found in the area, but in lower coverage (IES > 50) with a lower number of species in higher abundance and coverage (Victoria *et al.*, 2009, 2011). Ochyra (1998) reports *Sanionia uncinata* (Hedw.) Loeske and *Polytrichastrum alpinum* (Hedw.) G.L.Smith as the most abundant moss species in Maritime Antarctic, being in lower risk of threat compared with other moss species in this area. These results can suggest the sensibility of these plant communities to environmental changes, since

the species were found in small patches and populations, and it showed lower resistance and resilience, wherever the interrelationships within the organisms was low (Schaefer *et al.*, 2004). Any impacts on these species can be irreversible (Victoria & Pereira, 2007).

For example, we can cite the most frequent *Bryaceae* occurrences found. *Ptychostomum pseudotriquetrum* (Hedw.) J.R. Spence & H.P. Ramsay and *Bryum orbiculatifolium* Card. et Broth. Depend on ice-melt found in the water lines of austral summer (Allison & Lewis-Smith, 1973; Kanda, 1986). *P. pseudotrichetrum* has higher abundance in our samples from King George Island and can be considered a lower degree of threatened species compared to *B. orbiculatifolium*. The size of *P. pseudotrichetrum* population provides best response in the case of fast environmental changes, perhaps an adaptative success related of a higher coverage degree (Lewis-Smith, 2001).

Victoria *et al.* (2011) records for small sites of Admiralty Bay area, both in the King George Island (Ulmann Point and Comandante Ferraz beach) similar results to those found for the whole South Shetlands archipelago, whereby *S. uncinata* also occurs in higher frequency and coverage. However with less frequency for *P. alpinum* *P. pseudotrichetrum*, for

Ferraz beach, and *Syntrichia magellanica* (De Not.) Mitt, for Ulmann Point the species are the second most important for each area, perhaps because of the lower complexity of these two plant communities sampled, these communities being composed mainly of emergent species, such as these two species mentioned (Victoria *et al.*, 2009).

Victoria & Pereira (2007) reported the same condition for Arctowski region and Hennequin Point, both regions located in Admiralty Bay area. The other frequent moss species mentioned were found to be important species for the plant communities at Hennequin Point and in Arctowski region (Victoria & Pereira, 2007), except for *Hennediela heimii* (Hedw.) Zand, which was found in higher frequency in Ferraz beach in the present study compared with other areas.

All moss species, as well the land biota found in Admiralty Bay, were directly and indirectly affected by human presence. The maintenance of scientists and military inside and outside of research stations, shelters and camps, involves high consumption of fossil combustibles and creates high residue production, causing unclear impacts on Antarctica wildlife (Olech, 1996).

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Conclusion

This essay demonstrates the fragility of moss formation in the ice-free areas of northern Maritime Antarctic, such species of *Bryum*, *Pohlia* and *Andreaea* appear as the mostly threatened species. A descriptive data bank can collaborate for the continued monitoring of plant communities, contributing to the conservation of plant species in Admiralty Bay area. The phytosociological studies can contribute to the management of scientific activities involved with the Brazilian Antarctic Program.

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