

The microarthropods of sub-Antarctic Prince Edward Island: a quantitative assessment

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Abstract The biodiversity in the sub-Antarctic region is threatened by climatic change and biological invasions, which makes the understanding of distributions of biotas on sub-Antarctic islands essential. Although the distribution patterns of vascular plants and insects on sub-Antarctic islands are well documented, this is not always the case for microarthropods. This study provides the first quantitative assessment of the distribution and abundance of microarthropods on Prince Edward Island (PEI), one of two islands in the Prince Edward Island group. Microarthropod community structure differed significantly between PEI and nearby Marion Island, with only two invasive alien species found on PEI compared with Marion Island. Furthermore, species richness, abundance and community structure differed significantly between habitat types on both islands. This study emphasizes the importance of quarantine measures when visiting PEI to maintain its status as one of the more pristine islands in the sub-Antarctic region.

Introduction

Species geographic ranges are not static. Indeed, they may change over a variety of spatial scales, from the occupancy of patches in metapopulations (Hanski 1999), to large scale shifts in range position owing to changes in climate or habitat suitability (Hill et al. 1999; Root et al. 2003). Presently, the dynamics of species ranges are affected not only by factors that have always influenced them (see Gaston 2003), but also by the local impacts of anthropogenic global climate change (e.g. Parmesan et al. 1999; Walther et al. 2002), and the movement of individuals by humans in an ever-growing wave of biological invasions (Mack et al. 2000; Cassey et al. 2005; Gewin 2005). The latter factors are of considerable importance in the sub-Antarctic, where climate is changing rapidly on many, if not most, islands (Bergström and Chown 1999; Smith 2002). Species from a wide variety of taxa have been introduced to these islands from elsewhere by humans, become established, and spread to become biological invaders with significant impacts (Chapuis et al. 1994; Frenot et al. 2005). In consequence, climatic change and biological invasions are viewed as the most significant threats to sub-Antarctic biodiversity (Bergström and Chown 1999; le Roux et al. 2005; Whinam et al. 2005).

Conserving biodiversity in the face of these threats requires that the biotas of the islands, their local and regional distributions, and the processes underlying these distributions are reasonably well understood. For some taxa and islands this understanding is relatively well developed. In the case of vascular plants and insects, not only are distributions well known (e.g. Gremmen 1981; Vogel 1985; Hughes 1987; Chown

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1992; Frenot et al. 2001; Chown and Klok 2001; Turner et al. 2006), but the processes underlying them have been comprehensively investigated at a variety of spatial scales (e.g. Chown et al. 1998, 2002, 2005; Ernsting et al. 1999; Smith et al. 2001; Hugo et al. 2004; Bergström et al. 2005; Greve et al. 2005; le Roux and McGeoch 2004; Shaw et al. 2005). By contrast, for other groups, such as the bryophytes, lichens, springtails and mites, this understanding lags far behind (but see Bellido and Cancela da Fonseca 1988; Pugh and Barsch 1993; Pugh 1994; Bergström and Selkirk 1997; Convey et al. 1999; Gabriel et al. 2001; McGeoch et al. 2006).

In many cases, comprehensive, island-specific inventories remain scarce for these taxa, and in those cases where sampling has been comprehensive (e.g. Marshall and Chown 2002), quantitative assessments of the determinants (or correlates) of distributions remain scarce. Moreover, the dynamics of species ranges, even at the scale of whole-island inventories, are poorly comprehended because regular monitoring is rare in most of the islands (for exceptions, see Scott 1990; Ernsting et al. 1999; Gremmen and Smith 1999; Frenot et al. 2001; Slabber and Chown 2002; Bergström et al. 2005). This means that whilst immensely valuable catalogues for many taxa are becoming available (Pugh 1993, 2004; Pugh et al. 2002; Pugh and Scott 2002), they are static assessments of a dynamic situation. Given the rate and extent of climatic change and biological invasions in the sub-Antarctic, conservation managers will consequently find themselves with outdated information on which to base their actions.

Remedying this situation is relatively straightforward for islands that are permanently occupied by scientific personnel. However, this is more difficult for those that are unoccupied, remote, and of special conservation value (owing to the lack of human disturbance) (e.g., Heard Island, I'le des Pingouins) (Dreux et al. 1988; Delettre et al. 2003). Nonetheless, periodic, quantitative baseline surveys would go a considerable way to ensure appropriate conservation measures for them. Here we provide such a survey for the mites and springtails of Prince Edward Island, one of the two islands in the sub-Antarctic Prince Edward group (Smith 1987). This island is considered one among the more pristine in the sub-Antarctic (Chown et al. 2001), and consequently has been accorded special protection as part of the Prince Edward Islands Special Nature Reserve (Anonymous 1996). Although occasional visits have partly documented the mites and springtails from the island

(Marshall et al. 1999), no studies have comprehensively and quantitatively sampled a variety of habitats in the island.

Materials and methods

Marion Island (46°54'S 37°45'E) and Prince Edward Island (46°38' S 37°57'E) are cool, sub-Antarctic islands that lie to the north of the Antarctic Polar Frontal Zone. They are separated by approximately 19 km and, with exceptions such as extent of Pleistocene glaciations, are thought to have similar climates, and climatic and geological histories (Smith 1987; Hall 2002). Prince Edward Island (45 km²) is about one sixth the size of Marion Island (290 km²), and rises to only 672 m, by comparison with the latter's 1,230 m. The islands share many, but not all of the indigenous species that have so far been found at the archipelago, and Prince Edward Island has far fewer alien and invasive species than Marion Island (Crafford et al. 1986; Smith 1987; Gremmen and Smith 1999; Chown et al. 2002). For both these reasons, and a variety of others, Prince Edward Island has a special conservation status within South African law, and visits to the island are constrained both in frequency and duration (Anonymous 1996).

In 2000, the Prince Edward Islands Management Committee granted permission for a short (3 days) visit to Prince Edward Island to quantitatively sample mites and springtails, especially to assess the extent to which alien and/or invasive species are present at the island. This visit took place in April 2000. Sampling was conducted on the eastern and southern sides of Prince Edward Island in eight habitats (Table 1). Ten samples were taken randomly from each habitat (in an area of approximately 500 m² per habitat) using an O'Connor split corer (inside diameter of core = 70 mm, height = 70 mm; surface area = 0.0039 m²). Microarthropods were extracted from the cores using a Macfadyen high gradient extraction protocol of two days at 25°C and 2 days at 30°C (Barendse and Chown 2001). The single exception was fellfield soils from which microarthropods were extracted by flotation in sieved cold water and further by means of differential wetting (Southwood 1978) with kerosene and 70% ethanol (see Barendse and Chown 2001 for detail). Springtail and mite species were identified to the lowest possible taxonomic level (usually species), counted and are in storage in 99% ethanol at the University of Stellenbosch.

Table 1 Habitat types and the associated plant species sampled on Marion and Prince Edward Islands (Gremmen 1981; Smith 1987; Smith et al. 1993; Hänel and Chown 1998; Smith et al. 2001; Smith and Steenkamp 2001) (*information extrapolated from Marion Island notes, Gremmen 1981; Smith 1987; Smith et al. 1993; Hänel and Chown 1998; Smith et al. 2001; Smith and Steenkamp 2001) (*m a.s.l.* = meters above sea level; *DR* = decomposition rate; soil moisture indicated as % of dry mass)

Family: Plant species	Habitat complex	Sample sites	m a.s.l.	Soil moist.	Notes
Marion Island					
Mires					
Bryophytes					
Amblystegiaceae: <i>Sanionia uncinata</i> (Hedw.) Loeske	Mesic mire	Nellie Humps	50	3,000	With <i>Acacena</i> , wet, sheltered, organic acid soils, low in organic C and P, low DR
Jungermanniaceae: <i>Jamesoniella colorata</i> (Lehm.) Schiffn	Dry mire	Nellie Humps	50	1,296	With <i>Blepharidophyllum</i> , wet, sheltered, organic acid soils, low in organic C and P, low DR
Scapaniaceae <i>Blepharidophyllum densifolium</i> (Hook.) Angstr.	Mesic mire	Nellie Humps	50	1,296	With <i>Jamesoniella</i> , wet, sheltered, organic acid soils, low in organic C and P, low DR
High altitude mire vegetation		Long Ridge South	400		Wet, sheltered, organic acid soils, low DR
Middle altitude mire vegetation		Hendrik Fister Kop	250		Wet, sheltered, organic acid soils, low DR
Slope					
Vascular plants					
Rosaceae: <i>Acacena magellanica</i> Lam. Vahl	Drainage line	Skua Ridge, Tom, Dick and Harry	100, 75	707	With <i>Sanionia</i> , well drained soils, high in P and organic C and N, high DR
Polypodiaceae <i>Blechnum penna-marina</i> (Poir) Kuhn	Closed Fernbrake	Nellie Humps	100	614	With <i>Acacena</i> , well drained soils, high in P and organic C and N, high DR
Biotic and salt spray influenced					
Vascular plants					
Asteraceae: <i>Cotula plumosa</i> Hook. f.	Cotula herbfield	Ship's Cove to Blue Petrel Bay	15–20	658	With <i>Poa</i> , wettish, acid soils, high in Na, Mg, P, C and N, high DR
Poaceae: <i>Poa cookii</i> Hook. f.	Coastal tussock grassland	Bullard Beach	20	525	With <i>Cotula</i> , wettish, acid soils, rich in organic and inorganic N, P and C, high DR
Crassulaceae: <i>Crassula moschata</i> Forst. F.	Coastal saltspray, herbfield	Archway Bay	20	400	With <i>Cotula</i> , wettish, acid soils, high in Na, Mg, P, Ca and organic C, high DR
Fellfield					
Vascular plants					
Apiaceae: <i>Azorella selago</i> Hook. f.	Mesic fellfield	Kerguelen Rise	300	329	In fellfield, dry, exposed, mineral basic/saline soils, high in Ca, Mg, Na, K and N
Fellfield soil	Mesic fellfield	Kerguelen Rise	300	329	With <i>Azorella</i> , dry, exposed, mineral basic/saline soils, high in Ca, Mg, Na, K, P and N, low DR
Prince Edward Island					
Mires					
Mire vegetation					
Slope					
Vascular plants					
Rosaceae: <i>Acacena magellanica</i> Lam. Vahl	Drainage line	Platkop	150–200	707	*With <i>Blechnum</i> , well drained soils, high in P and organic C and N, high DR ^a
Polypodiaceae <i>Blechnum penna-marina</i> (Poir) Kuhn	Closed fernbrake	Platkop	150–200	614	*With <i>Acacena</i> , well drained soils, high in P and organic C and N, high DR ^a
Biotic and salt spray influenced					
Vascular plants					
Asteraceae: <i>Cotula plumosa</i> Hook. f.	Cotula herbfield	McNish Bay	20	658	*With <i>Poa</i> , wettish, acid soils, high in Na, Mg, P, C and N; high DR ^a

Table 1 continued

Poaceae: <i>Poa cookii</i> Hook. f.	Coastal tussock grassland	Golden Gate	70	525	*With <i>Cottula</i> , wettest, acid soils, rich in organic and inorganic N, P and C, high DR ^a
Crassulaceae: <i>Crassula moschata</i> Forst. F.	Coastal saltspray, herbfield	East Cape	20	400	*With <i>Cottula</i> , wettest, acid soils, high in Na, Mg, P, Ca and organic C, high DR ^a
Fellfield					
Vascular plants					
Apiaceae: <i>Azorella selago</i> Hook. f.	Mesic fellfield	Horingberg	550	329	*In fellfield, dry, exposed, mineral basic/saline soils, high in Ca, Mg, Na, K and N ^a
Fellfield soil	Mesic fellfield	Horingberg	550	329	*With <i>Azorella</i> , dry, exposed, mineral basic/saline soils, high in Ca, Mg, Na, K, P and N, low DR

For comparative purposes, the data collected at Prince Edward Island were compared with those collected using identical methods in the same month in 1997 on Marion Island (see Gabriel et al. 2001; Barendse et al. 2002), with the exception of the *Azorella selago* and fellfield soil samples, which were taken in April 1998 as part of the work by Barendse and Chown (2001); Gabriel et al. (2001) (Table 1). In the latter case, samples at Marion Island were taken by identifying two transects consisting of four quadrats each. Five samples were taken from each quadrat, giving a total of 40 samples for *A. selago* (using the O'Connor corer), and 40 samples for fellfield (using a 30 cm × 30 cm box sampled to 10 cm depth). For the other habitats, five quadrats were identified and five samples taken from each quadrat giving a total of 25 samples for each plant species, except for the high altitude mire site where only four quadrats were used (20 samples) (Gabriel et al. 2001). As was the case for the Prince Edward Island samples, Macfadyen high gradient extraction was used except for the fellfield samples where flotation and differential wetting were implemented. Extraction efficiency varies with species, life stage and substratum type, and comparisons between similar habitats and species will thus be most reliable.

Raw counts of number of individuals per species were converted to densities per square meter for all samples to compare data from different sampling methods. Generalized linear models (McCullagh and Nelder 1998) were used to determine the relationship between species richness and abundance (separate models for each of these dependent variables) and the explanatory variables: island and habitat. A Poisson error distribution was assumed for species richness, whereas a normal error distribution was assumed for density of individuals per square meter, the first being count data and the latter continuous (Quinn and Keough 2002). A logarithmic link function was used in all the models and deviance used as a measure of goodness of fit (Dobson 2002). Models of the same structure were also used excluding exotic species from the data (see Appendix for exotic species).

Differences in microarthropod community structure between islands were examined using cluster analysis based on group averaging and Bray-Curtis similarity measures (Primer v5; Clarke and Gorley 2001). Abundance data were fourth root transformed and standardized prior to analysis (to weigh common and rare species equally) (Clarke and Warwick 1994). Analysis of similarity (ANOSIM) was used to

test for significant differences in communities on the two islands (Clarke and Warwick 1994). This is a non-parametric permutation procedure applied to rank similarity matrices underlying sample ordinations that calculated a global R-statistic. The closer a significant global R is to 1.0, the more distinct the difference between those communities (Clarke and Warwick 1994). Non-metric multi-dimensional scaling (MDS) was used to display the relationship between microarthropod communities on the islands in different plant species. These multivariate analyses were also conducted with all exotic microarthropod species removed from the data set to examine the effect of exotic species on community structure

within and between Marion Island and Prince Edward Island.

Results and discussion

A total of 37 different microarthropod taxa was sampled from Prince Edward Island (Appendix), eight of which could not be determined to generic level. The Collembola included all Marion Island endemic species, with the exceptions of *Cryptopygus tricuspis* and *Katianna* sp. (Gabriel et al. 2001). Both species are comparatively rare on Marion Island, and tend either not to be found in spatially-limited quantitative sampling,

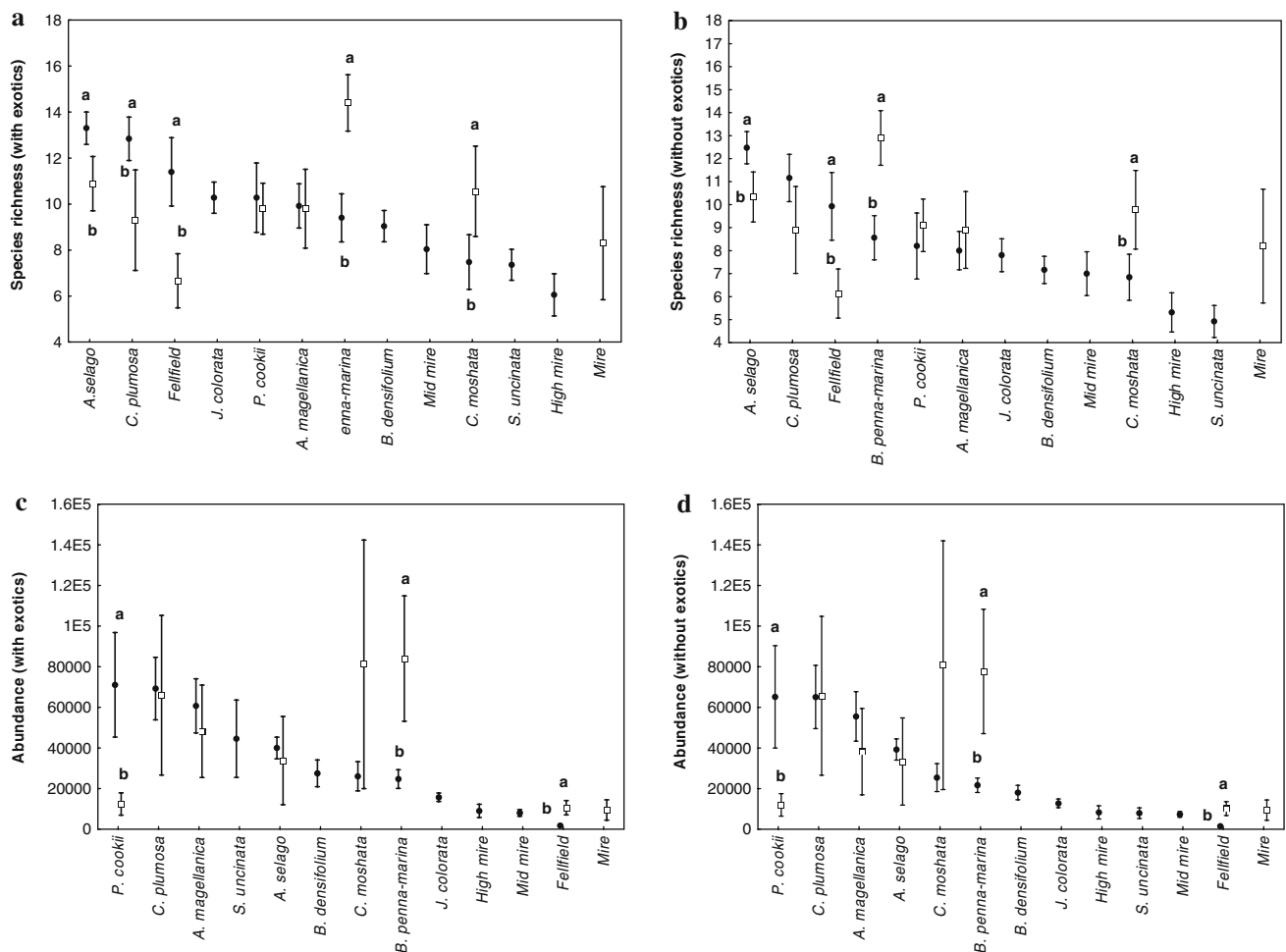


Fig. 1 Species richness (a, b) and abundance (c, d) of microarthropods with and without exotic species in the dataset in different plants species on Marion Island (filled circles) and Prince Edward Island (open squares) (mean \pm 95% confidence intervals). Different letters (superscript) indicate a significant difference of $P < 0.05$ between the same plant species on the two islands. (Marion Island: *Acaena magellanica*, *Blechnum*

penna-marina, *Cotula plumosa*, *Crassula moschata*, *Poa cookii*; *Jamesoniella colorata*, *Blepharidophyllum densifolium*, *Sanionia uncinata*, Middle altitude mire: $n = 25$, *Azorella selago*, *Fellfield*: $n = 40$, High altitude mire: $n = 20$; Prince Edward Island: *A. magellanica*, *B. penna-marina*, *C. plumosa*, *P. cookie*, *Mire*: $n = 10$, *A. selago*, *C. moschata*: $n = 9$, *Fellfield*: $n = 15$)

or to be low in abundance (Gabriel et al. 2001; Hugo et al. 2004). Given the limited sampling at Prince Edward Island, their absence is not unexpected, and it seems likely that further sampling will recover both species from the island and confirmation of their presence must remain a priority. By contrast, only one invasive alien species, *Ceratophysella denticulata*, was found on Prince Edward Island. This species occurs in large numbers ($> 38,000$ ind. m^{-2}) on Marion Island, and has been introduced widely across the globe (Christiansen and Bellinger 1995; Greenslade 2002). Although the time of its arrival on Prince Edward Island is uncertain, it seems unlikely that it had arrived before annexation of the islands by South Africa, given that so few species were introduced by sealers to Prince Edward Island (Crafford et al. 1986; Cooper and Condy 1988). However, during the 1970s and 1980s, regular, reasonably uncontrolled visits were made to Prince Edward Island, and in the latter decade a field hut at Cave Bay was regularly used and replenished directly from the station at Marion Island. The practise of packing wooden crates on vegetation surrounding the scientific station buildings at Marion Island immediately prior to aircraft and ship operations probably ensured the transfer of this species to Prince Edward Island, given that it is very abundant around the station, and that other species, such as the slug *Deroceras panormitanum*, have been successfully spread around Marion Island in this way (Chown et al. 2002).

Approximately 58 mite species have been recently recorded from Marion Island (excluding species that could not be found in systematic sampling, but which have been reported previously from the island) (Marshall et al. 1999; Chown et al. 2002). Of these, 42 have been regularly recorded in the sampling of a variety of habitats, including the shore and intertidal areas on the island (Barendse et al. 2002). A total of 28 species from the quantitative sampling on Prince Edward Island (Appendix) is therefore low, but not unreasonably so, given the limited sampling which excluded the shoreline (owing to the densities of sub-Antarctic fur seals). That several of the species could not be identified is also a reflection of the absence of formal keys to many of the taxa and the scarcity of suitable taxonomic expertise. Indeed, the state of both mite and springtail systematics in the sub-Antarctic is of considerable concern, given that less than five systematists are concerned with these groups from the region. This means that even for faunas as depauperate as those of the sub-Antarctic, the taxonomic impediment (Samways 1994) remains substantial. Although some problems exist with DNA

barcoding (Will and Rubinoff 2004; Prendini 2005), this does seem to be one way to overcome the current systematic crisis in the region. Nonetheless, the mite species that were recovered corresponded well with those species regularly found on Marion Island (Marshall et al. 1999), and it is not expected that many new species will be found. Of the 28 species found here, only one is thought to be an alien species: Cilibidae sp. The status of this species is uncertain at the Prince Edward Islands, and it has been classified as alien (Chown et al. 2002) because the family as a whole is absent from all other islands in the sub-Antarctic (Pugh 1993). Until such time as the species is identified, its status will remain uncertain, but for precautionary reasons it is considered alien. As to when and how it might have reached Prince Edward Island is wholly unclear, and its presence may even suggest that it should be considered indigenous to the islands.

In the quantitative analyses, neither mean species richness nor mean abundance differed significantly between the islands (species richness: dev/df = 0.91, $\chi^2 = 1.31$, $P = 0.25$; abundance: dev/df = 1.05, $\chi^2 = 0.74$, $P = 0.39$). However, habitat type contributed significantly to the generalized linear models (species richness: dev/df = 0.91, $\chi^2 = 29.74$, $P < 0.001$; abundance: dev/df = 1.05, $\chi^2 = 68.06$, $P < 0.001$) (Fig. 1 a, c), and a significant interaction between habitat type and island was also identified (species richness $\chi^2 = 57.39$, $P < 0.001$; abundance $\chi^2 = 63.01$, $P < 0.001$). Similar patterns were observed when exotic species were removed from the data set. Again neither mean species richness nor mean abundance differed significantly between islands (species richness: dev/df = 0.95, $\chi^2 = 0.07$, $P = 0.80$; abundance: dev/df = 1.05, $\chi^2 = 0.76$, $P = 0.38$), habitat type was a significant term in the models (species richness: dev/df = 0.95, $\chi^2 = 34.66$, $P < 0.001$; abundance: dev/df = 1.05, $\chi^2 = 63.38$, $P < 0.001$) (Fig. 1b, d), and the habitat type * island interaction terms were significant (species richness: $\chi^2 = 46.82$, $P < 0.001$; abundance: $\chi^2 = 60.18$, $P < 0.001$).

To some extent, these results must reflect the difference in sampling intensity between the islands. Greater sampling intensity might have shown up significant differences in abundance owing to the presence of abundant invasive species on Marion Island (Gabriel et al. 2001), especially as higher sampling intensity would have reduced the variance found in the Prince Edward Island samples. It has, however, been suggested that competition from invasive species might reduce the abundances of indigenous ones on sub-Antarctic islands (Convey

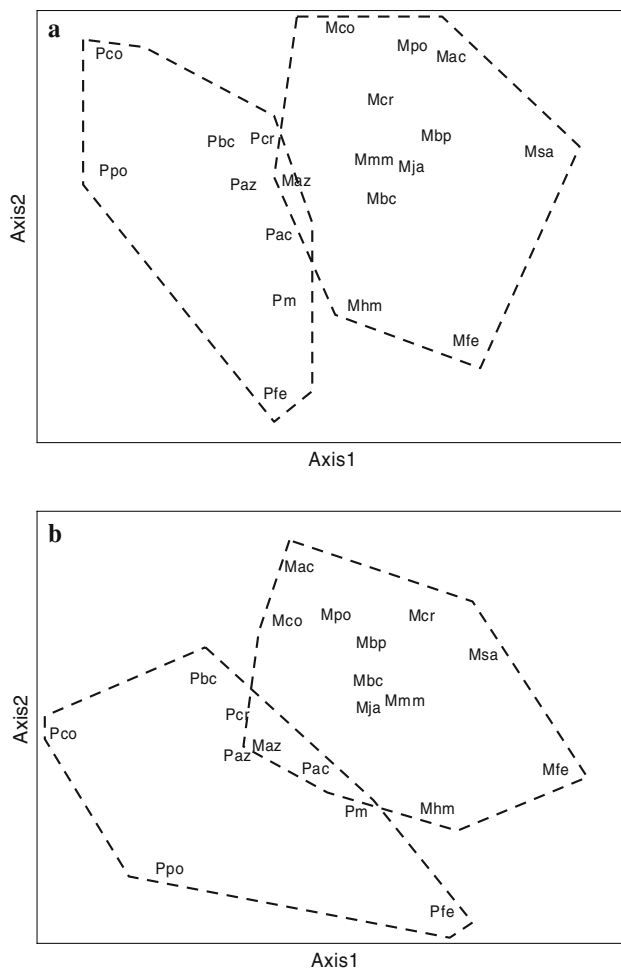


Fig. 2 Non-metric multi-dimensional scaling (*MDS*) ordination of the abundance of microarthropods on Marion and Prince Edward Islands in different plant species, with exotic species (**a**) and without exotic species (**b**). (stress: $a = 0.18$; $b = 0.19$). (*M* = Marion, *P* = Prince Edward, *ac* = *Acaena magellanica*, *bc* = *Blechnum penna-marina*, *co* = *Cotula plumosa*, *cr* = *Crassula moschata*, *po* = *Poa cookii*, *az* = *Azorella selago*, *hm* = high mire, *mm* = mid mire, *fe* = fellfield, *ja* = *Jamesoniella colorata*, *bp* = *Blepharidophyllum densifolium*, *sa* = *Sanionia uncinata*, *m* = mire)

et al. 1999; Chown et al. 2002), and therefore the direction of any sampling effect cannot be ascertained without further investigation. Nonetheless, these quantitative assessments do demonstrate that habitat type has a significant influence on the abundance of the microarthropods on the islands. Indeed, the influence of habitat type on the abundance of individual species and their contribution to arthropod microarthropod assemblage structure was also clear

from the community analyses (Fig. 2a). In this analysis, removal of the alien species also resulted in greater similarity amongst the habitat types on the two islands (Fig. 2b) (in the former case, ANOSIM Global $R = 0.44$, $P = 0.001$; whilst in the latter Global $R = 0.37$, $P = 0.001$). These results are in keeping with other investigations from Marion Island that have demonstrated a significant effect of habitat on invertebrate abundance (Burger 1978; Gabriel et al. 2001; Barendse et al. 2002), and a clear change in assemblage ordination patterns when alien species are removed from the analyses (Gabriel et al. 2001). However, they also highlight significant differences in assemblage composition in similar habitats on the two islands. These differences are not surprising, given that predation by cats radically reduced the spatial distribution of guano input by burrowing seabirds on Marion Island by comparison with Prince Edward Island, and in so doing also likely influenced invertebrate abundance (Crafford and Scholtz 1987). Further investigations are required to substantiate these differences.

In conclusion, this study has provided the first quantitative assessment of the distribution and abundance of microarthropods for Prince Edward Island. Although the sampling was spatially and temporally restricted (owing to management requirements), it revealed patterns similar to that found for other taxa and on the nearby Marion Island. That is, habitat type has a profound influence on assemblage patterns, and, more importantly, that Prince Edward Island is not as heavily invaded by microarthropods as is Marion Island. The latter finding supports the status of the island as one of the more pristine in the sub-Antarctic. Thus, further work to verify the abundances and distributions of the arthropods on the island creates something of a management conundrum, which can only be resolved by the strictest of quarantine measures.

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Appendix

Table 2

Table 2

Species	<i>Acaena</i>	<i>Blechnum</i>	<i>Cotula</i>	<i>Crassula</i>
Acari				
Acari sp.1	0	0	0	0
Acari sp.2	25.97 ± 25.97	0	0	0
Acari sp.3	0	415.58 ± 182.44	51.95 ± 51.95	28.86 ± 28.86
Acari sp.4	0	51.95 ± 34.63	0	28.86 ± 28.86
Acari sp.5	0	25.97 ± 25.97	0	0
Acari sp.7	0	0	25.97 ± 25.97	0
Acari sp.8	0	0	0	0
Acari sp.9	0	51.95 ± 34.63	0	0
Rhodacaridae sp.	831.17 ± 390.67	467.53 ± 211.37	883.12 ± 496.16	981.24 ± 206.61
<i>Dendrolaelaps</i> sp.	51.95 ± 34.63	51.95 ± 34.63	14,805.19 ± 2,111.56	202.02 ± 94.62
Cillibidae sp. ^a	10,025.97 ± 4,546.60	6,077.92 ± 954.11	233.77 ± 157.04	404.04 ± 156.75
<i>Nanorchestes</i> sp.	25.97 ± 25.97	51.95 ± 34.63	0	144.30 ± 97.87
<i>Eupodes minutes</i>	11,896.10 ± 6,174.90	7,714.29 ± 2,095.18	6,051.95 ± 2,582.95	7,445.89 ± 2,576.76
<i>Tydeus</i> sp.	0	0	0	519.48 ± 384.77
<i>Rhagidia</i> sp.	0	51.95 ± 34.63	0	0
<i>Ereynetes macquariensis</i>	51.95 ± 51.95	77.92 ± 77.92	0	346.32 ± 188.70
<i>Bdellodes</i> sp.	259.74 ± 154.88	103.90 ± 42.42	0	0
<i>Liochthonius australis</i>	0	77.92 ± 39.68	25.97 ± 25.97	0
<i>Macquarioppia striata</i>	155.84 ± 88.30	1,194.81 ± 297.92	0	28.86 ± 28.86
<i>Austroppia crozetensis</i>	11,220.78 ± 4,063.33	11,922.08 ± 2,181.22	883.12 ± 346.75	3,751.80 ± 2,354.48
<i>Halozetes</i> sp.	0	103.90 ± 57.43	51.95 ± 34.63	28.86 ± 28.86
<i>Halozetes fulvus</i>	2,779.22 ± 881.29	649.35 ± 205.80	1,064.94 ± 293.48	5,685.43 ± 1,551.48
<i>Podocarus auberti</i>	0	0	0	0
<i>Domotorina marionensis</i>	1,792.21 ± 386.13	623.38 ± 160.58	25.97 ± 25.97	202.02 ± 112.70
<i>Schwiebea talpa subantarctica</i>	0	0	0	288.60 ± 288.60
<i>Algophagus</i> sp.	0	155.84 ± 88.30	9,350.65 ± 7,821.40	0
<i>Neocalvolia</i> sp.	0	0	25.97 ± 25.97	0
Species richness	12	19	13	15
Abundance	39,116.88 ± 16,824.62	29,870.13 ± 6,793.48	33,480.52 ± 13,999.82	20,086.58 ± 8,128.78
Collembola				
<i>Ceratophysella denticulata</i> ^a	0	233.77 ± 90.39	25.97 ± 25.97	28.86 ± 28.86
<i>Tullbergia bisetosa</i>	1,298.70 ± 309.76	857.14 ± 251.08	3,272.73 ± 1,114.30	490.62 ± 257.73
<i>Folsomotoma marionensis</i>	3,714.29 ± 1,047.62	23,324.68 ± 3,939.50	181.82 ± 87.02	18,903.32 ± 15,323.26
<i>Cryptopygus dubius</i>	0	207.79 ± 114.86	22,077.92 ± 7101.78	26,378.07 ± 4406.69
<i>Cryptopygus antarcticus</i>	129.87 ± 104.26	129.87 ± 58.08	0	1,038.96 ± 685.84
<i>Cryptopygus caecus</i>	0	0	571.43 ± 244.27	606.06 ± 606.06
<i>Megalothorax</i> sp.	3,558.44 ± 2,018.65	23,194.81 ± 7418.46	0	13,419.91 ± 8255.92
<i>Sminthurinus tuberculatus</i>	389.61 ± 96.80	6,207.79 ± 869.65	6,363.64 ± 2,137.06	230.88 ± 152.71
<i>Sminthurinus granulatus</i>	0	0	0	0
Species richness	5	7	6	8
Abundance	9090.91 ± 3,577.09	54,155.84 ± 12,742.02	32,493.51 ± 10,710.39	61,096.68 ± 2,9717.07
Total species richness	17	26	19	23
Total abundance	48,207.79 ± 20,401.71	84,025.97 ± 19,535.50	65,974.03 ± 24,710.21	81,183.26 ± 37,845.85
Species	<i>Poa</i>	<i>Azorella</i>	Mire	Fellfield
Acari				
Acari sp.1	0	28.86 ± 28.86	0	0
Acari sp.2	0	0	0	0
Acari sp.3	77.92 ± 55.44	0	0	17.32 ± 17.32
Acari sp.4	0	0	1038.96 ± 407.94	225.11 ± 79.62
Acari sp.5	0	0	0	0
Acari sp.7	0	0	0	0
Acari sp.8	0	0	0	17.32 ± 17.32
Acari sp.9	0	0	0	0
Rhodacaridae sp.	597.40 ± 145.14	577.20 ± 94.62	77.92 ± 55.44	103.90 ± 61.05
<i>Dendrolaelaps</i> sp.	2,311.69 ± 655.33	173.16 ± 86.58	51.95 ± 34.63	103.90 ± 42.42
Cillibidae sp. ^a	311.69 ± 158.71	404.04 ± 168.28	25.97 ± 25.97	398.27 ± 126.40
<i>Nanorchestes</i> sp.	25.97 ± 25.97	0	25.97 ± 25.97	0
<i>Eupodes minutes</i>	909.09 ± 482.45	2,568.54 ± 1,722.62	1,350.65 ± 1,124.74	138.53 ± 83.56
<i>Tydeus</i> sp.	0	0	0	0

Table 2 continued

<i>Rhagidia</i> sp.	0	0	0	0
<i>Ereynetes macquariensis</i>	25.97 ± 25.97	317.46 ± 166.42	51.95 ± 34.63	0
<i>Bdellodes</i> sp.	0	0	51.95 ± 34.63	51.95 ± 27.77
<i>Liochthonius australis</i>	0	0	77.92 ± 39.68	0
<i>Macquarioppia striata</i>	0	0	519.48 ± 289.75	17.32 ± 17.32
<i>Austroppia crozetensis</i>	207.79 ± 75.48	4,184.71 ± 1,479.76	233.77 ± 105.68	69.26 ± 30.70
<i>Halozetes</i> sp.	623.38 ± 404.62	0	25.97 ± 25.97	0
<i>Halozetes fulvus</i>	1,220.78 ± 637.47	57.72 ± 38.18	1,454.55 ± 342.40	1679.65 ± 438.94
<i>Podocarus auberti</i>	155.84 ± 88.30	0	0	0
<i>Domatorina marionensis</i>	25.97 ± 25.97	288.60 ± 109.90	1,584.42 ± 508.47	3809.52 ± 892.84
<i>Schwiebea talpa subantarctica</i>	0	57.72 ± 38.18	259.74 ± 122.44	17.32 ± 17.32
<i>Algophagus</i> sp.	129.87 ± 129.87	0	0	0
<i>Neocalvolia</i> sp.	1,454.55 ± 1,240.97	0	103.90 ± 57.43	0
<i>Hyadesia halophila</i>	233.77 ± 179.33	0	0	0
<i>Hyadesia</i> sp.	181.82 ± 95.24	0	0	0
Species richness	16	10	16	13
Abundance	8,493.51 ± 4,426.23	8,658.00 ± 3,933.39	6,961.04 ± 3,261.77	6,649.35 ± 1,852.55
Collembola				
<i>Ceratophysella denticulata</i> ^a	77.92 ± 55.44	0	0	0
<i>Tullbergia bisetosa</i>	961.04 ± 309.88	1,616.16 ± 232.23	25.97 ± 25.97	103.90 ± 42.42
<i>Folsomotoma marionensis</i>	909.09 ± 566.75	7,647.91 ± 3,257.73	545.46 ± 376.30	0
<i>Cryptopygus dubius</i>	259.74 ± 139.61	4,098.12 ± 1,431.05	0	155.84 ± 61.05
<i>Cryptopygus antarcticus</i>	207.79 ± 93.25	3,145.74 ± 1,213.24	935.07 ± 506.62	3,393.94 ± 592.01
<i>Cryptopygus caecus</i>	727.27 ± 402.02	2,193.36 ± 592.16	0	0
<i>Megalothorax</i> sp.	0	5,281.39 ± 4735.66	545.46 ± 517.24	0
<i>Sminthurinus tuberculatus</i>	337.66 ± 225.94	1,125.54 ± 1031.72	441.56 ± 177.65	259.74 ± 71.70
<i>Sminthurinus granulosus</i>	415.58 ± 387.59	0	0	0
Species richness	8	7	5	4
Abundance	3,896.10 ± 2,180.47	25,108.23 ± 12,493.79	2,493.51 ± 1,603.78	3913.42 ± 767.17
Total species richness	24	17	21	17
Total abundance	12,389.61 ± 6,606.70	33,766.23 ± 16,427.18	9,454.55 ± 4,865.55	10,562.77 ± 2619.72

Mean (± SE) density of mites (Acari) and springtails (Collembola) in eight plant communities sampled on Prince Edward Island (*Acaena magellanica*, *Blechnum penna-marina*, *Cotula plumosa*, *Poa cookie*, Mire: $n = 10$, *Azorella selago*, *Crassula moschata*: $n = 9$, Fellfield: $n = 15$)

^aIntroduced species after Chown et al. 2002

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