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The invertebrates of sub-Antarctic Bishop Island

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Abstract We report on the first comprehensive collection of invertebrates made on sub-Antarctic Bishop Island, which lies 33 km south of Macquarie Island. A total of 15 species were collected, of which 14 also occur amongst the 168 species recorded from Macquarie Island. We hypothesise that the greater species richness of Macquarie Island relative to Bishop Island is largely caused by the greater habitat diversity on Macquarie Island but that other factors, including accidentally introduced species, may also be important.

Introduction

Bishop Island (55°06′S, 158°43′30″E) lies 33 km south of Macquarie Island on the Macquarie Ridge, about 1,330 km southeast of Tasmania, Australia and 1,410 km north of the Antarctic continent (Lugg et al. 1978). Bishop Island is a rocky platform of about 45 m altitude and 3 ha area. It has an intermittent covering of soil of up to 15-cm depth, which is vegetated in places by the coastal cushion plant *Colobanthus muscoides*. The island is surrounded by 24 smaller rock stacks, which together with Bishop Island compose the Bishop and Clerk Islands (MacKenzie 1968). Landings on the island have been rare because of bad weather and submerged reefs.

The only invertebrate species previously recorded from the island were collected during a half-hour visit by two researchers flown by helicopter from the vessel *Thala Dan* (Lugg et al. 1978). Before that, the only recorded visit to Bishop Island was when a helicopter from USS *Glacier* landed for a few minutes on an outlying rock platform. No collections were made on that visit. Here we report on a collection made on a 3-h helicopter visit in December 1993 from the MV *Icebird*, and compare the Bishop Island fauna with that of Macquarie Island.

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Materials and methods

Four invertebrate habitats were recognised on Bishop island: (1) underneath loose rocks or in rock crevices, in unvegetated areas; (2) associated with the coastal cushion plant *Colobanthus muscoides*; (3) in soil without vegetation; and (4) in soil, litter and amongst the rocks of bird nesting sites.

Two sampling methods were used. First, hand collections were made in all habitat types using featherweight forceps and an aspirator. Second, three samples each were collected of vegetation, soil (15-cm diameter, 10-cm depth) and material from nest burrows and penguin colonies. On the following day, invertebrates were extracted from these samples using Tullgren funnels (Tullgren 1918). Specimens were identified by taxonomic specialists. All specimens were lodged with the Australian National Insect Collection, CSIRO Division of Entomology, Canberra.

Results

Fifteen species were collected from the four terrestrial habitat types (Tables 1 and 2). All species have sub-Antarctic affinities with two species also known from the Auckland Islands, one species from New Zealand, and another from Chilé (Table 1). All species except *Cryptopygus antarcticus maximus* (Collembola) have also been recorded from neighbouring Macquarie Island (Table 3).

Three species collected from Bishop Island are of uncertain status. The first species, a mesostigmatid mite with undescribed genus and species, was referred to by Watson (1967) as ‘‘species 2, *Celaenogamasus* ?’’. It is

Table 1 The invertebrates of Bishop Island and recorded localities (*MI* Macquarie Is, *CI* Campbell Is, *SOI* S. Orkney Is, *SShI* S. Shetland Is, *SG* South Georgia, *SSI* S. Sandwich Is, *B* Bouvetøya, *MPEI* Marion and Prince Edward Is, *CrI* Crozet Is, *KI* Kerguelen Is, *HI* Heard Is. Other locations *NZ* New Zealand, *AI* Auckland Islands, *P* southern Patagonia, *T* Tierra del Fuego. Letters indicate the record source as follows: *a* Pugh 1993, *b* Watson 1967, *c* Wallwork 1963, *d* Wallwork 1964, *e* Hickman 1939, *g* Greenslade 1990, *h* Greenslade and Wise 1986, *i* Sømme 1986, *j* Deharveng 1981, *k* Benham 1922, *I* Michaelsen 1905, *m* Block and Stary 1996)

Family	Species	Location												
		Sub-Antarctic and maritime Antarctic islands											Antarctica	Other
		MI	CI	SOI	SShI	SG	SSI	B	MPEI	CrI	KI	HI		
Acari														
Ologamasidae	*Parasitiphis jeanneli* (André)	a				a				a	a	a		AI(a)
Ologamasidae	*Hydrogamasellus antarcticus* (Trägårdh)	a				a				a			a	
Uropodidae	*Uropoda* sp.	a, b												
Cercomegistidae	"Species 2, *Celaenogamasus*?"	a, b												
Ameronothridae	*Alaskozetes antarcticus* Michael	a, c		a	a	a	m	m	a		a		a	NZ(a)
Ameronothridae	*Halozetes crozetensis* (Richters)	a, d	a						a	a	a	a		
Oppiidae	*Austroppia crozetensis* (Richters)	a		a		a	a		a	a	a			P(c), T(m)
Araneae														
Desidae	*Myro kerguelenensis* Cambridge	e								i	e	e		
Collembola														
Isotomidae	*Cryptopygus tricuspis* Enderlein	g							g	g		g		
Isotomidae	*Cryptopygus antarcticus maximus* Deharveng	?									j			
Neanuridae	*Friesea tilbrooki* Wise	h				h		i				h		
Onychiuridae	*Tullbergia templei* Wise	h									h	h		
Diptera														
Tethinidae	*Apetaenus watsoni* Hardyb													
Oligochaeta														
Enchytraeidae	*Marionina werthi* Michaelsen	k									l			
Enchytraeidae	*Lumbricillus macquariensis* Benham	k	k									k		AI(l)

thought that this species may form the basis of a new family (R. B. Halliday, personal communication).

The second species, *Lumbricillus macquariensis* Benham, differs from the description of *L. macquariensis* Benham (1922), which does, however, show considerable variation in size and setal arrangement. The Bishop Island specimens are larger (15–25 mm) and have subneural glands in the region of xiv–xvii.

The third species, a collembolan, is probably *Cryptopygus antarcticus maximus*, one of four subspecies distinguished by Deharveng (1981). However, the Bishop Island specimens differ from the typical form in that they have up to 29 setae on the manubrium (c.f. 20 on the typical form), and a relatively undeveloped thoracic and anterior abdominal segment macrochaetal pattern with only 1 macrochaeta on the mesothorax and metathorax (c.f. 3). Although the number of anterior subcoxal setae is within the typical range (17–22), about half of the specimens have 5 posterior subcoxal setae (c.f. 4). These characters have validity at species level. Consequently, the Bishop Island specimens are not definitely identified to subspecies at this time. The genus *Cryptopygus* requires revision and a likely result will be the description of new species from the sub-Antarctic as well as subspecies being raised to species status. The Bishop Island specimens may represent a new subspecies, which is also likely to occur on Macquarie Island. Alternatively, *Cryptopygus antarcticus maximus* is more variable than the original description suggests.

Discussion

Seven of the fifteen species that were collected from Bishop Island in 1993 were also collected on the 1976 visit, although not all of the earlier specimens were identified to species. The identified invertebrates col-

Table 2 Invertebrate species collected from Bishop Island listed by habitat (*Rock*, open rocky unvegetated environment, under loose rocks, or in rock crevices; *Vegetation*, associated with the coastal cushion plant *Colobanthus muscoides*; *Soil*, unvegetated soil; *Bird nests*, associated with bird colonies or nest burrows)

Species	Habitat			
	Rock	Vegetation	Soil	Bird nests
Acari				
Parasitiphis jeanneli		x	x	
Hydrogamasellus antarcticus			x	
Uropoda sp.		x	x	
"species 2, *Celaenogamasus*?"		x	x	
Alaskozetes antarcticus	[a]			x
Halozetes crozetensis	[a]	x	x	
Austroppia crozetensis		x		
Araneae				
Myro kerguelenensis	x	x	x	
Collembola				
Cryptopygus antarcticus maximus		x	x	x
Cryptopygus tricuspis		x		
Friesea tilbrooki			x	
Tullbergia templei			x	
Diptera				
Apetaenus watsoni	x		x	x
Oligochaeta				
Marionina werthi				x
Lumbricillus macquariensis		x		x

[a] Collected from rock crevices on egg cases of *Myro kerguelenensis*

Table 3 Free-living arthropods, molluscs and oligochaetes of Macquarie Island (Greenslade 1990) and Bishop Island

	Total number of species recorded			Total number of species recorded	
	Macquarie Island	Bishop Island		Macquarie Island	Bishop Island
Oligochaeta	8	2	Coleoptera	8	0
Mollusca	4	0	Hymenoptera	1	0
Collembola	31	4	Lepidoptera	1	0
Diptera	15	1	Amphipoda	1	0
Thysanoptera	1	0	Isopoda	1	0
Psocoptera	1	0	Araneae	3	1
Hemiptera	3	0	Acarina	≈ 90	7
			Total	168	15

lected in 1976 included two mites, namely *Alaskozetes antarcticus* and *Parasitiphis jeanneli*, and a collembolan identified as "probably *Tullbergia mediantarctica*" (Lugg et al. 1978), which we now identify as *Tullbergia templei*. Partly determined species collected in 1976 included a spider, which may have been *Myro kerguelenensis*, the pupae and larvae of a small dipteran, which may have been *Apetaenus watsoni*, and a few "worms" (Lugg et al. 1978). Species not collected on the 1978 visit were the mesostigmatid mites *Uropoda* sp., *Hydrogamasellus antarcticus* and "species 2, *Celaenogamasus*?" (Watson 1967), the cryptostigmatid mites *Halozetes crozetensis* and *Austroppia crozetensis*, the Collembola *Cryptopygus antarcticus maximus, Cryptopygus tricuspis*, *Friesea tilbrooki*, and two species of oligochaete worm, *Marionina werthi* and *Lumbricillus macquariensis*.

At least five hypotheses can be proposed to explain the greater species richness of Macquarie Island (168 species) relative to Bishop Island (15 species), three of which relate to the greater size of Macquarie Island (12,785 ha vs. 3 ha). First, islands of larger size may contain more habitats (Connor and McCoy 1979). Second, the number of species increases with island size because population sizes also increase, reducing the probability of extinction (Preston 1962; MacArthur and Wilson 1967; Simberloff 1972). Third, the number of species is controlled by passive sampling of immigrants from the species pool; larger islands receive larger samples than smaller islands and thus contain more species (Preston 1962; MacArthur and Wilson 1967). Fourth, Bishop Island is younger than Macquarie Island and thus has had less time for new species to immigrate. Much of Macquarie Island probably emerged

above sea level between 200,000 and 50,000 years ago (Selkirk et al. 1990), whereas if a similar uplift history is assumed for Bishop Island it would have emerged less than 15,000 years ago. Fifth, species richness on Macquarie Island has been augmented by the accidental introduction of species by humans.

Most of the difference in species richness between the two islands is probably due to habitat diversity. Habitats on Bishop Island superficially resemble the barren plateau of Macquarie Island, while Macquarie Island contains large areas of physically and floristically more complex habitats, which include grasslands and herbfields of various kinds (Selkirk et al. 1990). To what extent factors other than habitat diversity play a role is not easy to judge. In particular, it is not possible to evaluate the role of natural extinction and immigration processes because we have no data. Some argument can be made that natural introductions to Macquarie Island contribute to the difference between the two islands, at least for some invertebrate groups. Macquarie Island has a long history of human visitation and occupation (Cumpston 1968), and there is good evidence for the accidental introduction of at least two invertebrate species (van Klinken and Green 1992; Richardson and Jackson 1995). Further, Pugh (1994) has suggested that as many as 45 mite species may be alien to Macquarie Island, which is an unusually high number for a sub-Antarctic island. The case of the spiders provides one example where it is difficult to determine the relative roles of habitat and accidental introductions. While all three spider species recorded from Macquarie Island occur on the coast, only *Myro kerguelenensis* also inhabits the plateau, which appears superficially similar to the habitat of Bishop Island. Only *Myro kerguelenensis* occurs on Bishop Island. *Myro kerguelenensis* has sub-Antarctic affinities, while the ranges of the other two species include southern New Zealand. This lack of New Zealand species on Bishop Island could be related to habitat differences or alternatively may be because no species have been accidentally introduced to Bishop Island from New Zealand. Only further work on the habitat requirements of the three species would adequately resolve this issue.

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