ZooKeys 419: 29–71 (2014)
doi: 10.3897/zookeys.419.7180
www.zookeys.org

RESEARCH ARTICLE

A peer-reviewed open-access journal
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Ecological Biogeography of the Terrestrial Nematodes of Victoria Land, Antarctica

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Academic editor: *D. Fitch* | Received 3 February 2014 | Accepted 10 April 2014 | Published 23 June 2014

http://zoobank.org/639DB7C1-674C-4BFB-BE31-F3052648A2DB

Citation: Adams BJ, Wall DH, Virginia RA, Broos E, Knox MA (2014) Ecological Biogeography of the Terrestrial Nematodes of Victoria Land, Antarctica. ZooKeys 419: 29–71. doi: 10.3897/zookeys.419.7180

Abstract
The terrestrial ecosystems of Victoria Land, Antarctica are characteristically simple in terms of biological diversity and ecological functioning. Nematodes are the most commonly encountered and abundant metazoans of Victoria Land soils, yet little is known of their diversity and distribution. Herein we present a summary of the geographic distribution, habitats and ecology of the terrestrial nematodes of Victoria Land from published and unpublished sources. All Victoria Land nematodes are endemic to Antarctica, and many are common and widely distributed at landscape scales. However, at smaller spatial scales, populations can have patchy distributions, with the presence or absence of each species strongly influenced by specific habitat requirements. As the frequency of nematode introductions to Antarctica increases, and soil habitats are altered in response to climate change, our current understanding of the environmental parameters associated with the biogeography of Antarctic nematofauna will be crucial to monitoring and possibly mitigating changes to these unique soil ecosystems.

Keywords
Biodiversity, dispersal, climate change, *Eudorylaimus*, freeliving nematodes, *Geomonhystera*, habitat suitability, invasive species, *Panagrolaimus*, *Plectus*, *Scottnema*, soil

Introduction

Understanding the global distribution of biodiversity is critical for studying the evolution, ecology and dynamics of ecosystems and to address how global scale changes in climate, invasive species, and land use will affect ecosystems, ecosystem services, and subsequently, people. Antarctic terrestrial ecosystems might seem less sensitive to global change because this polar desert has low species diversity distributed across a limited area of biologically active ice-free land, comprising less than 0.32% of the continent's 14 million km^2 (Chown and Convey 2007). However, terrestrial ecosystems of Antarctica are not immune to global changes (Adams et al. 2009; Chown et al. 2012b). Small changes in polar climate are amplified through biophysical feedbacks leading to biologically significant alterations in soil habitats and their communities (Doran et al. 2002; Nielsen et al. 2011a). The low species diversity of Antarctic soils makes them uniquely suited for studying the relationships between soil biodiversity and ecosystem functioning, and identifying how global changes may affect species level changes in biodiversity, community composition and distribution (Barrett et al. 2008; Simmons et al. 2009). Measures to conserve, manage and sustain ecosystem functioning in Antarctic and Earth's other low diversity terrestrial environments will rely on knowledge of species diversity, distributions, and their role in ecosystem processes (Adams et al. 2006; Barrett et al. 2008; Wall 2004).

Aboveground, the diversity and biogeography of terrestrial flora (mosses, lichens and liverworts) has been recently assessed and used to further refine the geographic floral regions of Antarctica (Peat et al. 2007). It is well known that the warmer maritime and subantarctic ecosystems have higher precipitation, organic soils, a more diverse and abundant vegetation (Bölter et al. 2002; Maslen 1979; Nielsen et al. 2011b; Peat et al. 2007) and greater soil faunal diversity (including earthworms and beetles) than continental Antarctica (Block and Christensen 1985; Chown and Van Drimmelen 1992). For example, the northern maritime Antarctic has 100-115 moss and *c*. 350 lichen species compared to continental Antarctica's 20–30 moss and *c*. 90 lichen species (Peat et al. 2007). Throughout Victoria Land vascular plants are absent and fauna are reduced to only a few soil groups and are represented by a patchy spatial distribution of protozoans, nematodes, rotifers, tardigrades, springtails (Collembola), and mites (Acarina) (Adams et al. 2006; Bamforth et al. 2005; Frati et al. 1997; Moorhead et al. 1999; Stevens and Hogg 2002; Virginia and Wall 1999).

Nematoda are a major component of soil food webs in all terrestrial ecosystems including the exposed lands of Antarctica, though their spatial distribution and abundance are highly heterogeneous. In more productive ecosystems, they typically have much higher diversity (Wall Freckman and Virginia 1998) than the Antarctic (Boag and Yeates 1998; Bunt 1954; Maslen 1981). For example, 431 nematode species were recorded from a Cameroon tropical forest ecosystem, with a maximum of 89 species found in 200 individuals enumerated in a soil core (Bloemers et al. 1997). In contrast, the diversity of nematodes in all of Antarctica, including the continental, maritime, and Sub- Antarctic is 54 nematode species, of which only *c.* 22 species, all endemic, occur on the ice-free terrestrial areas of the continent (Andrássy 1998; Andrássy 2008).

In Antarctica, soil nematodes have been studied primarily in localized and easily accessible areas largely centered around research bases and concentrated on the Antarctic peninsula and islands of the maritime Antarctic and further south in ice-free areas. As a consequence there is relatively little known of their regional biogeography or of the habitats that are suitable for functioning communities. Additionally, there are many remote inland ice-free areas which have yet to be sampled (Convey 1996; Wall 2005), adding to questions on how widespread species are, and whether species rich communities and habitats exist in the more extreme climate zones of the continent.

Regional to continental-scale descriptions of the Antarctic nematofauna have pointed to a paucity of distributional records for much of the continent (Andrássy 1998; Velasco-Castrillón and Stevens 2014). Amongst all regions of Antarctica, Victoria Land is arguably the most intensively studied (Adams et al. 2006). Victoria Land is "that part of Antarctica which fronts on the western side of the Ross Sea, extending southward from about 70°30'S to 78°00'S, and westward from the Ross Sea to the edge of the polar plateau" (USGS 2003). Here, we synthesize information on the nematode biodiversity, geographic distribution and soil and sediment habitats of the terrestrial nematodes in Victoria Land, Antarctica. Much of this information comes from a series of studies to assess nematode diversity and distribution begun in austral summer 1989–1990 by Wall (formerly Freckman) and Virginia and extending to the present as part of the McMurdo Dry Valley Long Term Ecological Research program funded by the US National Science Foundation (www.mcmlter.org). We report on findings of these studies through 2004 which captures most of the biodiversity information gathered by this research group, whereas more recent research has focused on nematode species response to climate change and soil resource manipulations (Ayres et al. 2010; Doran et al. 2002; Simmons et al. 2009). For purposes of our synthesis, we define two areas, Northern Victoria Land - the area from about 70°30'S to about 76°S, encompassing Terra Nova Bay, Edmonson Point and Cape Hallett (Figure 1); and Southern Victoria Land - the area from about 76°S to about 78°S including all of the McMurdo Dry Valleys and nearby coastal regions (Adams et al. 2006) (Figure 2).

The McMurdo Dry Valleys (76°5'to 78°5'S, 160°0' to 164°0'E) are located along the TransAntarctic Mountains in Southern Victoria Land and comprise about 4,800 km^2 of ice-free land and have different geo/ecological legacies and climatic conditions (Lyons et al. 2000; Moorhead et al. 1999). They are the oldest, driest and coldest deserts on earth (Beyer et al. 1999; Campbell et al. 1998; Fountain et al. 1999). Annual precipitation is less than 10 cm water equivalent, most of which sublimates before it melts (Doran et al. 2002; Fountain et al. 1999). Mean annual air temperature is –20°C (Fountain et al. 1999) and surface soil temperature ranges from -59°C in winter to 26°C for short periods during summer (Doran et al. 2002). No vertebrate animals or vascular plants are present and mosses and lichens are rare and mostly confined to ephemeral meltponds, streams and lake moats (Cameron et al. 1970; Horowitz et al. 1972; Kappen 1993). Across the region soils are poorly developed, coarse textured (95 to 99% sand by

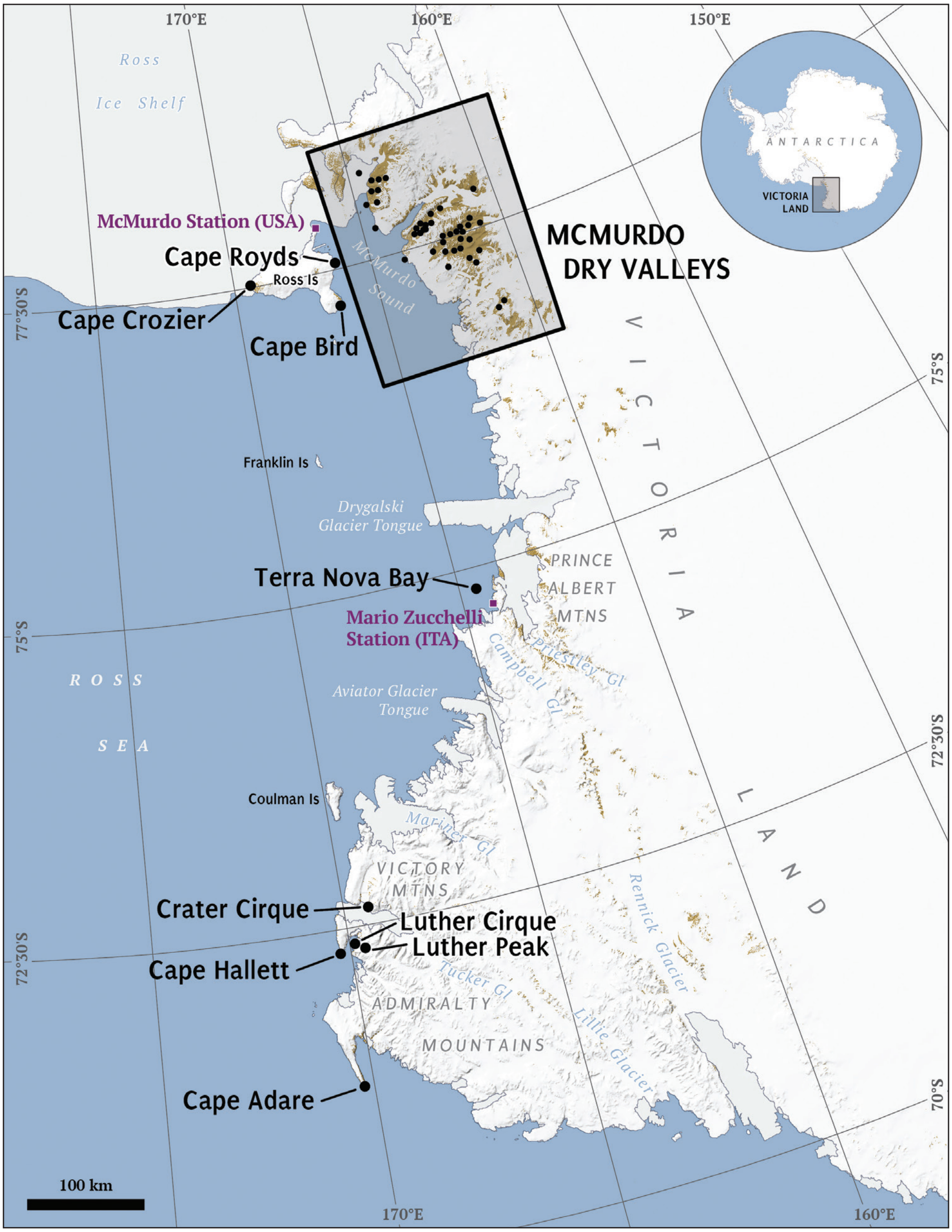

Figure 1. Victoria Land, Antarctica. Labeled areas represent study locations and major geographic features referenced in the tables and text. Box inset of the McMurdo Dry Valleys is rotated 180 °and expanded in Figure 2.

weight) (Bockheim 1997), low in organic carbon (<1%) (Burkins et al. 2000), saline, and have low biological activity compared to warmer ecosystems (Ball et al. 2009; Barrett et al. 2006a; Parsons et al. 2004). Nematodes are the dominant soil invertebrate,

Figure 2. McMurdo Dry Valleys, Antarctica. Labeled areas represent study locations and major geographic features referenced in the tables and text.

but many soils (~35%) lack extractable soil invertebrates and approximately 50% of McMurdo Dry Valleys soils that contain invertebrates have only one invertebrate species (Freckman and Virginia 1997; Wall Freckman and Virginia 1998).

The distributions of the Dry Valley metazoan species are associated with specific sites and correlate to soil habitat differences in organic matter content, moisture and salinity, and microclimate differences encountered over environmental gradients of coastal to interior sites, latitude, and soil chronosequences and differences in glacial tills (Barrett et al. 2006a).

Coastal areas of Victoria Land are a moister environment than the Dry Valleys and are habitat for birds and marine mammals (e.g. skua gulls, penguins, and seals). Penguin rookeries are associated with ornithogenic soils with significant inputs of carbon and nitrogen transferred from the marine environment to the soil (Bargagli et al. 1997). Ornithogenic soils are the only soils south of the Antarctic Circle containing high concentrations (14–21%) of organic matter (Campbell and Claridge 1966; Heine and Speir 1989). However, even with high C and N availability these soils often have lower nematode diversity than soils of the Dry Valleys, probably owing to very high concentrations of salts and soil compaction and cementing (Porazinska et al. 2002a; Sinclair 2001).

Each of the unique soil ecosystems of Victoria Land imposes considerable physiological constraints on nematode life history traits, requiring adaptive responses to freeze/thaw cycling, osmotic and desiccation stress, and a short growing season (Convey 1996). Nematode responses include cryoprotective dehydration via anhydrobiosis (Adhikari et al. 2009; Adhikari and Adams 2011; Crowe et al. 1992), as well as tolerance to inter and intracellular freezing (Adhikari et al. 2010; Wharton 2003, 2010) and multiyear lifecycles (de Tomasel et al. 2013; Overhoff et al. 1993; Yeates et al. 2009). In addition to stress survival, anhydrobiosis also facilitates long-distance aeolian dispersal (Barrett et al. 2006a), an important mechanism implicated in explanations of their geographic distributions and population genetic structure (Adams et al. 2006; Courtright et al. 2000). All of the nematodes of Victoria Land are inferred to be microbivores with the exception of *Eudorylaimus*, which is omnivorous (Yeates et al. 1993) (but see Wall 2007).

Nematodes were first collected in Victoria Land by the British 'Discovery' expedition of 1901-1903, from Discovery Bay, South Victoria Land and described by Steiner (1916) as *Dorylaimus antarcticus* (syn. *Eudorylaimus antarcticus* (Yeates 1970)). The nematodes of Victoria Land then remained largely unstudied for over half a century, until the work of Yeates (1970) and Timm (1971). Between them, these two papers described or redescribed all Victoria Land genera of the time and laid the foundation for future taxonomic work. Yeates (1970) recorded *Plectus* from southern coastal Victoria Land and synonymized *Dorylaimus antarcticus* and *Antholaimus antarcticus* with *Eudorylaimus antarcticus*. However, subsequent studies have described further *Eudorylaimus* species from continental Antarctica: *E. glacialis* (Andrássy 1998), *E. nudicaudatus* (Heyns 1993) and *E. shirasei* (Kito et al. 1996), *E. quintus* (Andrássy 2008) and *E. sextus* (Andrássy 2008). Due to the taxonomic uncertainty of early accounts (Adams et al. 2006), we will henceforth use *Eudorylaimus* sp. in reference to all previous reports of distribution. Timm (1971) synonymized *Plectus murrayi* with *P. antarcticus* (de Man 1904) and studied parts of southern and northern coastal Victoria Land and the McMurdo Dry Valleys. He also re-described three known species: *E. antarcticus* (Steiner 1916), *Monhystera villosa* (Bütschli 1873) and *Plectus frigophilus* (Kirjanova 1958), and described two new species, *Scottnema lindsayae* and *Panagrolaimus davidi*. *Monhystera villosa* was later synonymized with *Geomonhystera antarcticola* (Andrássy 1998). These early studies focused exclusively on the identification and description of nematode species and not their ecologies.

In the McMurdo Dry Valley Region, most nematological studies have investigated the diversity, ecology and distribution patterns of up to three nematode genera; *Eudorylaimus*, *Plectus*, *Scottnema* (Adams et al. 2006), while the coastal areas of Victoria Land remain less well known (Adams et al. 2006; Bargagli et al. 1997; Barrett et al. 2006a; Porazinska et al. 2002a; Raymond et al. 2013a; Sinclair and Sjursen 2001; this paper; Timm 1971; Vinciguerra 1994). Our effort here is a synthesis of the biogeographic distribution of nematodes in Victoria Land and a consideration of the soil habitats that are associated with nematode distribution, diversity and abundance.

Materials and methods

Based on published and unpublished data, we summarized biogeographic information on the species represented within each nematode genus described in Victoria Land. In addition to published papers, we present information obtained from data on soil, and lake and stream sediment samples collected throughout Victoria Land, by the authors and team members during the austral summers between and including 1990 and 2004. Data referred to as "this study (year)" were derived from nematode soil extraction procedures optimized for Antarctic soils and all nematodes were identified to species (Freckman and Virginia 1993). Frozen soils from these samples are archived at the Wall lab in the Department of Biology at Colorado State University, Fort Collins, CO, USA. Formalin-preserved extracted specimens from these soils are archived in the meiofauna collection of the Monte L. Bean Life Science Museum at Brigham Young University, Provo, UT, USA. Non-occurrences are not reported but can be extrapolated from Tables 1–5. A brief summary of published information on the ecology of each genus is also provided (Table 6).

Results and discussion

Only five genera of terrestrial nematodes are recorded from Victoria Land Antarctica: *Scottnema*, *Plectus*, *Eudorylaimus*, *Panagrolaimus*, and *Geomonhystera*. For some genera species delimitation remains unresolved (Andrássy 1998; Velasco-Castrillón and Stevens 2014).

Scottnema (Rhabditida: Cephalobidae)

Scottnema is an exclusively Antarctic genus comprised of only one species, *S. lindsayae* (Timm 1971). *Scottnema lindsayae* (synonymous with *S. lindsayi*) is thought to have evolved from a common ancestor of the genus *Acrobeles* (Shishida and Ohyama 1986), with a recent phylogenetic analysis placing the genus *Stegelletina* as its closest relative (Boström et al. 2011). *S. lindsayae* is the most southerly known occurring nematode in the world, found as far south as Mt Harcourt (83°08.99'S, 163°21.81'E) near the base of the Beardmore Glacier (Adams et al. 2007).

Biogeographic distribution. *Scottnema lindsayae* is the dominant nematode of Victoria Land (Table 1) based on abundance and widespread distribution in numerous samples from the McMurdo Dry Valleys (Courtright et al. 2001; Freckman and Virginia 1990; 1993, 1997; Moorhead et al. 1999; Porazinska et al. 2002b; Powers et al. 1995b; Powers et al. 1998; Treonis et al. 1999, 2000). *S. lindsayae* was first described in Victoria Land in samples from Wright Valley and the southern coastal region (Marble Point, Strand Moraines) (Timm 1971) and has since been recorded in the northern coastal region occurring as far north as Luther Cirque (72°22.20'S, 169°53.10'E) (Table 1).

S. lindsayae also occurs on two islands off the coast of Victoria Land: Ross Island (Porazinska et al. 2002a; Sinclair 2001; Timm 1971) and Kay Island (Vinciguerra 1994). On the opposite side of Antarctica, Shishida and Ohyama (1986) report *S. lindsayae* from Rundvågshetta, East Ongul Island (69°01'S, 39°58'E), and Mouratov et al. (2001) report *S. lindsayae* near Machu Picchu station (62°05.51'S, 58°28.21'W) on the coast of Admiralty Bay, although Andrássy (1998) questions this report.

Habitat. *S. lindsayae* survives in a wide range of terrestrial habitats (Table 1). In Victoria Land *S. lindsayae* occurs most commonly in dry, bare and sandy or rocky soils and has been found at 30–40 cm soil depth near south shore of Lake Hoare (Powers et al. 1995b). Less frequently, *S. lindsayae* occurs in the moister habitats such as: snow covered soil (subnivian); near streams and in lake sediments (this paper; Treonis et al. 1999; Vinciguerra 1994); and, under mosses (e.g. *Bryum antarcticum*) (Timm 1971; Vinciguerra 1994). *S. lindsayae* has also been found associated with an algal mat (Timm 1971) but whether the algal mat was from soil, a lake or a stream is unknown.

In comparison with other nematodes of Victoria Land, *S. lindsayae* occurs most frequently and at greater abundances in soil habitats with lower moisture, higher pH, higher EC, and higher inorganic C (Courtright et al. 2001; Freckman and Virginia 1997; Moorhead et al. 1999; Porazinska et al. 2002b; Powers et al. 1998; Treonis et al. 1999). In these habitat types, *S. lindsayae* may comprise >99% of invertebrates present (Treonis et al. 1999, 2002), and may be the only invertebrate present. Treonis et al. (2000) found that *S. lindsayae* becomes anhydrobiotic in coarse textured Dry Valley soils at a gravimetric soil moisture threshold of ~2%. In a study of 32 samples from one site on King George Island (62°05.51'S, 58°28.21'W), Mouratov et al. (2001) suggested soil moisture content may be one of the main factors determining the distribution of *S. lindsayae* and found that the species has a preference for soil moisture of 2–5%. Many studies in the McMurdo Dry Valleys (Barrett et al. 2006c; Courtright

Table 1. Biogeographic distribution of *Scottnema lindsayae* in Victoria Land, Antarctica. NP = not published. NA = specific coordinates not available within the named locale identified above. For references to "this paper", the year collected refers to the year at the beginning of the austral summer in which samples were collected at 0-10 cm depth unless otherwise indicated. For abundance, 'Present' indicates no abundance information available, Low = >0 to 20 nematodes per kg dry soil, M-low = 21 to 200 nematodes per kg dry soil, Medium = 201 to 600 nematodes per kg dry soil, M-high = 601 to 1000 nematodes per kg dry soil, High = 1001 to 2000 nematodes per kg dry soil, V-high = >2000 nematodes per kg dry soil, n = number of samples and % = percentage of samples in which *S. lindsayae* occurred. [A]There may have been a typographical error in the original publication reporting this latitude/longitude. *Geographic coordinates associated with the recognized Antarctic place name for a general feature as listed by the USGS Advisory Committee on Antarctic Names (http://geonames.usgs.gov/antarctic/) and updated by the Polar Geospatial Center (http://www.pgc.umn.edu).

Biogeographic location	Lat (S)	Long (E)	Habitat	Abundance	Reference
Victoria Land	*74°15.00'	163°00.00'			
-	NP	NP	"river", wet mosses	Present	(Vinciguerra 1994)
McMurdo Dry Valleys	*77°30.00'	162°00.00'			
-	NP	NP	soil	Present	(Freckman and Virginia 1990)
-	NP	NP	soil	M-high	(Freckman and Virginia 1993)
-	NP	NP	soil	Present	(Freckman and Virginia 1997)
Alatna Valley	*76°52.82'	161°13.82'			
East, middle and south west end	NA	NA	soil	Medium (n=20, 40%)	This paper, collected in 1995
Battleship Promontory	*76°54.85'	160°59.34'			
-	NA	NA	soil	Medium (n=17, 88%)	This paper, collected in 1993
-	76°55.30'	161°04.79'	soil	M-high (n=9, 22%)	This paper, collected in 1994
-	NA	NA	soil	Medium (n=6, 83%)	This paper, collected in 1996
-	76°52.00'	161°05.00'	soil	Present	(Courtright et al. 2000)
Southwestern Bluff	76°55.00'	161°03.00'	soil	Medium (n=14, 57%)	This paper, collected in 2001
-	76°55.30'	161°04.22'	soil	Medium (n=6, 83%)	This paper, collected in 2003
Barwick Valley	*77°20.71'	161°06.09'	soil	Medium (n=10, 40%)	This paper, collected in 1994
Beacon Valley	*77°49.00'	160°39.00'	soil	Low (n=24, 4%)	This paper, collected in 1990
Garwood Valley	*78°02.00'	164°10.00'			
-	NA	NA	soil	High (n=6, 100%)	This paper, collected in 1993
-	78°02.00'	164°10.00'	soil	Medium	(Wall Freckman and Virginia 1998)
-	78°02.00'	164°10.00'	soil	Present	(Courtright et al. 2000)
-	NA	NA	soil	V-high (n=13, 100%)	This paper, collected in 2002

Biogeographic location	Lat (S)	Long (E)	Habitat	Abundance	Reference
McKelvey Valley	*77°26.00'	161°33.00'			
Upper	NA	NA	soil	High (n=18, 50%)	This paper, collected in 1990
Lower	NA	NA	soil	Low (n=14, 14%)	This paper, collected in 1990
Miers Valley	*78°06.00'	164°00.00'			
Miers Glacier	*78°05.00'	163°40.00'	moraine	Present	(Timm 1971)
-	NA	NA	soil	M-high (n=24, 88%)	This paper, collected in 1990
Taylor Valley	*77°38.82'	163°03.08'			
Canada Glacier	*77°37.00'	162°59.00'	soil	Present	(Timm 1971)
Lacroix Glacier	*77°40.00'	162°33.00'			
Between Lake Bonney and Lacroix Glacier	NP	NP	small runoff stream	Present	(Timm 1971)
Southeast of Lacroix Glacier	*77°40.00'	162°30.00'	sandy soil	Present	(Timm 1971)
Lake Bonney	*77°43.00'	162°25.00'			
South side East Lobe	77°42.92'	162°27.65'	soil	Low (n=9, 29%)	This paper, collected in 1993
	NA	NA	soil polygons	Medium (n=99, 64%)	This paper, collected in 1994
-	NA	NA	soil	Medium (n=2, 50%)	This paper, collected in 1995
-	77°42.92'	162°27.65'	soil	Low	(Courtright et al. 1996)
-	NP	NP	soil polygons	Medium	(Moorhead et al. 1999)
South side West Lobe	77°42.5'	162°31.2'	soil	Medium (n=18, 94%)	This paper, collected in 1999, 2001 and 2002 (Simmons et al. 2009)
-	77°42.92'	162°27.65'	soil	Present	(Courtright et al. 2000)
-	NA	NA	soil and stream sediment	Medium (n=20, 45%)	This paper, collected in 2000
South side West Lobe	NA	NA	soil	M-low (n=96, 45%)	This paper, collected in 2000, 2002 and 2003
South side East Lobe	77°42.55'	162°27.39'	soil	Low	(Courtright et al. 2001)
Lake Chad	*77°38.55'	162°45.70'	soil	Medium (n=9, 22%)	This paper, collected in 1995
-	77°38.10'	162°48.15'	soil	Present	(Boström et al. 2011)
Lake Fryxell	*77°36.58'	163°09.10'			
-	NA	NA	soil	Medium (n=26, 23%)	This paper, collected in 1990
South side	77°35.94'	163°22.68'	soil	V-high (n=9, 100%)	This paper, collected in 1993
-	77°35.94'	163°22.68'	soil	High (n=10, 80%)	This paper, collected in 1993
-	NA	NA	soil	High (n=102, 87%)	This paper, collected in 1994

Biogeographic location	Lat (S)	Long (E)	Habitat	Abundance	Reference
-	NA	NA	soil	Medium (n=4, 75%)	This paper, collected in 1995
-	77°35.94'	163°22.68'	soil	V-high	(Courtright et al. 1996)
Von Guerard (F6) stream	77°36.49'	163°14.95'	soil	V-high (n=30, 100%)	This paper, collected in 1996, 1997, 1998, 2001 and 2003
-	NA	NA	soil	V-high (n=5, 100%)	This paper, collected in 1997
Von Guerard Stream/ Harnish Creek network	*77°37.00'	163°15.00'	soil and stream sediments	Medium	(Treonis et al. 1999)
-	NP	NP	soil polygons	High	(Moorhead et al. 1999)
Huey Creek stream	*77°36.00'	163°06.00'	soil	Medium (n=7, 29%)	This paper, collected in 1999
Von Guerard stream	*77°37.00'	163°15.00'	soil	High (n=8, 100%)	This paper, collected in 1999
South side F6 stream	77°36.49'	163°14.92'	soil	V-high (n=12, 100%)	This paper, collected in 1999 and 2001
-	[A]77°55.94'	163°22.68'	soil	Present	(Courtright et al. 2000)
Harnish Creek transect	*77°37.00'	163°13.00'	soil and stream sediment	M-high (n=20, 90%)	This paper, collected in 2000
South side by F6 (SF)	NA	NA	soil	V-high (n=96, 100%)	This paper, collected in 2000, 2002 and 2003
South-east shore	77°35.56'	163°22.41'	soil	V-high	(Courtright et al. 2001)
-	77°36.00'	[A]162°15.00'	soil	V-high	(Treonis et al. 2002)
South side near F6	77°36.40'	163°15.30'	soil and lake sediment	High (n=12, 67%)	This paper, collected in 2002
South side near Green Creek	77°37.36'	163°03.91'	soil	M-high (n=20, 85%)	This paper, collected in 2003
South side near F6	77°36.72'	163°15.18'	soil	High (n=20, 90%)	This paper, collected in 2003
Von Guerard stream	77°37.00'	163°15.00'	soil	High	(Barrett et al. 2006c)
Green Creek	77°37.36'	163°03.91'	soil	M-High	(Barrett et al. 2006c)
Lake Hoare	*77°38.00'	162°51.00'			
North side	77°37.49'	162°54.31'	soil	M-low (n=18, 100%)	This paper, collected in 1993
South side	77°38.03'	162°52.75'	soil	High (n=9, 100%)	This paper, collected in 1993
South side	77°37.59'	162°52.57'	soil	High (n=56, 100%)	This paper, collected in 1993, 1994, 1995, 1996, 1997 and 2001
North side	77°38.00'	162°53.00'	soil (0-2.5, 2.5-5, 5-10, 10-20 cm	High	(Powers et al. 1994a; 1995a)
South shore	NP	NP	soil at varying elevation	Medium	(Powers et al. 1998)
-	NA	NA	soil polygons	High (n=104, 96%)	This paper, collected in 1994
South side	77°38.02'	162°52.23'	soil	High (n=40, 83%)	This paper, collected in 1994, 1995, 1996, 1997 and 2001
North side	77°38.00'	162°53.00'	soil	Medium	(Powers et al. 1995a)
South side	77°38.00'	162°53.00'	soil at varying elevation	M-high	(Powers et al. 1995a)

Biogeographic location	Lat (S)	Long (E)	Habitat	Abundance	Reference
South side	77°38.00'	162°53.00'	soil (0-2.5, 2.5-5, 5-10, 10-20 cm)	Medium	(Powers et al. 1995b)
South side	NA	NA	soil polygons	M-high (*n*=24, 100%)	This paper, collected in 1995
North side	77°37.49'	162°54.31'	soil	M-low	(Courtright et al. 1996)
South side	77°38.03'	162°52.75'	soil	M-high	(Courtright et al. 1996)
-	NP	NP	soil	Medium	(Freckman and Virginia 1997)
South side	NA	NA	soil	M-high (*n*=12, 100%)	This paper, collected in 1997
South side	77°38.00'	162°53.00'	soil	Medium	(Powers et al. 1998)
-	NP	NP	soil polygons	High	(Moorhead et al. 1999)
North side	NA	NA	soil	V-high (*n*=8, 100%)	This paper, collected in 1999
South side	NA	NA	soil	M-high (*n*=8, 100%)	This paper, collected in 1999
South side	77°38.07'	162°52.59'	soil	M-high (*n*=18, 100%)	This paper, collected in 1999, 2001 and 2002
North side	77°37.49'	162°54.31'	soil	Present	(Courtright et al. 2000)
South side	77°38.03'	162°52.75'	soil	Present	(Courtright et al. 2000)
South side	77°38.00'	162°53.00'	soil	M-high	(Treonis et al. 2000)
North side	77°37.29'	162°54.19'	soil	M-low	(Courtright et al. 2001)
South side	77°38.02'	162°52.45'	soil	M-high	(Courtright et al. 2001)
South side	77°38.00'	162°53.00'	soil	M-high	(Porazinska et al. 2002b)
-	77°38.00'	162°53.00'	soil	Medium	(Treonis et al. 2002)
-	77°37.90'	162°53.20'	soil and lake sediments	M-high (*n*=11, 73%)	This paper, collected in 2002
-	NP	NP	soil	Present	(Overhoff et al. 1993)
North side	NP	NP	lake bottom detritus	Present	(Vinciguerra 1994)
-	77°37.00'	160°50.00'	soil	Medium	(Wall Freckman and Virginia 1998)
South side	NA	NA	wetlands (upland ponds)	M-low (*n*=48, 19%)	This paper, collected in 2000
-	NP	NP	soil	High	(Treonis et al. 2000)
-	NP	NP	0-5 cm soil (exposed and subnivian)	High	(Gooseff et al. 2003)
South side	NP	NP	bare soil >80 m from wetlands (upland ponds)	Medium	(Moorhead et al. 2003)
Mummy Pond	77°40.06'	162°39.00'	soil	Low (*n*=5, 20%)	This paper, collected in 1997
Nussbaum Riegel	77°38.52'	162°46.89'	soil	V-High (*n*=5, 20%)	This paper, collected in 1997
Victoria Valley	*77°23.00'	162°00.00'			

Biogeographic location	**Lat (S)**	**Long (E)**	**Habitat**	**Abundance**	**Reference**
Lower Victoria Valley	77°21.81'	162°19.11'	soil	High (*n*=10, 60%)	This paper, collected in 1993
NP	77°21.81'	162°19.11'	soil	High (*n*=9, 100%)	This paper, collected in 1993
Lake Vida	*77°23.29'	161°56.05'			
-	NA	NA	soil	Medium (*n*=16, 19%)	This paper, collected in 1990
-	77°23.35'	162°02.60'	soil	Medium (*n*=10, 50%)	This paper, collected in 1993
-	NA	NA	soil	Medium (*n*=11, 27%)	This paper, collected in 1994
-	77°22.58'	161°13.56'	soil	NA (*n*=2, 100%)	This paper, collected in 2000
Vida Met Station	NA	NA	soil	Low (*n*=4, 50%)	This paper, collected in 2002
-	NA	NA	soil	M-high (*n*=10, 80%)	This paper, collected in 1997
-	77°23.00'	162°00.00'	soil	M-high	(Wall Freckman and Virginia 1998)
-	NA	NA	soil	NA (*n*=6, 83%)	This paper, collected in 2003
Victoria Lower Glacier	*77°18.00'	162°40.00'			
-	77°21.81'	162°19.11'	soil	High	(Courtright et al. 1996)
-	77°22.57'	162°13.56'	soil	NA (*n*=6, 83%)	This paper, collected in 2000
-	77°21.81'	162°19.11'	soil	Present	(Courtright et al. 2000)
South-west	77°21.49'	162°19.07'	soil	High	(Courtright et al. 2001)
Victoria Upper Glacier	*77°16.00'	161°25.00'			
-	77°17.35'	161°33.03'	soil	High (*n*=10, 60%)	This paper, collected in 1993
-	77°17.35'	161°33.03'	soil	Low (*n*=9, 11%)	This paper, collected in 1993
Victoria Upper Lake	*77°19.00'	161°35.00'	soil	M-high (*n*=20, 35%)	This paper, collected in 1990
Wright Valley	*77°31.39'	161°58.70'			
Dais	*77°33.00'	161°16.00'			
-	NP	NP	soil	Present	(Courtright et al. 2000)
-	NA	NA	soil	NA (*n*=3, 100%)	This paper, collected in 2000
East of Meserve Glacier	*77°31.00'	162°17.00'	algal mat	NP	(Timm 1971)
Labyrinth	*77°33.00'	160°50.00'			
West	77°33.04'	160°43.15'	soil	M-low (*n*=9, 100%)	This paper, collected in 1993
-	77°33.04'	160°43.15'	soil	M-low (*n*=9, 78%)	This paper, collected in 1993
-	77°33.04'	160°43.15'	soil	Low	(Courtright et al. 1996)
-	77°31.00'	161°50.00'	soil	M-low	(Wall Freckman and Virginia 1998)
West	77°33.02'	160°43.09'	soil	Low	(Courtright et al. 2001)

Biogeographic location	Lat (S)	Long (E)	Habitat	Abundance	Reference
-	NA	NA	soil	Low (n=12, 17%)	This paper, collected in 2003
Lake Brownworth	*77°26.00'	162°45.00'			
-	NP	NP	soil	Present	(Overhoff et al. 1993)
-	77°26.13'	162°42.61'	soil	M-low (n=9, 33%)	This paper, collected in 1993
-	77°26.13'	162°42.61'	soil	M-low	(Courtright et al. 1996)
-	77°26.13'	162°42.61'	soil	Present	(Courtright et al. 2000)
South-west shore	77°26.08'	162°42.37'	soil	M-low	(Courtright et al. 2001)
Met Station	NA	NA	soil	Medium (n=4, 75%)	This paper, collected in 2002
Bull Pass	*77°28.00'	161°46.00'	soil	Medium (n=22, 23%)	This paper, collected in 1990
Lake Bull	*77°31.51'	161°42.68'	soil	Low (n=12, 17%)	This paper, collected in 1990
-	77°28.00'	161°46.00'	soil	High (n=24, 33%)	(Poage et al. 2008)
Lake Vanda	*77°32.00'	161°33.00'			
Near Lake Vanda	77°32.00'	161°33.00'	soil	Present	(Timm 1971)
Vanda Station	77°31.00'	161°40.00'	soil	M-low (n=2, 100%)	This paper, collected in 2002
Unspecified Locations					
-	NA	NA	soil	M-low (n=5, 80%)	This paper, collected in 1997
-	NA	NA	soil	Present (n=1, 100%)	This paper, collected in 2000
-	NA	NA	soil	Present (n=10, 60%)	This paper, collected in 2003
Koettlitz Glacier and Southern Coastal Regions	*78°15.00'	164°15.00'			
Péwé Lake	*77°56.67'	164°16.87'	stony soil near the lake	Present	(Timm 1971)
Strand Moraines	*77°45.04'	164°29.90'	sandy soil	Present	(Timm 1971)
Marble Point	*77°26.00'	163°50.00'	mossy soil (*Bryum antarcticum*)	Present	(Timm 1971)
Northern Coastal Region					
Cape Hallett	72°19.29'	170°13.52'	soil	Low (n=67, 56%)	(Raymond et al. 2013a)
Crater Cirque	*72°37.49'	169°22.48'	lake bottom detritus and wet mosses	Present	(Vinciguerra 1994)
Edmonson Point	*74°20.00'	165°08.00'			
-	NA	NA	soil	Medium (n=10, 80%)	This paper, collected in 1996
-	NA	NA	soil	Present (n=28, 36%)	This paper, collected in 1996
-	NP	NP	soil	Present	(Bargagli et al. 1997)

Biogeographic location	Lat (S)	Long (E)	Habitat	Abundance	Reference
-	NA	NA	soil	Medium (n=8, 63%)	This paper, collected in 2001
Gondwana Station	74°37.57'	164°11.91'	soil	M-Low (n=371, 79%)	(Raymond et al. 2013a)
Luther Peak	*72°21.88'	169°50.91'			
Luther Cirque	72°22.20'	169°53.10'	soil	Medium (n=40, 85%)	This paper, collected in 2003
Luther Vale North	72°22.00'	169°53.00'	soil	Medium	(Barrett et al. 2006c)
Luther Vale South	72°22.00'	169°53.00'	soil	Medium	(Barrett et al. 2006c)
Terra Nova Bay	*74°54.51'	164°27.19'			
600 km north and south of the Italian station	NP	NP	mosses, lichens, fresh water sediments and penguin excrements (there are no details of whether *S. lindsayae* occurred in all habitats or only in some)	Present	(Vinciguerra et al. 1994)
-	74°20.00'	165°08.00'	soil	Present	(Courtright et al. 2000)

et al. 2001; Porazinska et al. 2002b; Powers et al. 1998) have identified a relationship between greater abundance of *S. lindsayae* and low soil moisture. *S. lindsayae* tolerates a wide range of soil moistures, but is typically absent from flowing meltstreams and saturated soils. Interactions between soil moisture and salinity are complex and create changing osmotic conditions in soils. In a comparative study of dry soil and moist soil under snowpacks no correlation was found between *S. lindsayae* and soil moisture (Gooseff et al. 2003), which could be attributed to changing osmotic potential and salinity. Soil salinity factors (EC and pH) have a significant influence on the distribution of *S. lindsayae* in the Dry Valleys (Freckman and Virginia 1997; Poage et al. 2008; Porazinska et al. 2002b). For example, *S. lindsayae* are found predominantly in soils with an EC<700 mS cm^{-1} (Courtright et al. 2001; Nkem et al. 2006a; Poage et al. 2008), and appear unable to tolerate salinity over 4100 mS cm^{-1} (Nkem et al. 2006a).

S. lindsayae is recorded at a range of elevations, from the McMurdo Dry Valley floors to about 600 and 1300 m above sea level (at Mt. Suess and Battleship Promontory, respectively) in Victoria Land (Moorhead et al. 2003; Porazinska et al. 2002b; Powers et al. 1998; this paper) and 800 m above sea level outside of Victoria Land (Adams et al. 2006). On Ross Island, *S. lindsayae* occurs in soils located away from penguin rookeries and in soils with ornithogenic inputs (Sinclair and Sjursen 2001), but is absent within rookeries (Porazinska et al. 2002a; Sinclair 2001; Yeates et al. 2009). Similar observations are not recorded for Victoria Land. Other studies recording the presence of *S. lindsayae* outside of Victoria Land have found the nematode amongst mosses (e.g. *Saniona uncinata*) and at King George Island, associated with a perennial plant (*Deschampsia antarctica*) (Mouratov et al. 2001; Shishida and Ohyama 1986; Vinciguerra 1994; Wharton and Brown 1989).

Plectus **(Plectida: Plectidae)**

Several *Plectus* species have been described from Antarctica: *P. antarcticus* (de Man 1904), *P. parietinus* (Bastian 1865), *P. parvus* (Bastian 1865), *P. cirratus* (Bastian 1865), *P. belgicae* (de Man 1904), *P. murrayi* (Yeates 1970), *P. acuminatus* (Bastian 1865) and *P. frigophilus* (Kirjanova, 1958). Many species are morphologically similar and several taxonomic statements remain unresolved (Andrássy 1998; Boström 2005; Velasco-Castrillón and Stevens 2014).

Biogeographic distribution. Four *Plectus* species have been recorded from Victoria Land: *P. antarcticus*, *P. frigophilus*, *P. murrayi* and *P. acuminatus*. Specimens of *P. antarcticus* previously described from Victoria Land have been reinterpreted as synonymous with *P. murrayi* (and *P. belgicae* and *P. parvus*) (Kito et al. 1991; Timm 1971; Yeates 1979) such that there are only three currently recognized *Plectus* species in Victoria Land. Most studies have described *Plectus* spp. (*murrayi* and *frigophilus*) from the McMurdo Dry Valleys (Gooseff et al. 2003; Porazinska et al. 2002b; Timm 1971; Wall Freckman and Virginia 1998) with only two studies reporting the occurrence of *Plectus* spp. in other areas of Victoria Land. Bargagli et al. (1997) reported *Plectus* spp.

Table 2. Biogeographic distribution of *Plectus* species in Victoria Land, Antarctica. NP = not published, NA = not available, mur = *P. murrayi*. frig = *P. frigophilus*, where both exist = spp. For abundance, [A]abundance is per kg moss and adhering rock fragments not soil, Low = >0 to 20 nematodes per kg dry soil, M-low = 21 to 200 nematodes per kg dry soil, Medium = 201 to 600 nematodes per kg dry soil, M-high = 601 to 1000 nematodes per kg dry soil, High = 1001 to 2000 nematodes per kg dry soil, V-high = >2000 nematodes per kg dry soil, *n* = number of samples and % = percentage of samples in which *Plectus* occurred. For references to "this paper", the year collected refers to the year at the beginning of the austral summer in which samples were collected to 0-10 cm depth. [B]This publication refers to a map for more details on sample location.

Biogeographic location	Lat (S)	Long (E)	Habitat	Species	Abundance	Reference
McMurdo Dry Valleys	*77°30.00'	162°00.00'				
-	NP	NP	soil	spp.	Present	(Freckman and Virginia 1990)
-	NP	NP	soil	spp.	Low	(Freckman and Virginia 1993)
-	NP	NP	soil	*mur*	Present	(Freckman and Virginia 1997)
-	NP	NP	streams	spp.	Present	(Moorhead et al. 1999)
Alatna Valley	*76°52.82'	161°13.82'				
Battleship Promontory	*76°54.85'	160°59.34'	soil	*mur*	Low (*n*=17, 6%)	This paper, collected in 1993
East, middle and southwestern end	NA	NA	soil	*mur*	Low (*n*=20, 10%)	This paper, collected in 1995
Garwood Valley	*78°02.00'	164°10.00'				
Garwood Lake	*78°02.00'	164°15.00'	NP	*frig*	Present	(Timm 1971)
-	NA	NA	soil	*mur*	M-low (*n*=6, 50%)	This paper, collected in 1993
-	78°02.00'	164°10.00'	soil	*mur*	M-low	(Wall Freckman and Virginia 1998)
-	NA	NA	soil	*mur*	Low (*n*=13, 8%)	This paper, collected in 2002
Miers Valley	*78°06.00'	164°00.00'				
Miers Glacier	*78°05.00'	163°40.00'	mossy soil from glacier foot, runoff stream	*frig*	Present	(Timm 1971)
-	NA	NA	soil	*mur*	M-low (*n*=24, 29%)	This paper, collected in 1990
Taylor Valley	*77°38.82'	163°03.08'				
Canada Glacier	*77°37.00'	162°59.00'				
Near the glacier	NP	NP	soil	*frig*	Present	(Timm 1971)
-	77°37.31'	162°58.26'	windblown sediment on top of glacier	*mur*	Present (*n*=2, 100%)	This paper, collected in 1997
Waterfall (upper west)	NA	NA	cryconite hole	*mur*	Present	This paper, collected in 2001
Lake Bonney	*77°43.00'	162°25.00'				

Biogeographic location	Lat (S)	Long (E)	Habitat	Species	Abundance	Reference
-	NP	NP	lake, soil nearby	*frig*	Present	(Timm 1971)
-	NA	NA	soil polygon cracks	*mur*	Low (*n*=99, 5%)	This paper, collected in 1994
-	NA	NA	soil	*mur*	Medium (*n*=2, 100%)	This paper, collected in 1995
-	NA	NA	algal mat	spp.	Present (*n*=5, 100%)	This paper, collected in 1995
West Lobe	77°43.50'	162°18.95'	soil	*mur*	Low (*n*=18, 33%)	This paper, collected in 1999, 2001 and 2002
-	NA	NA	soil and stream sediment	*mur*	M-low (*n*=20, 30%)	This paper, collected in 2000
West Lobe	NA	NA	soil	*mur*	Low (*n*=72, 7%)	This paper, collected in 2000 and 2003
-	77°43.40'	162°18.40'	soil and sediment	*mur*	Low (*n*=12, 25%)	This paper, collected in 2002
Lake Chad	*77°38.55'	162°45.70'				
-	NP	NP	NP	*frig*	Present	(Timm 1971)
-	NA	NA	algal mat	spp.	NA (*n*=1, 100%)	This paper, collected in 1995
-	NA	NA	soil	*mur*	M-low (*n*=9, 56%)	This paper, collected in 1995
Lake Fryxell	*77°36.58'	163°09.10'				
-	NP	NP	NP	*frig*	Present	(Timm 1971)
-	NP	NP	algae in a drift stream near the lake	spp.	Present	(Wharton and Brown 1989)
-	NA	NA	algal mat	*ant*	M-low (*n*=10, 100%)	This paper, collected in 1990
-	NA	NA	soil	*mur*	M-high (*n*=26, 77%)	This paper, collected in 1990
-	77°35.94'	163°22.68'	soil	*mur*	Low (*n*=10, 10%)	This paper, collected in 1993
-	NA	NA	algal mat	spp.	NA (*n*=1, 100%)	This paper, collected in 1995
-	NA	NA	soil	*mur*	Medium (*n*=4, 75%)	This paper, collected in 1995
Von Guerard stream/ Harnish Creek network	*77°37.00'	163°15.00'	stream sediments and surrounding soils	spp.	M-low	(Treonis et al. 1999)
Huey Creek	*77°36.00'	163°06.00'	soil	*mur*	M-low (*n*=7, 57%)	This paper, collected in 1999
Harnish Creek	*77°37.00'	163°13.00'	soil and sediment	*mur*	M-low (*n*=20, 60%)	This paper, collected in 2000
South side	NA	NA	soil	*mur*	Low (*n*=72, 4%)	This paper, collected in 2000 and 2002
South side	77°36.40'	163°15.30'	soil and sediment	*mur*	V-High (*n*=12, 75%)	This paper, collected in 2002
South side	77°36.49'	163°14.95'	soil	*mur*	Low (*n*=6, 17%)	This paper, collected in 2003
South side	77°36.49'	163°14.92'	soil	*mur*	Low (*n*=6, 17%)	This paper, collected in 2003
South side near Green Creek	77°37.36'	163°03.91'	soil	*mur*	Medium (*n*=20, 60%)	This paper, collected in 2003

Biogeographic location	Lat (S)	Long (E)	Habitat	Species	Abundance	Reference
Green Creek	77°37.36'	163°03.91'	soil	*mur*	Medium	(Barrett et al. 2006c)
Lake Hoare	*77°38.00'	162°51.00'				
North side	77°37.49'	162°54.31'	soil	*mur*	Low (*n*=18, 6%)	This paper, collected in 1993
South side	NP	NP	soil at varying elevation	spp.	Low	(Powers et al. 1994b; 1998)
South side	77°38.00'	162°53.00'	soil (0-2.5, 2.5-5, 5-10, 10-20 cm)	*mur*	Low	(Powers et al. 1995a)
South side	77°37.93'	162°53.19'	soil at varying elevation	*mur*	Low (*n*=150, 6%)	This paper, collected in 1995, 1998 and 2002
North side	77°37.49'	162°54.31'	soil	*mur*	Low	(Courtright et al. 1996)
South side	77°38.00'	162°53.00'	soil	mur	Low	(Powers et al. 1998)
North side	NA	NA	soil	*mur*	M-low (*n*=8, 50%)	This paper, collected in 1999
North side	77°37.29'	162°54.19'	soil	*mur*	Low	(Courtright et al. 2001)
South side	77°38.02'	162°52.23'	soil	*mur*	Low (*n*=8, 13%)	This paper, collected in 2001
South side	77°38.00'	162°53.00'	soil	*mur*	Low	(Porazinska et al. 2002b)
-	77°37.90'	162°53.20'	soil and lake sediment	*mur*	V-High (*n*=11, 82%)	This paper, collected in 2002
South side	77°38.02'	162°53.05'	soil	*mur*	Low (*n*=6, 17%)	This paper, collected in 2003
-	77°37.00'	162°50.00'	soil	*mur*	M-low	(Wall Freckman and Virginia 1998)
-	NP	NP	soil	*mur*	M-low	(Treonis et al. 2000)
South side	NA	NA	high elevation upland pond areas	spp.	Low (*n*=48, 19%)	This paper, collected in 2000
-	NP	NP	0-5 cm soil (subnivian)	*mur*	M-low	(Gooseff et al. 2003)
South side	NP	NP	high elevation upland pond areas	spp.	M-low	(Moorhead et al. 2003)
Taylor Glacier	*77°44.00'	162°10.00'	windblown sediment on top of glacier	*mur*	Present (*n*=1, 100%)	This paper, collected in 1998
Suess Glacier	*77°38.00'	162°40.00'	soil nearby	*frig*	Present	(Timm 1971)
Suess Lake	NP	NP	NP	*frig*	Present	(Timm 1971)
Victoria Valley	*77°23.00'	162°00.00'	soil	*mur*	Present (*n*=6, 17%)	This paper, collected in 2003
Wright Valley	*77°31.39'	161°58.70'				
Along Onyx River	*77°31.31'	161°49.39'	pond	spp.	Present	(Timm 1971)
East of Meserve Glacier	*77°31.00'	162°17.00'	algal mat	spp.	Present	(Timm 1971)
Canopus Pond	NP	NP	NP	*frig*	Present	(Timm 1971)
Lake Vanda	*77°32.00'	161°33.00'	lake, soil nearby	*frig*	Present	(Timm 1971)
Lower Wright Lake (=Lake Brownworth)	*77°26.00'	162°45.00'	NP	*frig*	Present	(Timm 1971)

Biogeographic location	Lat (S)	Long (E)	Habitat	Species	Abundance	Reference
Edge of Lake Canopus	*77°33.00'	161°31.00'	algal growth at the edge of the lake	spp.	Present	(Wharton and Brown 1989)
Between Lake Vanda and Lake Bull	NP	NP	dry algae around the edge of small ponds	spp.	Present	(Wharton and Brown 1989)
Between Lake Vanda and Lake Bull	NP	NP	wet algae in meltwater and around the edge of small ponds	spp.	Present	(Wharton and Brown 1989)
Bull Pass	*77°28.00'	161°46.00'	soil	*mur*	M-low (n=22, 18%)	This paper, collected in 1990
Lake Bull	*77°31.51'	161°42.68'	soil	*mur*	Low (n=12, 8%)	This paper, collected in 1990
-	77°31.00'	161°50.00'	soil	*mur*	M-low	(Wall Freckman and Virginia 1998)
Koettlitz Glacier and Southern Coastal Regions	*78°15.00'	164°15.00'				
Cape Chocolate (just north of)	*77°56.05'	164°34.70'	moraine	*frig*	Present	(Timm 1971)
Marble Point	*77°26.00'	163°50.00'				
-	NP	NP	moss (*Bryum antarcticum*)	*mur*	V-high[A]	(Yeates 1970)
-	NP	NP	mossy soil and melt pools with abundant algae (*Nostoc commune*)	*mur*	Present	(Timm 1971)
-	NP	NP	meltpools w/ abundant algae (*Nostoc commune*), mossy soil	*frig*	Present	(Timm 1971)
Pewe Lake	NP	NP	NP	*frig*	Present	(Timm 1971)
Strand Moraines	*77°45.04'	164°29.90'				
-	NP	NP	mossy soil and melt pools with abundant algae (*Nostoc commune*)	spp.	Present	(Timm 1971)
-	NP	NP	sandy soil, mossy soil, stream with abundant algae	*frig*	Present	(Timm 1971)
Northern Coastal Region						
Cape Hallett	*72°19.00'	170°16.00'				
-	NP	NP	NP	spp.	Present	(Timm 1971)
Willett Cove	72°19.00'	170°14.00'	soil	*mur*	Medium	(Barrett et al. 2006c)
-	NA	NA	soil amongst penguin rookery	*mur*	M-low (n=20, 30%)	This paper, collected in 2003
-	72°19.29'	170°13.52'	soil		Low (n=67, 56%)	(Raymond et al. 2013a)
Edmonson Point	*74°20.00'	165°08.00'				
-[B]	NP	NP	wet moss near a brook	*mur*	Present	(Vinciguerra 1994)
-	NP	NP	soil	spp.	Present	(Bargagli et al. 1997)
-	NA	NA	soil	*mur*	M-high (n=10, 70%)	This paper, collected in 1996

Biogeographic location	Lat (S)	Long (E)	Habitat	Species	Abundance	Reference
-	NA	NA	soil	*mur*	NA (n=28, 50%)	This paper, collected in 1996
-	NA	NA	soil	*mur*	M-low (n=8, 63%)	This paper, collected in 2001
Gondwana Station	74°37.57'	164°11.91'	soil		Low (n=371, 84%)	(Raymond et al. 2013a)
Luther Peak	72°22.20'	169°53.10'	soil	*mur*	Low (n=40, 8%)	This paper, collected in 2003
Luther Vale South	72°22.00'	169°53.00'	soil	*mur*	Low	(Barrett et al. 2006c)
Terra Nova Bay	*74°54.51'	164°27.19'				
600 km north and south of the Italian station	NP	NP	mosses, lichens, fresh-water sediments and penguin excrements (no details of whether *Plectus* occurred in all habitats or only in some)	spp.	Present	(Vinciguerra et al. 1994)
Barclay Glacier						
-	NP	NP	algae growing in meltwater	*mur*	Present	(Wharton and Brown 1989)

from Edmonson Point and Vinciguerra et al. (1994) found *P. antarcticus*, *P. frigophilus* and *P. acuminatus* at Terra Nova Bay.

In the McMurdo Dry Valleys, only *P. murrayi* and *P. frigophilus* occur, with *P. murrayi* the most abundant and widespread (Table 2). *P. murrayi* and *P. frigophilus* (Kito et al. 1991; Shishida and Ohyama 1986) are endemic to the Antarctic, but not solely to Victoria Land. Close to Victoria Land, *P. murrayi* and *P. frigophilus* have been recorded frequently from Ross Island (e.g. Cape Royds, Cape Evans, Cape Crozier, McMurdo Station and Rocky Point) (Dougherty et al. 1960; Murray 1910; Porazinska et al. 2002a; Sinclair 2001; Wharton and Brown 1989) and *P. frigophilus* has been recorded on Dunlop Island (Timm 1971; USGS 2003). *P. antarcticus* occurs primarily in the maritime, and thus most of the recordings of *P. antarcticus* on the continent are assumed to be *P. murrayi* (Andrássy 1998).

Habitat. All *Plectus* spp. of Victoria Land occupy similar habitats. They are present in soils and sediments (Ayres et al. 2007) and are frequently associated with moist environments and areas supporting algae (e.g. *Nostoc commune*) and moss (e.g. *Bryum antarcticum*) (Table 2). This is consistent with the habitats in which *Plectus* spp. are found in other regions of Antarctica (Andrássy 1998; Andrássy and Gibson 2007; Timm 1971; Wharton and Brown 1989; Yeates 1970).

Soil moisture is a critical factor determining the suitability of habitats for *Plectus* spp. Mouratov et al. (2001) studying *Plectus* spp. in the maritime Antarctic found that they had a preference for soil water content of 7-10%. In the McMurdo Dry Valleys, Courtright et al. (2001) similarly observed *P. murrayi* was more likely to occur in habitats with higher moisture contents. This moisture requirement may explain other distributional trends in the occurrence of *Plectus*. In the maritime Antarctic, Mouratov et al. (2001) found *Plectus* spp. abundance to be highest in the deepest soil layer they studied and under the moss, *Saniona uncinata*. In these environments soil moisture is likely to be higher at depth in the soil profile and also under mosses than in bare surface soil habitats. Courtright et al. (2001) also noted that *P. murrayi* were more frequently found in soils with higher NH_4-N, NO_3-N, organic C, and organic C/organic N ratios than other nematode genera (e.g. *Scottnema*). *Plectus* spp. seem to be sensitive to variation in soil salinity and only occur in soils with low EC (<100 mS cm^{-1}), which typically are moist environments where salts have been leached from the soil or sediment. Shishida and Ohyama (1986) noted that *P. frigophilus* seems to prefer habitats of fresh water algae to those of mosses.

Eudorylaimus (Dorylaimida: Dorylaimidae)

There are six recognized *Eudorylaimus* species endemic to continental Antarctica: *E. antarcticus* (Yeates, 1970), *E. nudicaudatus* (Heyns, 1993), *E. shirasei* (Kito, Shishida & Ohyama, 1996), *E. glacialis* (Andrássy, 1998), *E. quintus* (Andrássy 2008) and *E. sextus* (Andrássy 2008). *E. antarcticus* is nearly universally reported as the sole species recovered from Victoria Land, but it has been suggested that this species is widely

Table 3. Biogeographic distribution of *Eudorylaimus* species in Victoria Land, Antarctica. NP = not published. NA = not available. *ant* = *E. antarcticus*. *gla* = *E. glacialis*. For abundance, Low = >0 to 20 nematodes per kg dry soil, M-low = 21 to 200 nematodes per kg dry soil, Medium = 201 to 600 nematodes per kg dry soil, M-high = 601 to 1000 nematodes per kg dry soil, High = 1001 to 2000 nematodes per kg dry soil, V-high = >2000 nematodes per kg dry soil, n = number of samples and % = percentage of samples in which *Eudorylaimus* occurred. [A]There may have been a typographical error in the original publication reporting this longitude. [B]ASPA = Antarctic Specially Protected Area (previously Site of Special Scientific Interest). For references to "this paper", the year collected refers to the year at the beginning of the austral summer in which samples were collected at 0-10 cm depth.

Biogeographic location	Lat (S)	Long (E)	Habitat	Species	Abundance	Reference
McMurdo Dry Valleys	*77°30.00'	162°00.00'				
-	NP	NP	soil	*ant*	Present	(Freckman and Virginia 1990)
-	NP	NP	soil	*ant*, *gla*	M-low	(Freckman and Virginia 1993)
-	NP	NP	soil	*ant*	Present	(Freckman and Virginia 1997)
-	NP	NP	soil, sediment	*ant*	Present	(Moorhead et al. 1999)
Alatna Valley	*76°52.82'	161°13.82'				
Battleship Promontory	*76°54.85'	160°59.34'				
-	NA	NA	soil	*ant*	M-low (n=17, 65%)	This paper, collected in 1993
-	76°55.30'	161°04.79'	moist soil, green with algae and between dolomite rocks	*ant*	Low (n=9, 22%)	This paper, collected in 1994
-	NA	NA	soil	*ant*	M-low (n=6, 17%)	This paper, collected in 1996
Southwestern Bluff	76°55.00'	161°03.00'	soil	*ant*	Low (n=14, 7%)	This paper, collected in 2001
-	NA	NA	soil	*ant*	Low (n=6, 50%)	This paper, collected in 2003
Garwood Valley	*78°02.00'	164°10.00'				
Garwood Lake	*78°01.58'	164°15.42'	NP	*ant*	Present	(Timm 1971)
-	NA	NA	soil	*ant*	M-low (n=6, 100%)	This paper, collected in 1993
-	78°02.00'	164°10.00'	soil	*ant*	M-low	(Wall Freckman and Virginia 1998)
-	NA	NA	soil	*ant*	M-low (n=13, 23%)	This paper, collected in 2002
McKelvey Valley	*77°26.00'	161°33.00'				
Upper	NA	NA	soil	*ant*	M-low (n=18, 33%)	This paper, collected in 1990
Miers Valley	*78°06.00'	164°00.00'				
Miers Glacier (the foot of)	*78°05.00'	163°40.00'	moss	*ant*	Present	(Timm 1971)
Runoff stream from the Miers Glacier	*78°05.00'	163°40.00'	NP	*ant*	Present	(Timm 1971)
Miers Lake	*78°06.00'	163°51.00'	NP	*ant*	Present	(Timm 1971)

Biogeographic location	Lat (S)	Long (E)	Habitat	Species	Abundance	Reference
-	NA	NA	soil	*ant*	M-low (*n*=24, 50%)	This paper, collected in 1990
Taylor Valley	*77°38.82'	163°03.08'				
Lake Bonney	*77°43.00'	162°25.00'				
-	NP	NP	NP	*ant*	Present	(Timm 1971)
-	NA	NA	soil	*ant*	Low (*n*=99, 52%)	This paper, collected in 1994
-	NA	NA	soil	*ant*	M-low (*n*=2, 100%)	This paper, collected in 1995
-	NA	NA	algal mat	*ant*	NA (*n*=5, 60%)	This paper, collected in 1995
-	NP	NP	soil, sediment	*ant*	Low	(Moorhead et al. 1999)
West Lobe	77°43.50'	162°18.95'	soil	*ant*	Low (*n*=18, 61%)	This paper, collected in 1999, 2001 and 2002
-	NA	NA	soil, sediment	*ant*	M-low (*n*=20, 35%)	This paper, collected in 2000
West Lobe	NA	NA	soil	*ant*	Low (*n*=48, 2%)	This paper, collected in 2000
Lake Chad	*77°38.55'	162°45.70'				
-	NP	NP	NP	*ant*	Present	(Timm 1971)
-	NA	NA	soil	*ant*	M-low (*n*=9, 56%)	This paper, collected in 1995
-	NA	NA	algal mat	*ant*	NA (*n*=1, 100%)	This paper, collected in 1995
Lake Fryxell	*77°36.58'	163°09.10'				
-	NP	NP	NP	*ant*	Present	(Timm 1971)
-	NP	NP	algae in a drift stream near the lake	*ant*	Present	(Wharton and Brown 1989)
-	NA	NA	plant material	*ant*	Present (*n*=10, 100%)	This paper, collected in 1990
-	NA	NA	soil	*ant*	Medium (*n*=26, 77%)	This paper, collected in 1990
South side	77°35.94'	163°22.68'	soil	*ant*	Low (*n*=9, 11%)	This paper, collected in 1993
-	NA	NA	soil	*ant*	Low (*n*=102, 41%)	This paper, collected in 1994
South side	77°36.49'	163°18.95'	soil	*ant*	Low (*n*=18, 33%)	This paper, collected in 1996, 1998 and 2001
-	NA	NA	soil	*ant*	Low (*n*=5, 20%)	This paper, collected in 1997
-	NA	NA	algal mat	*ant*	Present (*n*=1, 100%)	This paper, collected in 1998
-	NA	NA	soil	*ant*	Medium (*n*=4, 75%)	This paper, collected in 1998
Von Guerard stream/ Harnish Creek	*77°37.00'	163°15.00'	stream sediments and surrounding soils	*ant*, *gla*	Medium	(Treonis et al. 1999)
-	NP	NP	soil, sediment	*ant*	Low	(Moorhead et al. 1999)
Von Guerard stream	*77°37.00'	163°15.00'	soil	*ant*	M-low (*n*=8, 63%)	This paper, collected in 1999
Huey Creek stream	*77°36.00'	163°06.00'	soil	*ant*	M-low (*n*=7, 29%)	This paper, collected in 1999
South side	77°36.49'	163°14.92'	soil	*ant*	M-low (*n*=12, 83%)	This paper, collected in 1999 and 2001

Biogeographic location	Lat (S)	Long (E)	Habitat	Species	Abundance	Reference
Harnish Creek	*77°37.00'	163°13.00'	soil and stream sediment	*ant*	Medium (*n*=20, 70%)	This paper, collected in 2000
South side	NA	NA	soil	*ant*	M-low (*n*=96, 97%)	This paper, collected in 2000, 2002 and 2003
-	77°36.00'	[A]162°15.00'	soil	*ant*	Low	(Treonis et al. 2002)
South side near F6 stream	77°36.40'	163°15.30'	soil and lake sediment	*ant*	M-low (*n*=12, 33%)	This paper, collected in 2002
South side near Green Creek	77°37.36'	163°03.91'	soil	*ant*	Medium (*n*=20, 45%)	This paper, collected in 2003
South Side near F6 stream	77°36.72'	163°15.18'	soil	*ant*	M-low (*n*=20, 35%)	This paper, collected in 2003
Green Creek	77°37.36'	163°03.91'	soil	*?*	Medium	(Barrett et al. 2006c)
Von Guerard stream	*77°37.00'	163°15.00'	soil	*?*	M-Low	(Barrett et al. 2006c)
Lake Hoare	*77°38.00'	162°51.00'				
North side	77°37.49'	162°54.31'	soil	*ant*	Low (*n*=18, 78%)	This paper, collected in 1993
South side	77°38.03'	162°52.75'	soil	*ant*	Low (*n*=9, 33%)	This paper, collected in 1993
South side	NA	NA	soil	*ant*	Low (*n*=12, 25%)	This paper, collected in 1993
South side	77°37.59'	162°52.57'	soil	*ant*	M-low (*n*=56, 77%)	This paper, collected in 1993, 1994, 1995, 1996, 1997 and 2001
North side	77°38.00'	162°53.00'	soil (0-2.5, 2.5-5, 5-10, 10-20 cm)	*ant*	M-low	(Powers et al. 1994a)
South side	NP	NP	soil at varying elevations	*ant, gla*	M-low	(Powers et al. 1994b)
-	NA	NA	soil polygons	*ant*	Low (*n*=104, 17%)	This paper, collected in 1994
North side	77°38.00'	162°53.00'	soil (0-2.5, 2.5-5, 5-10, 10-20 cm)	*ant*	M-low	(Powers et al. 1995b)
South side	77°38.00'	162°53.00'	soil at varying elevations	*ant*	Low	(Powers et al. 1995a)
South side	NA	NA	soil polygons	*ant*	Low (*n*=24, 54%)	This paper, collected in 1995
South side	77°37.93'	162°53.19'	soil	*ant*	M-low (*n*=150, 51%)	This paper, collected in 1995, 1998 and 2002
North side	77°37.49'	162°54.31'	soil	*ant*	Low	(Courtright et al. 1996)
-	NP	NP	soil	*ant*	M-low	(Freckman and Virginia 1997)
South side	77°38.00'	162°53.00'	soil	*ant, gla*	Medium	(Powers et al. 1998)
-	NP	NP	soil, sediment	*ant*	Low	(Moorhead et al. 1999)
North side	NA	NA	soil	*ant*	Low (*n*=8, 38%)	This paper, collected in 1999
South side	NA	NA	soil	*ant*	M-low (*n*=8, 75%)	This paper, collected in 1999
South side	77°38.00'	162°53.00'	soil	*ant*	M-low	(Treonis et al. 2000; 2002)
North side	77°37.29'	162°54.19'	soil	*ant*	Low	(Courtright et al. 2001)
South side	77°38.07'	162°52.59'	soil	*ant*	Low (*n*=12, 58%)	This paper, collected in 2001, 2002
South side	77°38.00'	162°53.00'	soil	*ant*	M-low	(Porazinska et al. 2002b)
-	77°37.90'	162°53.20'	soil and lake sediment	*ant*	M-low (*n*=11, 64%)	This paper, collected in 2002

Biogeographic location	Lat (S)	Long (E)	Habitat	Species	Abundance	Reference
-	77°37.00'	160°50.00'	soil	*ant*	M-low	(Wall Freckman and Virginia 1998)
-	NP	NP	soil	*ant*	M-low	(Treonis et al. 2000)
-	NP	NP	0-5 cm soil (subnivian)	*ant*	M-low	(Gooseff et al. 2003)
Nussbaum Riegel	77°38.52'	162°46.89'	soil	*ant*	Low (*n*=5, 60%)	This paper, collected in 1997
Suess Glacier, 50 m away	*77°38.00'	162°40.00'	soil	*ant*	Present	(Timm 1971)
Suess Pond	NP	NP	NP	*ant*	Present	(Timm 1971)
Victoria Valley	*77°23.00'	162°00.00'				
Lake Vida	*77°23.29'	161°56.05'	NP	*ant*	Present	(Timm 1971)
Upper	NA	NA	soil	*ant*	Low (*n*=20, 5%)	This paper, collected in 1990
Victoria Upper Glacier	77°17.35'	161°33.03'	soil	*ant*	Low (*n*=10, 43%)	This paper, collected in 1993
-	77°23.00'	162°00.00'	soil	*ant*	Low	(Wall Freckman and Virginia 1998)
-	NA	NA	soil	*ant*	Present (*n*=6, 50%)	This paper, collected in 2003
Wright Valley	*77°31.39'	161°58.70'				
Between Lake Vanda and Lake Bull	NP	NP	dry algae around the edge of small ponds	*ant*	Present	(Wharton and Brown 1989)
Dais	*77°33.00'	161°16.00'	soil	*ant*	Low (*n*=3, 67%)	This paper, collected in 2000
East of Meserve Glacier	*77°31.00'	162°17.00'	algal mat	*ant*	Present	(Timm 1971)
Labyrinth	*77°33.00'	160°50.00'				
West	77°33.04'	160°43.15'	soil	*ant*	Low (*n*=9, 89%)	This paper, collected in 1993
-	77°33.04'	160°43.15'	soil	*ant*	Low (*n*=9, 11%)	This paper, collected in 1993
-	77°33.04'	160°43.15'	soil	*ant*	Low	(Courtright et al. 1996)
West	77°33.02'	160°43.09'	soil	*ant*	Low	(Courtright et al. 2001)
-	NA	NA	soil	*ant*	Low (*n*=12, 8%)	This paper, collected in 2003
Bull Pass	*77°28.00'	161°46.00'	soil	*ant*	Low (*n*=12, 33%)	This paper, collected in 1990
Bull Lake	*77°31.51'	161°42.68'	soil	*ant*	Low (*n*=22, 5%)	This paper, collected in 1990
-	*77°28.00'	161°46.00'	soil	*ant*	M-Low (*n*=24, 12.5%)	(Poage et al. 2008)
Lake Vanda	*77°32.00'	161°33.00'				
-	NP	NP	NP	*ant*	Present	(Timm 1971)
Near Lake Vanda and Péwé Lake	*77°32.00'	161°33.00'	stony soil	*ant*	Present	(Timm 1971)
Met Station	NA	NA	soil	*ant*	M-low (*n*=2, 100%)	This paper, collected in 2002

Biogeographic location	Lat (S)	Long (E)	Habitat	Species	Abundance	Reference
Lake Brownworth	*77°26.00'	162°45.00'	NP	*ant*	Present	(Timm 1971)
-	NA	NA	soil	*ant*	Low (*n*=5, 60%)	This paper, collected in 1997
-	77°31.00'	161°50.00'	soil	*ant*	M-low	(Wall Freckman and Virginia 1998)
-	NA	NA	soil	*ant*	Present (*n*=10, 50%)	This paper, collected in 2003
Onyx River pond	*77°32.00'	161°45.00'	NP	*ant*	Present	(Timm 1971)
Linnaeus Terrace ASPA[B]	77°35.83'	161°05.00'	soil	*ant*	Low (*n*=16, 6%)	This paper, collected in 1990
Koettlitz Glacier and Southern Coastal Regions	*78°15.00'	164°15.00'				
Cape Chocolate (north)	*76°56.00'	164°35.00'	moraine	*ant*	Present	(Timm 1971)
Strand Moraines	*77°45.04'	164°29.90'	algal mat (in stream bed), sandy soil	*ant*	Present	(Timm 1971)
Marble Point	*77°26.00'	163°50.00'	NP	*ant*	Present	(Timm 1971)
Northern Coastal Regions						
Cape Adare	*71°17.00'	170°14.00'	NP	*ant*	Present	(Timm 1971)
Cape Hallett	*72°19.00'	170°16.00'				
Hallett Station	*72°19.00'	170°16.00'	NP	*ant*	Present	(Timm 1971)
-	NA	NA	soil	*ant*	Low (*n*=20, 20%)	This paper, collected in 2003
Cape Hallett	72°19.29'	170°13.52'	soil		Low (*n*=67, 67%)	(Raymond et al. 2013a)
Edmonson Point	*74°20.00'	165°08.00'				
-	NA	NA	soil	*ant*	Low (*n*=10, 30%)	This paper, collected in 1996
-	NA	NA	soil	*ant*	Present (*n*=28, 7%)	This paper, collected in 1996
-	NP	NP	NP	*ant*, *gla*	Present	(Bargagli et al. 1997)
-	NA	NA	soil	*ant*	Low (*n*=8, 25%)	This paper, collected in 2001
Gondwana Station	74°37.57'	164°11.91'	soil	*ant*	Low (*n*=371, 37%)	(Raymond et al. 2013a)
Luther Peak	*72°21.88'	169°50.91'	soil	*ant*	M-low (*n*=40, 85%)	This paper, collected in 2003
Luther Vale North	72°22.00'	169°53.00'	soil	*?*	M-Low	(Barrett et al. 2006c)
Luther Vale South	72°22.00'	169°53.00'	soil	*?*	M-Low	(Barrett et al. 2006c)
Terra Nova Bay	*74°54.51'	164°27.19'				
600 km north and south of the Italian station	NP	NP	mosses, lichens, fresh-water sediments and penguin excrement (there are no details of whether *Eudorylaimus* occurred in all habitats or only in some)	*ant*	Present	(Vinciguerra et al. 1994)
Barclay Glacier	NP	NP	algae in meltwater	*ant*	Present	(Wharton and Brown 1989)

codistributed with *E. glacialis* (Andrássy 2008). We report both where two distinct morphotypes were observed.

Biogeographic distribution. *E. antarcticus* is widely distributed within Victoria Land (Table 3). Steiner (1916) described the original specimens, which were collected by the Discovery Expedition from Discovery Bay (no notes were made on habitat). Later studies list *E. antarcticus* from locations throughout the McMurdo Dry Valleys, (reported most frequently from Taylor Valley) and in northern Victoria Land at Edmonson Point and Terra Nova Bay (Table 3).

Outside of the Victoria Land region, *E. antarcticus* has been reported from several of the maritime islands (Signy, Alexander, King George, Anvers) (e.g. Maslen 1982; Mouratov et al. 2001; Shishida and Ohyama 1989; Spaull 1973a, b; Wharton and Block 1993). Andrássy (1998, 2008), in contrast, argues for a more restricted distribution within Victoria Land (Andrássy 2008).

Habitat. *E. antarcticus* in Victoria Land occurs at varying elevation and most commonly in soils and in lake sediments. The genus has also frequently been associated with algal mats, both dry and moist found in meltwater, streambeds and lakes. *E. antarcticus* has been reported less frequently in areas of moss and from soils. In contrast, outside Victoria Land (e.g. Ross Island) the occurrence of *E. antarcticus* in a moss habitat (e.g. *Bryum argenteum*) is common, but it does not occur in penguin rookeries (on Ross Island or in Victoria Land). In soils of the McMurdo Dry Valleys *E. antarcticus* tends to be found in soils with higher moisture, NH_4-N, NO_3-N, organic C, and organic C/organic N ratios, and only occurs in soils with low salinity (EC <100 mS cm^{-1}) (Courtright et al. 2001).

Panagrolaimus (Panagrolaimida: Panagrolaimidae)

Biogeographic distribution. The Antarctic *Panagrolaimus* consists of two species, *P. magnivulvatus* and *P. davidi* (but see Raymond et al. 2013b). Both are endemic (Andrássy 1998). *P. davidi* is the only species recorded from Victoria Land and its occurrence is rare (see Table 4). Until the present study, the only record of *P. davidi* in Victoria Land was from Marble Point (Timm 1971). The current study shows that *P. davidi* is also present in the northern coastal region of Victoria Land, at Edmonson Point and Cape Hallett and in Miers Valley, one of the McMurdo Dry Valleys. Thus, *P. davidi* occurs most frequently in coastal regions but is not necessarily restricted to them.

P. davidi has been recorded from Ross Island (e.g. Freckman and Virginia 1993; Porazinska et al. 2002a; Sinclair 2001; Sinclair and Sjursen 2001; Timm 1971; Wharton and Brown 1989). *Panagrolaimus* spp. have also been reported from several of the maritime islands (summarized in Andrássy 1998 and references therein, see also Raymond et al. 2013b).

Habitat. Penguin rookeries and moss-covered soils appear to be the most favorable habitats for *P. davidi* in Victoria Land and are consistent with the habitats where *P. davidi* has been found in other Antarctic ice-free areas (Porazinska et al. 2002a; Sin-

Table 4. Biogeographic distribution of *Panagrolaimus davidi* in Victoria Land, Antarctica. NP = not published. NA = not available. For references to "this paper", the year collected refers to the year at the beginning of the austral summer in which samples were collected. For abundance, M-low = 21 to 200 nematodes per kg dry soil, Medium = 201 to 600 nematodes per kg dry soil, n = number of samples and % = percentage of samples in which *Panagrolaimus* occurred.

Biogeographic location	Lat (S)	Long (E)	Habitat	Abundance	Reference
McMurdo Dry Valleys	*77°30.00'	162°00.00'			
Miers Valley	*78°06.00'	164°00.00'	soil	M-low (n=24, 29%)	This paper, collected in 1990
Southern Coastal Region					
Marble Point	*77°26.00'	163°50.00'	mossy soil (*Bryum antarcticum*)	Present	(Timm 1971)
Northern Coastal Region					
Cape Bird	77°13.00'	166°26.00'	soil in penguin rookery	Medium (n=29, 52%)	(Porazinska et al. 2002a)
Cape Crozier	77°27.00'	169°11.00'	soil in penguin rookery	M-low (n=27, 48%)	(Porazinska et al. 2002a)
Cape Hallett	*72°19.00'	170°16.00'			
-	NA	NA	soil in penguin rookery	Low (n=2, 50%)	This paper, collected in 2002
Willet Cove	72°19.00'	170°14.00'	soil	M-High	(Barrett et al. 2006c)
Seabee Spit	72°18.83'	170°13.00'	soil	Low	(Barrett et al. 2006c)
Cape Hallett	72°19.29'	170°13.52'	soil	M-Low (n=56, 56%)	(Raymond et al. 2013a)
Cape Royds	77°33.00'	166°10.00'	soil amongst penguin rookery	M-low (n=66, 20%)	(Porazinska et al. 2002a)
-	NA	NA	soil pits amongst penguin rookery	Med (n=20, 70%)	This paper, collected in 2003
Edmonson Point	*74°20.00'	165°08.00'	soil	Present (n=28, 4%)	This paper, collected in 1996
Gondwana Station	74°37.57'	164°11.91'	soil	M-Low (n=371, 34%)	(Raymond et al. 2013a)

clair 2001; this paper; Timm 1971; Wharton and Brown 1989). Evidence indicates *P. davidi* occurs in habitats of high primary productivity and soil organic matter (as does *P. magnivulvatus*) regardless of its source of origin (e.g. mosses or penguin guano) though it is primarily associated with penguin rookeries (Porazinska et al. 2002a; Sinclair and Sjursen 2001). The presence of *P. davidi* is strongly correlated with organic carbon, organic nitrogen, chlorophyll *a* (a measure of primary productivity) and ammonium (Porazinska et al. 2002a; Sinclair and Sjursen 2001). The species is also more abundant in the highly productive areas of moss and algae along snow melt streams than in adjacent soils (Sinclair and Sjursen 2001).

Geomonhystera (Monhysterida: Monhysteridae)

Several nematode species originally described as *Monhystera* were redescribed by Andrássy in 1981 as *Geomonhystera*. Among these was *Monhystera villosa* from the Antarctic (Timm 1971), which Andrássy subsequently redescribed as a new species, *Geomonhystera antarcticola* (Andrássy 1998). It is the only known species of *Geomonhystera* on the continent, thus, we report all published observations of the genus from Victoria Land as *G. antarcticola*.

Biogeographic distribution. *G. antarcticola* are generally rare, and along with *P. davidi* are the least abundant and most patchily distributed of all nematodes in Victoria Land. Other species of *Geomonhystera* occur in the islands of the maritime Antarctic (Signy, Coronation, Elephant, Intercurrence and Galindez) where *G. antarcticola* is one of the most common nematode species (Maslen 1981; Newsham et al. 2004; Spaull 1973a, b, c). They were originally recorded as Monhysterid genus A. and renamed as *Monhystera villosa* by Maslen (1979). Newsham et al. (2004) identified specimens from Signy Island as *G. villosa*.

Sohlenius et al. recorded *Monhystera* from the Nunataks of Dronning Maud Land, East Antarctica (Sohlenius et al. 1995, 1996), and they have also been recovered from Macquarie Island of the Sub-Antarctic (Bunt 1954) and Signy Island of the maritime Antarctic (Caldwell 1981; Maslen 1981; Spaull 1973a, b, c; Wharton and Block 1993) but only identified as *Monhystera* spp., so it is unknown whether these nematodes could also be *Geomonhystera*. Some previously recorded *Monhystera* of the subantarctic (*M. vulgaris*, and *M. filiformis*) (Bunt 1954) are not *Geomonhystera* but more likely *Eumonhystera* (Andrássy 1981) or *Halomonhystera* (Andrássy 2006).

Habitat. The habitat of *Geomonhystera* in Victoria Land differs from that of *Geomonhystera* as described by Andrássy (1981), and for *Geomonhystera* of the maritime Antarctic, and *Monhystera* spp. of the maritime Antarctic and Dronning Maud Land. In Victoria Land, *Geomonhystera* are similarly found in soil, but have also been associated with algal mats (e.g. Timm 1971; Wharton and Brown 1989) and moss carpets (Andrássy 1998, this paper). *Monhystera* spp. described from the Nunataks of Dronning Maud Land (Sohlenius et al. 1995; 1996) have only been found under lichens but there is no apparent link between *Geomonhystera* of Victoria Land and lichens.

Table 5. Biogeographic distribution of *Geomonhystera antarcticola* in Victoria Land, Antarctica. NP = not published. NA = not available. For references to "this paper", the year collected refers to the year at the beginning of the austral summer in which samples were collected. For abundance, Low = >0 to 20 nematodes per kg dry soil, M-low = 21 to 200 nematodes per kg dry soil, *n* = number of samples and % = percentage of samples in which *Geomonhystera* occurred.

Biogeographic location	Lat (S)	Long (E)	Habitat	Abundance	Reference
McMurdo Dry Valleys	*77°30.00'	162°00.00'			
Alatna Valley	*76°52.82'	161°13.82'			
Battleship Promontory	*76°54.85'	160°59.34'			
-	NA	NA	soil	Low (*n*=17, 47%)	This paper, collected in 1993
Southwestern Bluff	76°55'.00	161°03'.00	soil	Low (*n*=14, 14%)	This paper, collected in 2001
-	NA	NA	soil	Low (*n*=6, 50%)	This paper, collected in 2003
Taylor Valley	*77°38.82'	163°03.08'			
Lake Bonney	*77°43.00'	162°25.00'	soil	M-low (*n*=2, 50%)	This paper, collected in 1998
Wright Valley	*77°31.39'	161°58.70'			
183 m east of Meserve Glacier	*77°31.00'	162°17.00'	algal mat on soil	Present	(Timm 1971)
Between Lake Vanda and Lake Bull	NP	NP	dry algae from the edge of a small pond	Present	(Wharton and Brown 1989)
-			soil	Low (*n*=10, 20%)	This paper, collected in 2003
Northern Coastal Region					
Edmonson Point	*74°20.00'	165°08.00'	soil	Present	(Bargagli et al. 1997)

Table 6. Ecology of Nematode Genera in Victoria Land.

Genus	Co-occurs with	Nematode community complexity	Feeding	Reproduction
Scottnema	*Eudorylaimus*, *Plectus*, *Geomonhystera*, *Panagrolaimus* (rare, only in Dry Valleys; Bargagli et al. 1997; Courtright et al. 2001; this paper),	1 species- most common 2 species- often (usually *E. antarcticus*), 3 or 4 species- rare 5 species- not recorded (Courtright et al. 2001; Freckman and Virginia 1997; this paper)	bacteria, yeast (Overhoff et al. 1993)	amphimictic (Overhoff et al. 1993)
Plectus	*Scottnema*, *Eudorylaimus*, *Geomonhystera*, *Panagrolaimus*	1 species- rare 2 species- most common (usually with *Eudorylaimus*), 3- often 4 species- rare 5 species- not recorded	bacteria (Wharton and Brown 1989)	usually unisexual (parthenogenic), males do exist but are very rare (Andrássy 2008; Kito et al. 1991; Vinciguerra 1994)
Eudorylaimus	*Scottnema*, *Plectus*, *Geomonhystera*, *Panagrolaimus*	1 species- not recorded 2 species- most common (usually with *Scottnema* or *Plectus*), 3- often 4 species- rare 5 species- not recorded	*Eudorylaimus* are thought to feed on fungi, unicellular algae and soil invertebrates (Raymond et al. 2013a; Yeates et al. 1993); presence of chloroplasts in esophagus (Wall 2007)	amphimictic (*E. antarcticus*) (Yeates 1970)
Panagrolaimus	*Scottnema* (rare, only in Dry Valleys), *Eudorylaimus*, *Plectus*	1 species- common (most common outside of Victoria Land) 2 species- rare 3- common (with *Eudorylaimus* and *Plectus*), 4 species- rare, only in Dry Valleys 5 species- not recorded (Porazinska et al. 2002a; this paper)	bacteria (Wharton 1994; Wharton and Barclay 1993)	amphimictic (Timm 1971)
Geomonhystera	*Scottnema*, *Eudorylaimus*, *Plectus*	1 species- not recorded 2 species- often (with *E. antarcticus*) 3- most common (with *S. lindsayae* and *E. antarcticus*) 4 species- often 5 species- not recorded (this paper)	algae, fungi, actinobacteria (Newsham et al. 2004)	amphimictic (Andrássy 1981; Timm 1971)

Discussion

Nematode diversity in Victoria Land is low compared to the Antarctic Peninsula, but the presence of a few cryptic species is likely (Barrett et al. 2006c; Raymond et al. 2013b). Extensive sampling across broader geographic scales, combined with molecular techniques will likely recover additional species from both locations. With the exception of *Panagrolaimus davidii* and *Geomonhystera* spp., all species are widely distributed throughout Victoria Land, from the south coast and the most southern McMurdo Dry Valleys to the northern coastal region. This distribution suggests that their dispersal is ubiquitous and primarily by wind while in anhydrobiois (Nkem et al. 2006b), and it is the suitability of the soil habitat that determines the likelihood of population and community establishment and functioning (Virginia and Wall 1999).

Our knowledge of nematode biodiversity, distribution, and function in Victoria Land is based on clusters of studies from a few distinct regions, such as the McMurdo Dry Valleys, and far northern coastal Victoria Land, which are accessible from established research stations. The rest of Victoria Land (including other inland ice-free areas) has been largely inaccessible. Studies throughout the McMurdo Dry Valleys are also patchy with some valleys being studied heavily (e.g. Taylor Valley) whilst others (e.g. Barwick Valley) have barely been investigated. More undescribed nematodes may occur in these less studied regions.

Conclusions

Habitat suitability for each nematode species is determined primarily by variations in soil factors such as quantities and types of organic material, moisture and salinity (Nkem et al. 2006a; Virginia and Wall 1999). *Scottnema lindsayae* is the most abundant and widespread nematode and has a unique tolerance for a wide range of extreme soil habitats, and it is also the most tolerant to low soil moisture and high salinity of all the nematode species studied. These conditions define the most common soil habitats throughout the cold desert ecosystems of Victoria Land and explain the high abundance and broad distribution of *S. lindsayae* throughout the region. There are less extensive suitable habitats available in Victoria Land for *Plectus* spp. and *Eudorylaimus antarcticus* as their distributions are limited to habitats with higher moisture, greater organic material and lower salinity. *P. davidii* has a very limited biogeographic distribution, almost entirely restricted to coastal Victoria Land. This species is found in habitats with high primary productivity, of which there are few. Factors defining suitable habitats and the biogeographic distribution of *Geomonhystera* spp. in Victoria Land are the least understood, largely due to very low abundance and limited occurrence, although they have been recovered from sites across Victoria Land. There appears to be an association with algae but little else is known of their habitat requirements.

We have made considerable progress in understanding the basic relationships between soil properties and the distribution of the key nematode taxa throughout

Victoria Land. Suitable habitats can be defined by moisture, salinity, organic matter and nutrient content, and the interactions between these factors. Manipulations of soil moisture and field observations of environmental change during pulse warming events show that nematode community composition can respond on time scales of seasons to decades (Ayres et al. 2010; Doran et al. 2002). The climate of Victoria Land is expected to change with warmer conditions (Adams et al. 2009; Jones et al. 1998; Salby et al. 2011; Solomon et al. 2007; Steig et al. 2009; Thompson and Solomon 2002) leading to increasing soil moisture, redistribution of salts, and potentially higher productivity (Gooseff et al. 2011; Nielsen et al. 2012). These changes may alter the spatial distributions of suitable habitats for individual nematode species and/or alter population size and community diversity (Nielsen et al. 2011b). Studies have shown the important role of nematodes in carbon cycling, suggesting that changes in nematode biogeography will be linked with changes in ecosystem functioning in Antarctic soils (Barrett et al. 2008).

The nematofauna of Victoria Land are capable of long distance dispersal by wind (Nkem et al. 2006b) but the Antarctic continent is effectively isolated from source populations elsewhere in the southern hemisphere (Convey et al. 2008; Convey and Stevens 2007). This leaves anthropogenic dispersal by way of tourists and scientists as the primary mechanism for the movement of alien species to Antarctica (Chown et al. 2012a). From a field sample collected in Wright Valley in the 2011-2012 field season, we recovered an individual living female *Cuticularia fermata*, a nematode heretofore known only from South Orkney Island (subantarctic island). Whether this specimen was transported to the site on clothing or equipment used by scientists or if there are established, low-density, isolated populations in the area is unknown. It is highly likely that the frequency of nematode introductions to Victoria Land will increase as tourism and scientific research increases (Chown et al. 2012a). There is a growing international consensus that action is needed to reduce the potential introductions of invasive soil species to continental Antarctica and the Peninsula and maritime regions (Chown et al. 2012b). A greater knowledge of nematode biogeography will be essential in understanding how to protect special soil habitats to preserve existing biodiversity and to prevent the introduction of non-native species and the potential harm they cause to the unique soil ecosystems of Antarctica.

Acknowledgements

We thank Rich Alward, Jackie Aislabie, Megan Balks, Jeb Barrett, Yvonne Baskin, Steve Blecker, Pella Brinkman, Dan Bumbarger, Melody Burkins, Iain Campbell, Katie Catapano, C. Page Chamberlain, Tom Cioppa, Ericha Courtright, Nicole DeCrappeo, Joel Feldman, John Freckman, Jerry Garcia, Ian Hawes, Mengchi Ho, David Hopkins, Mary Kratz, Ed Kuhn, Kevin Levine, Elizabeth Marlies, Jen Mercer, Johnson Nkem, Phil Novis, Andy Parsons, Mike Poage, Dorota Porazinska, Laura Powers, Rusty Rodriguez, Jim Schulz, Rebekka Stucker, Amy Treonis, Lewis White, Roger Worland, and David

Wynn-Williams for help collecting and processing soil samples. Ethan Adams, Eric Sokol and Ian Hogg helped process the *Cuticularia fermata* sample, which was collected as part of the NZ TABS project (http://nztabs.ictar.aq). This work could not have been completed without the dedicated, expert helicopter support provided by personnel of the US Coast Guard, US Navy VXE-6, Petroleum Helicopters Inc., and logistic and science support by ITT, Antarctic Support Associates, and Raytheon Polar Services. Brad Herried and Paul Morin of the Polar Geospatial Center (http://www.pgc.umn.edu) helped generate Figure 1. We very much appreciate the thoughtful, constructive criticisms of three anonymous reviewers. This research was supported by National Science Foundation Grants DPP 88-18049 and DPP 89-14655, OPP 9120123, OPP 9421025, and the McMurdo Long Term Ecological Research program (OPP 9211773, OPP 9810219).

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