Chapter 2
Myriapoda and Terrestrial Isopoda of the Prairies of Canada

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Abstract. Myriapods and terrestrial isopods play important roles in numerous ecosystem processes, especially decomposition, and in the structure of soil food webs. This chapter discusses five focal taxa, specifically the terrestrial Isopoda (commonly known as pill bugs, sow bugs, roly-polys, woodlice, or slaters) and the four classes of the Myriapoda: Diplopoda (millipedes), Chilopoda (centipedes), Pauropoda, and Symphyla (sometimes called garden centipedes). After a brief review is given for each taxon's phylogenetic position, global diversity, and ecological role, current knowledge of species diversity in the Canadian prairies is summarized. Biodiversity of these five groups is relatively low in the prairies of Canada. Terrestrial isopods have yet to be discovered in Alberta, Saskatchewan, or Manitoba. Diplopoda are represented by 10 species, while six species of Chilopoda are known or suspected from the prairies. The Canadian pauropod fauna consists of two species that may be present in the prairies. Twenty-three species of Symphyla are known elsewhere in Canada, but none are known from the Prairie Provinces. Little research on these taxa has been done in this region and much remains to be discovered, likely including species that are new to science. In addition to diversity and distribution studies, future research directions should include studies of the biology and ecology of these species.

Résumé. Les myriapodes et les isopodes terrestres jouent un rôle important dans de nombreux processus écosystémiques— notamment la décomposition— ainsi que dans la structure des chaînes alimentaires du sol. Ce chapitre traite de cinq taxons principaux : les isopodes terrestres (communément appelés cloportes) et les quatre classes de myriapodes : diplopodes (mille-pattes), chilopodes (scolopendres), pauropodes et symphyles (parfois appelés scolopendres des jardins). Après un bref examen de la position phylogénique de chaque taxon, de sa diversité mondiale et de son rôle écologique, le chapitre résume nos connaissances actuelles sur les espèces de ces cinq groupes relativement peu diversifiés des prairies canadiennes. Aucun isopode terrestre n'a été observé à ce jour en Alberta, en Saskatchewan ni au Manitoba. Les diplopodes sont représentés par 10 espèces, et six espèces de chilopodes sont présentes dans les prairies ou soupçonnées de l'être. La faune des pauropodes canadiens compte deux espèces qui pourraient être présentes dans les Prairies. Vingt-trois espèces de symphyles sont connues ailleurs au Canada, mais aucune n'a été observée dans les provinces des Prairies. Ces taxons n'ont fait l'objet que de peu de recherches dans la région, et il reste encore beaucoup à découvrir à leur sujet, y compris probablement de nouvelles espèces non décrites. En plus de se pencher sur la diversité et sur la répartition de ces insectes, les recherches futures devraient porter également sur leur biologie et leur écologie.

Introduction

There is no doubt that arthropod biodiversity is critically important ecologically and economically on local to global scales. While insects (subphylum Hexapoda, class Insecta) comprise the vast majority of arthropod diversity, other extant subphyla (Chelicerata, Crustacea, and Myriapoda) contribute to ecosystem functioning through many avenues. Many species in these groups contribute to ecosystem processes, such as decomposition, while others play important roles in food web dynamics (Coleman *et al.* 2004). I summarize

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what is known about the diversity, distribution, and ecology of five focal taxa of soil-dwelling, non-insect arthropods in the Canadian prairies. Four of these taxa comprise the Myriapoda: the major groups of the class Diplopoda (millipedes) and the class Chilopoda (centipedes), as well as the less well-known classes Pauropoda (pauropods) and Symphyla (symphylans, sometimes called garden centipedes). In addition, I will discuss the terrestrial Isopoda (class Crustacea: order Isopoda: suborder Oniscidea), which go by many common names (e.g., pill bugs, sow bugs, roly-polys, woodlice, slaters), but herein are simply called isopods. Most isopod species have similar niches to millipedes and thus are appropriate to discuss here.

Oniscidea forms a monophyletic group of isopods with slightly more than 3,600 species described (Schmidt 2008). The group is primarily terrestrial with some littoral species. Isopods are the only crustaceans that have been evolutionarily successful in terrestrial environments and are one of two crustacean groups (the second being Amphipoda) that include species capable of living their entire life away from water (Hopkin 1991). Isopods have two critical adaptations to terrestrial life where the major barrier for colonization from aquatic environments is the low moisture content of air. First, eggs and first instar young are reared in a marsupium, or brood pouch, which maintains a moist environment. Second, the pleopods, the appendages toward the posterior end of the body, have been modified into lungs (sometimes called pseudotracheae) and a nitrogenous waste excretion system that conserves water (Hopkin 1991; Oliver and Meechan 1993). However, isopods are still quite prone to desiccation and are thus found in moist soil, in leaf litter, in or under logs, and in riparian areas. Many isopod species are synanthropic (Jass and Klausmeier 2001), benefiting from the moist habitats around buildings.

Myriapoda likely forms a monophyletic group, but placement of Myriapoda within the Arthropoda is uncertain, as are relationships among Diplopoda, Chilopoda, Symphyla, and Pauropoda within Myriapoda (Sierwald and Bond 2007; Shear and Edgecombe 2009). These four taxa have very different ecological roles. Millipedes, like isopods, are important detritivores, fragmenting leaf litter and making it increasingly available for microbial decomposers (Cárcamo *et al.* 2000). Centipedes are important predators in many ecosystems, consuming many kinds of invertebrates (Giribet *et al.* 1999). Some centipedes are large enough to consume vertebrates and some will occasionally ingest detritus (Coleman *et al.* 2004; Mercurio 2010). Pauropoda consume fungi and detritus, or may be predaceous (Scheller 1990; Coleman *et al.* 2004). Symphyla are omnivorous and may be best known as pests in greenhouses (Edwards 1990; Coleman *et al.* 2004). Little is known about the biology and ecology of Pauropoda and Symphyla, in part because both taxa are tiny, pale soil dwellers with little diversity relative to taxa such as millipedes or insects. Globally, Pauropoda has about 500 described species (Scheller 1990) while Symphyla has about 200 (Scheller and Adis 1996); in comparison, there are over 12,000 millipede (Sierwald and Bond 2007) and over 3,000 centipede species (Giribet *et al.* 1999).

There have been few taxonomic or biodiversity studies on the focal taxa in Canada. Those that included the Prairies Ecozone (also called Palliser's Triangle), a triangular region dominated by grasslands that stretches across southern Alberta, Saskatchewan, and Manitoba (Shorthouse and Larson 2010), are listed in Table 1. Relatively few studies have been conducted on myriapods and isopods of the prairies. Only one of these studies (Scheller 1984) includes identification keys to the fauna. However, Kevan and Scudder (1989) is a good general identification resource for the Myriapoda of Canada, at least to the family level.

Table 1. Taxonomic or biodiversity studies of the focal taxa covering the Canadian prairies.

Taxon	Geographical Coverage; Comments	Reference
Isopoda	Canada and continental USA	Jass and Klausmeier 2001
Diplopoda	Canada and Alaska	Behan-Pelletier 1993
	Central Canada (Rocky Mountains to eastern Lake Superior); includes summary of entire Canadian fauna	Shelley 2002
Chilopoda	Canada and Alaska	Kevan 1983
	Canada, Alaska, presence/absence in USA	Behan-Pelletier 1993
	Canada, USA, and Greenland	Mercurio 2010
Pauropoda	Canada	Scheller 1984
	Canada, Alaska, presence/absence in USA	Behan-Pelletier 1993
Symphyla	Canada; species diversity estimate only	Scheller 1979
	Side note on Canadian Symphyla	Kevan 1983
	Canada; review of previous papers	Behan-Pelletier 1993

A lack of taxonomic research is not surprising because of the limited diversity present in the region. These groups are all particularly sensitive to moisture levels and would thus be expected to be depauperate in more xeric regions (e.g., grasslands). In addition, biodiversity is further reduced in the northern latitudes (Golovatch and Kime 2009).

Diversity in Canadian Prairies

Isopods **(Class Crustacea: Order Isopoda: Suborder Oniscidea)**

No terrestrial isopods have been reported from the Prairie Provinces of Alberta, Saskatchewan, and Manitoba (Jass and Klausmeier 2001). Many isopod species in North America are non-native and synanthropic, and they may be expected to occur in developed or disturbed areas within this region. However, the limited growing season and aridity make a fairly hostile environment even for invaders that are successful elsewhere. Few native isopods are found in the centre of the continent, that is, from the Rocky Mountains to the Mississippi River, north of Texas (Jass and Klausmeier 2000, 2001). Only a few introduced isopod species are known in the states that border the Prairies: Montana (four species), North Dakota (zero species, South Dakota also zero), and Minnesota (eight species) (Jass and Klausmeier 2001).

Millipedes **(Class Diplopoda)**

Shelley (2002) provides the most recent and thorough summary of the Canadian millipede fauna. Table 2 lists the 10 millipede species known from Canadian grasslands. It is interesting to note that 4 of the 10 species are introduced, and none are endemic to the region.

A complete listing of the Canadian fauna and potential species in Canadian grasslands can also be found in Shelley (2002), but little has been published on this topic in the last decade (but see Shelley 2007; Shelley and Smith 2011). One noteworthy addition is the genus *Scytonotus* C. L. Koch 1847 (Polydesmida: Polydesmidae), now known from one sample from Jasper National Park (Shelley 2007). This suggests the possibility that *Scytonotus* may exist in the Canadian grasslands, or in adjacent forested habitats.

In a similar situation is *Austrotyla borealis* Shear 1971 (Chordeumatida: Conotylidae), which is only known from the type locality in Jasper National Park (Hoffman 1999; Shelley 2002).

Several additional millipede species may be found in Canadian grasslands but have not been reported. *Polyxenus lagurus* (Linnaeus 1758) (Polyxenida, Polyxenidae), one of Shelley's (2002) potential species for central Canada, was recorded as existing in Alberta by Behan-Pelletier (1993). Behan-Pelletier (1993) also reported *Brunsonia atrolineata* (Bollman 1893) (Chordeumatida: Conotylidae) (as *Conotyla atrolineata*) from Alberta. Unfortunately, no locality data were published in this review of the fauna and these records are unconfirmed. Behan-Pelletier (1993) report *Parajulus perditus* Chamberlin 1920 (Julida: Parajulidae) (as *Bollmaniulus perditus*) from Alberta; this species is of uncertain validity (Hoffman 1999; Shelley 2002) and is not included in Table 2.

Table 2. Diplopoda (millipedes) known from Canadian grasslands (Shelley 2002). *Species checklist available at:* http://dx.doi.org/10.5886/672d42kv

Taxon	Comments
Julida Julidae	
Cylindroiulus latestriatus (Curtis 1845)	Introduced European species. Only reported from Edmonton but likely widespread in developed areas.
Blaniulidae	
Archiboreoiulus pallidus (Brade-Birks 1920)	Introduced European species.
Nopoiulus kochii (Gervais 1847)	Introduced European species. Only reported from Edmonton but may be widespread in developed areas.
Nemasomatidae	
Orinisobates expressus (Chamberlin 1941)	While included in Shelley's list for Canada with a record for Alberta, was omitted from the central Canada list.
Parajulidae	
Aniulus garius (Chamberlin 1912)	
Oriulus venustus (Wood 1864)	
Chordeumatida Caseyidae	
Underwoodia iuloides (Harger 1872)	
Underwoodia tida Chamberlin 1925	
Conotylidae	
Brunsonia albertana (Chamberlin 1920)	Shelley suggested that this species can be found on the western edge of the prairies, and further west.
Polydesmida Polydesmidae	
Polydesmus inconstans Latzel 1884	Introduced European species. Only reported from Edmonton but likely widespread in developed areas.

Centipedes (Class Chilopoda)

The Canadian centipede fauna is very poorly studied. A preliminary survey was assembled (Kevan 1983), but limited research has been published since. Kevan's (1983) literature review recorded 70 species from Canada and Alaska, but only 30 were recorded from Canada. Five species from Kevan's (1983) list are thought to occur in Canadian grasslands (Table 3). A sixth, *Scolopocryptops rubiginosus* L. Koch 1878 (Scolopendrida: Cryptopidae), was listed as unconfirmed (Kevan 1983; Behan-Pelletier 1993; Mercurio 2010), but Shelley (1992) determined that Scolopendromorpha were limited to British Columbia and Ontario. Introductions and greenhouse records of other Scolopendromorpha are listed by Kevan (1983), but none of these records apply to the prairies.

Other species have been listed as unconfirmed or are uncertain. For example, *Taiyuna occidentalis* (Geophilida: Chilenophilidae) was also listed as unconfirmed from the region (Kevan 1983); Behan-Pelletier (1993) reports this species from British Columbia only. Kevan (1983) also appeared to have reservations about *Lithobius forficatus* (Lithobiida: Lithobiidae) and similar species (see Table 3). Lastly, Behan-Pelletier (1993) reports *Paobius albertanus* (Lithobiida: Lithobiidae) from Alberta, but this is the only Lithobiidae they report from Alberta, Saskatchewan, and Manitoba. The reasons for the discrepancies between the checklists of Kevan (1983) and Behan-Pelletier (1993) are unclear.

Table 3. Chilopoda (centipedes) known or suspected from Canadian grasslands. *Species checklist available at:* http://dx.doi.org/10.5886/672d42kv

Taxon	Comments	References
Geophilomorpha		
Dignathodontidae		
Strigamia chionophila Wood 1862	Collected in Fort Whyte, Manitoba, for an experiment; also reported from Alberta.	Aitchison 1979; Mercurio 2010
Chilenophilidae		
Taiyuna occidentalis (Meinert 1886)	Kevan reports as unconfirmed from southern Manitoba, with several question marks.	Kevan 1983
Lithobiomorpha		
Henicopidae		
Lamyctes fulvicornis Meinert 1868	Collected in Fort Whyte, Manitoba, for an experiment. Introduced to some areas? See Kevan 1983.	Aitchison 1979; Kevan 1983
Lithobiidae		
Paobius albertanus Chamberlin 1922	Type locality in Alberta, but exact location is uncertain. The original description lists "the Spring Lakes Trip" (presumably a reference to lakes near Edmonton). However, Mercurio (2010) notes that the holotype label reads "Canada: Albert, Rauff[?], Alba" which I interpret as Banff, Alberta, the collector's home town.	Behan-Pelletier 1993; Mercurio 2010
Lithobius forficatus (Linnaeus 1758)	Introduced. Range probably "across southern Canada but may be confused with other species" (Kevan 1983).	Kevan 1983
Scutigeromorpha		
Scutigeridae		
Scutigera coleoptrata (Linnaeus 1758)	Introduced. Known from Saskatchewan and Alberta. Probably present inside buildings throughout North America.	Kevan 1983

The most recent summary of the centipede fauna in North America is an annotated catalogue published by Mercurio (2010) that lists, in addition to the incorrect *S. rubiginosus* record from Manitoba listed above, *P. albertanus* and *Strigamia chionophila* (Lithobiida: Lithobiidae) from Alberta and no centipedes from Saskatchewan. Other species listed above (Table 3) are not found in his province-level lists.

Pauropods **(Class Pauropoda)**

No species of Pauropoda are known from the Prairie Provinces of Alberta, Saskatchewan, and Manitoba, or in the neighbouring states to the south, Montana and North Dakota (Scheller 1984). Twenty-three species are known from elsewhere in Canada—with most of the diversity in Ontario, Québec, and British Columbia—and many more are predicted (Scheller 1984). Scheller's (1984) publication represents the first (and only?) published records of Canadian Pauropoda, although they are summarized by Behan-Pelletier (1993).

Symphylans **(Class Symphyla)**

Only two species have been reported from Canada, although up to 10 species are predicted to be discovered (Scheller 1979). *Scutigerella immaculata* (Newport 1884) (Symphyla: Scutigerellidae), an introduced species, is known across Canada, including Alberta, although not specifically from the prairies (Scheller 1979; Kevan 1983; Behan-Pelletier 1993). *Symphylella vulgaris* (Hanson 1903) (Symphyla: Scolopendrellidae) has also been reported from Québec (Kevan 1983; Behan-Pelletier 1993).

Research Priorities

Overall, taxonomy of these groups is in poor shape. Primarily because of the efforts of Hoffman, Shelley, and Shear, much of North American millipede taxonomy has undergone recent revision and the Canadian fauna has been mostly discerned. The other taxa are, however, in much worse shape. Few taxonomists are studying centipedes or isopods in North America, and few taxonomists globally are studying the North American fauna. Only a handful of people in the world study Pauropoda and/or Symphyla. Scheller has recently described species from Canada, the United States, and other countries, but no other researcher appears to be actively studying the North American fauna (Shear and Edgecombe 2009).

There are undoubtedly additional species of these five taxa in Canadian grasslands, both new to Canada and new to science (Scheller 1979, 1984; Kevan 1983); many of these may already be collected and are stored in museum collections. For non-insect arthropods, "knowledge of the diversity. . . still is very incomplete" (Behan-Pelletier 1993: 11) and taxonomy must be a research priority in order to facilitate full discovery of the biodiversity of the region. Determination of the geographical range of each species is another research priority that can go hand-in-hand with biodiversity discovery. This distribution information will be an important piece of conservation strategies for this region. Lastly, being little-studied and highly cryptic, the basic biology and ecology of most species within these groups are virtually unknown. Investigations in these areas are important to understanding the role of these species in grassland ecosystem functioning.

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