

The Potentially Rare and Endangered Terrestrial Arthropods in British Columbia: Revisiting British Columbia's Biodiversity

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ABSTRACT

This paper provides an update to portions of the annotated systematic list of the endemic and potentially rare and endangered terrestrial arthropods in British Columbia published by Scudder (1994). Detailed arthropod diversity inventories in forest sites in coastal British Columbia have provided significant new information on the presence and distribution of species in these habitats. Since 1991, over 3.4 million specimens have been collected and they form one of the largest databases in North America to answer biodiversity-driven questions concerning arthropods, endemism, disjunct distributions, dispersal capabilities and the impact of exotic species. We present evidence to support the assertion that these forests are global and continental foci of diversity for several taxa. The summarizing of these basic patterns of species richness and distribution for arthropods forms the framework that is at the heart of the biodiversity challenge. This information must be considered if the issues that surround the maintenance of biological diversity in British Columbia is to be integrated and interpreted at all taxonomic levels.

Key Words: Araneae, arthropod, Coleoptera, exotic, non-indigenous, old-growth forests, Oribatida.

Identification of the components of biological diversity important for conservation cannot be accomplished without an assessment of endemic, rare and threatened species. Scudder (1994) compiled the first major annotated, systematic list of potentially rare and endangered invertebrates in British Columbia based on existing published information and consultation with experts on each group. His work identified a total of 168 species endemic to the province and 448 rare species that occur only in British Columbia within Canada. An additional 203 more widely distributed species were listed on the basis of their limited occurrence or their restriction to threatened ecosystems. He noted that ongoing inventory

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work and research on collections, which were for the most part not consulted in the original study, would result in future modifications of the list.

Our current understanding of the conservation status of the arthropod fauna of British Columbia is derived from existing publications, current taxonomic knowledge and frequency of occurrence of individual species in collections. Catalogues which record the regional occurrence in Canada or North America (by province and state) are available for major arthropod taxa such as the beetles (Bousquet 1991), bees, wasps, sawflies and parasitic wasps (Krombein *et al.* 1979), flies (Stone *et al.* 1965), true bugs (Henry and Froeschner 1988) and oribatid mites (Marshall *et al.* 1987; Behan-Pelletier 1993). Additional provincial records can be found in regional and provincial checklists as well as lists of new regional or provincial records summarized by Scudder (1994). However, no comprehensive listing of the distribution and abundance of most groups of arthropods is available on a provincial scale. Taxonomic or ecological research studies on specific groups e.g. dragonflies and damselflies (Cannings and Stuart 1977), butterflies (Guppy *et al.* 1994; Layberry *et al.* 1998) or in specifically threatened ecosystems or habitats (Scudder 1992, 1993) provide detailed information on the distributions or the conservation status of these groups.

We present data from detailed arthropod diversity inventories in forest sites on Vancouver Island and the lower mainland which provide significant new information on the presence, distribution and abundance of species in these habitats. Since 1991, over 3.4 million specimens have been collected. Identifications of many arthropod taxa collected in these studies are continuing. However, the identifications completed to date form one of the largest data sets in North America to answer biodiversity-driven questions concerning arthropods, endemism, disjunct distributions, dispersal capabilities and the impact of exotic species. The information we present here is derived from specific taxa: the beetle mites (Oribatida); 2 families of beetles (Coleoptera)—the rove beetles (Staphylinidae and related families) and the bark and ambrosia beetles (Scolytidae); and the spiders (Araneae) for which we have a high degree of species resolution.

METHODS

These studies were carried out in ancient and regenerating coniferous forests in the Upper Carmanah Valley (CV; 48° 42' N, 124° 38' W) on the west coast of Vancouver Island, in coniferous forests at Rocky Point (RP; 48° 20' N, 123° 35' W) near Victoria; in montane old-growth forests at Mt. Cain (MC; 50° 14' N, 126° 20' W), north of Campbell River; and montane old-growth and selectively harvested forests at the Montane Alternative Silviculture Systems (MASS) research site (49° 51' N, 125° 26' W) south of Campbell River on Vancouver Island. These research studies were undertaken to determine the arthropod diversity of ancient and regenerating forests. Collecting techniques used to generate the datasets at CV, RP and MC included passive trapping (Malaise and pan traps), as well as direct sampling of branches and suspended moss mats (CV only). The MASS datasets were generated from specimens collected using passive trap systems (Malaise and

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window traps) and active trap systems (light and baited Lindgren funnel traps), as well as from direct sampling of branches and arboreal lichens.

RESULTS AND DISCUSSION

COLEOPTERA

More than 54,000 beetle specimens representing >400 species have been identified from trap collections at MASS. A total of 3,335 adult beetles representing 123 identified species were recovered in the CV studies.

Staphylinidae

The rove beetles were the numerically dominant family of beetles recovered from CV (59% of both individuals and species) and from MASS (75% of the individuals, 35% of the species). Sixty percent of the species of Coleoptera and 61% of the Staphylinidae collected at MASS were represented by 5 or fewer individuals in the collections.

Scudder (1994) recorded 37 species of potentially rare and threatened species of Staphylinidae (as defined by Lawrence and Newton 1995), 6 of which were considered endemic. Collections from CV and MASS have resulted in range extensions for 5 of those previously listed species (Table 1). With the exception of *Micropeplus brunneus*, <5 individuals of each of the species designated by Scudder (1994) were collected at the respective research sites. The large numbers of *M. brunneus* collected from the MASS site serve to illustrate the inadequacy of our current knowledge of the arthropod fauna of the province. This species was denoted as rare and endangered in British Columbia as it was known from only 3 localities and had not been collected in over 40 years (Scudder 1994). Our data would indicate that this species is more common than previously thought in the montane old-growth forests of Vancouver Island.

An additional 27 described species and an equal number of undescribed species of Staphylinidae were recorded from British Columbia for the first time (Bousquet 1991) at one or both of the study locations. Most of these taxa were represented by 5 or fewer individuals (Table 1). While some of these may represent rare and threatened endemics to British Columbia or Canada, their status cannot be determined until taxonomic revisions for each taxon are available.

Scudder (1994) included *Xylodromus depressus* as a potentially rare and endangered species because of its limited occurrence in British Columbia, although it does occur elsewhere in Canada. It is our contention that it should be removed from the listing, as Campbell and Davies (1991) note that it is not native to North America. Another 5 non-indigenous species of rove beetles were documented to be present at one or the other study location (Table 1). Most of these exotics are uncommon in the forest habitats sampled, being represented by <2 individuals in the collections. However, the numbers of one of the exotics captured at MASS, *Trichophya pilicornis*, were surprising, as <24% of the native Staphylinidae were as abundant. The overall abundance of *T. pilicornis*, and its presence at

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4 of the 5 locations sampled, suggest that it is strongly invasive in these forest habitats. Feeding habits are known for only 4 of the introduced taxa; all are predators on other arthropods.

Scolytidae

The North American scolytid fauna is well known taxonomically. McNamara (1991) records 204 species of bark and ambrosia beetles from Canada and Alaska, with 65% of the species present in the Canadian fauna occurring in British Columbia (134 spp.). Of these, Scudder (1994) lists a single species, *Hylocurus hirtellus*, as potentially rare and endangered in British Columbia, based on a single collection record from Victoria (Bright and Skidmore 1997). This collection represented the only record for this species in Canada, although it ranges as far south as Baja California (Scudder 1994). During recent research on non-indigenous introductions in the greater Vancouver area, *H. hirtellus* was collected in traps or reared from 4 locations separated by more than 35 km (Ladner to Langley). This native ambrosia beetle breeds in the dead wood associated with scars on living host plants and has been reared from 2 hosts, *Salix scouleriana* and *Populus* sp., which are widely distributed across the province. Further inventories of our native bark and ambrosia beetle will be necessary to determine the abundance and hence status, of this potentially rare and endangered species in British Columbia.

While only one native scolytid is listed as potentially rare and threatened in British Columbia, recent studies have shown that our fauna is being altered. Surveys of the Scolytidae in the greater Vancouver region demonstrate that exotic bark and ambrosia beetles are accumulating in the provincial fauna. Since 1995, 5 recently introduced species of Scolytidae have been discovered in the urban and managed forests of the lower mainland (Humble, unpub. data). These additions have doubled the number of introduced Scolytidae known to occur in British Columbia. Today, >7% of the species of Scolytidae (10 species) present in British Columbia are introductions (McNamara 1991; Wood and Bright 1992).

Surprisingly, introduced scolytids were found at both the MASS and CV research sites. A single adult of *Xyleborus dispar* was recovered from among the 3,341 adult Scolytidae (19 species) recovered at the former study site. Although a limited number of Scolytidae (26 individuals of 6 species) was recovered from the latter research site, one individual of a second non-indigenous species, *Xyleborinus saxeseni*, was present.

ARANEIDAE

The spider fauna has been well documented, with almost 11,000 individuals representing >167 species having been collected across the 4 research sites (Table 2). Eleven of these species were identified as rare and occurring only in British Columbia within Canada (Scudder 1994) and an additional 3 species were identified to be rare in British Columbia but occurring elsewhere in Canada (Table 3). Two species included in the former category, *Ethobuella tuonops* and *Antrodiaetus pacificus* were present at each of the study sites and a third species, *Linyphantes orcinus* was present at 3 of the 4 sites. An additional 2 species (*Walckenaeria columbia* and *Linyphantes pualla*) listed as occurring

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only in British Columbia in Canada, and 3 species (*Anyphaena aperta*, *Cybaeus signifer* and *Linyphantes orcinus*) identified as potentially rare in British Columbia but occurring elsewhere in Canada were recovered from 2 or 3 widely separated localities. These collections demonstrate that the aforementioned 8 species are more widespread than previous collections have indicated (West *et al.* 1984,1988; Scudder 1994) and may not be rare. Five of the species previously designated as potentially rare in British Columbia were present only at the RP study area and 2 species (*Bathyphantes orica* and *Hexura picea*) were present at MC and CV, respectively. Indeed, for *B. orica* and *Trachelas californicus*, these collections represent only the second collections of both species in the province (Scudder 1994). As the distributions of the latter 6 species are restricted in British Columbia, their status should remain as potentially rare pending further research.

Eleven of the species of Araneae collected from the 4 research sites are introductions to the fauna of the province (Table 3). All of the introduced species were present at the Rocky Point study site, and 9 were restricted only to that location. A single introduced species was recovered at each of the CV and MASS study sites. While the non-indigenous spider taxa are most numerous (14% of the species recovered) at RP, the collection of *Theridion bimaculatum* and *Philodromus dispar* in more remote forest habitats indicates the potential for dispersal of these introduced species.

ORIBATIDA

The oribatid mite fauna of the CV was intensively studied, especially the fauna associated with moss mats in the canopy of Sitka spruce (*Picea sitchensis*) (Behan-Pelletier and Winchester 1998). The arboreal oribatid mite fauna associated with the foliage and canopy lichens of Pacific silver fir (*Abies amabilis*) and western hemlock (*Tsuga heterophylla*) from MASS are currently being examined. More than 29,000 individuals of 24 species of Oribatida (14 Families) have been identified from MASS and 3,868 individuals of 52 species (27 Families) from CV. Less than 25% of the 68 species recovered across both sites can be assigned to existing species. Only 2 of the 15 taxa that can be assigned to existing species have previously been recorded from the province (Table 4). An additional 17 genera, which include at least 22 morphospecies, are recorded for the first time for the province, with 3 (*Dendrozetes*, *Paraleius* and *Crassoribatula*) also representing the first records of occurrence for Canada (Marshall *et al.* 1987; Behan-Pelletier 1993).

None of the Oribatida listed as potentially rare and endangered (Scudder 1994) were recovered at the study sites. The mite fauna of the province has been incompletely studied, especially the fauna associated with the forest canopy. Application of Scudder's (1994) criteria to assign a status to the described species recovered in these studies would result in an additional 7 species being added to the category of species rare in British Columbia but occurring elsewhere in Canada, and 6 species being considered rare and occurring in British Columbia only in Canada, as all of the taxa are recorded from at most 2 locations in the

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province. Such designations would be premature, as surveys of the canopy Oribatida have been completed at only the 2 study sites discussed.

The knowledge of the arthropod diversity for most taxa and habitats in British Columbia is both incomplete and inadequate for determining the potential status of rare and threatened species. We present new information for selected arthropod groups that illustrate the need for a comprehensive examination of the arthropod taxa of the province. Species included in taxa that are well known taxonomically (e.g. Scolytidae, Staphylinidae and Araneae) and listed by Scudder (1994) as potentially rare and threatened are now being described as more widely distributed than had previously been known. Other taxa (e.g. *Micropeplus brunneus*) are now shown to be relatively abundant at selected research sites and thus may not merit designation as potentially rare or threatened. For taxa such as the oribatid mites, determination of their status is impossible, as the mite assemblages of terrestrial habitats have not been well studied (Behan-Pelletier 1993; Scudder 1994). Additionally, the taxonomic expertise available for species descriptions and determinations is inadequate to deal with the diversity of the provincial arthropod fauna.

Quantitative data from these collections provide baseline information for comparisons to determine the impacts of various factors (e.g., non-indigenous introductions, habitat loss) that can threaten biological diversity in forest ecosystems. Non-indigenous spiders comprise a significant proportion of the fauna at Rocky Point, the study site nearest to long-term human settlement on southern Vancouver Island, but at present are minor elements of the fauna at the more remote forest sites. Non-indigenous species of Scolytidae and Staphylinidae are also present at the 2 remote forest habitats for which we have data. After habitat loss, non-indigenous introductions are the next most significant cause of loss of biodiversity. Introduced Scolytidae have been demonstrated to predominate in urban forest habitats in greater Vancouver and some species have recently been discovered invading the adjacent native forests (L.Humble unpub. data). Future quantitative collections at our study sites will allow us to determine if these introduced taxa are becoming more prevalent and may allow determination of their impacts on endemic species assemblages.

Knowledge of the abundance of individual species rather than presence/absence data allows refinement of concepts such as rarity and endemism. Although 3 undescribed species of *Mycobates* are present at the MASS study site and have not been recorded elsewhere in the province, they all cannot be considered rare. Adults of *Mycobates* n.sp. 1 comprise 33% of the adult oribatid mite fauna collected from the canopy foliar samples and will likely be found to be common in other montane forest habitats. The other 2 species of *Mycobates* are rare in canopy foliar samples but are somewhat better represented in canopy lichen samples. Like the oribatid fauna associated with moss mats in the canopy of Sitka spruce in the Carmanah Valley, species such as *Mycobates* n. sp. 2 and 3 may be threatened should their habitat (canopy lichens) be lost.

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It is important that arthropod diversity be studied at the species level; examination of arthropod diversity at the level of the family or other higher taxa provides no insights into rarity or endemism. Such research is dependent on a strong systematic infrastructure, which at the present time is totally inadequate in Canada (Ball and Danks 1993; Behan-Pelletier 1993; Danks and Ball 1993). Increased support for systematics research, collections and training is urgently needed to provide the necessary tools and expertise for the study of arthropod diversity.

The study of all aspects of diversity including rarity and endemism is dependent on the availability and long-term curation of reference collections. They provide the “raw materials” for systematics and taxonomic advancement, which develop basic tools such as keys and descriptions needed to distinguish the components of biological diversity (Danks and Ball 1993). Many of the arthropods collected in the studies outlined above and other studies throughout the Province are undescribed and are currently identified as “morphospecies”. It is important that vouchers of these, as well as fully determined species, are deposited in recognized and curated collections at the completion of arthropod diversity studies. The existence and availability of such voucher specimens allow comparisons to be made at the landscape level, even in the absence of specific identifications, and will also allow further refinements of the concepts of rare and threatened arthropods in the Province.

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Table 1. Potentially rare and threatened and/or introduced Staphylinidae (as defined by Lawrence and Newton 1995) from 2 arthropod diversity studies on Vancouver Island. Where listed, the designation of status given for each taxon in British Columbia is that of Scudder (1994): * indicates that the species occurs only in British Columbia in Canada, but is recorded from elsewhere in North America; and ** indicates that the species is endemic to British Columbia. Numbers of adults of each species are given for the Carmanah Valley (CV) and Montane Alternative Silviculture Systems (MASS) research sites. Total number of identified Staphylinidae recovered from the 2 sites are 1,967 and 54,490 adults respectively. First records for British Columbia (BC) and Canada are denoted by filled circles. Introduced species (Campbell and Davies 1991) are designated “I” under origin.

Status	Taxon	Study Site		First Record		Origin
		CV	MASS	BC	Canada	
*	<i>Micropeplus brunneus</i> Macklin		69			
*	<i>Nanobius serricollis</i> (LeConte)		1			
*	<i>Orus punctatus</i> Herman	1				
*	<i>Pseudohaida rothi</i> Hatch	5				
*	<i>Stenus ellipticus</i> Casey	1				
*	<i>Tanyrhinus singularis</i> Mannerheim	1				
**	<i>Trigonodemus fasciatus</i> Leech	1				
*	<i>Trigonurus sharpi</i> Blackwelder	2	4			
	<i>Stictalia (=Bolitochara) californica</i> Csy		1	•		
	<i>Autalia rivulus</i> Gravenhorst		1	•	•	
	<i>Orus sinuatus</i> Herman	2	1	•	•	
	<i>Phloeopora testacea</i> Mannerheim		4	•	•	
	<i>Quedius (Microsaurus) simplex</i> Hatch	4		•	•	
	<i>Cordalia obscura</i> (Gravenhorst)		2	•		I
	<i>Gabrius nigrutilus</i> (Gravenhorst)		1			I
	<i>Gabrius subnigrutilus</i> (Reitter)		1			I
	<i>Trichophya pilicornis</i> (Gyllenhal)		17			I
	<i>Xylodromus concinnus</i> (Marsham)		2			I
*	<i>Xylodromus depressus</i> (Gravenhorst)	1				I

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Table 2. Comparison of the number of families, genera, species and individuals of arachnids at 4 biodiversity study sites on Vancouver Island, British Columbia.

Site	No. of families	No. of genera	No. of species	No. of individuals
Rocky Point	15	50	76	3,093
Carmanah Valley	16	53	74	2,179
Mt. Cain	16	62	78	1,699
MASS	16	47	68	3,774
Total: all sites	18	74	167+	10,745

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Table 3. Potentially rare and threatened and/or introduced spiders (Araneae) from 4 arthropod diversity studies on Vancouver Island. Where listed, the designation of status given for each taxon in British Columbia is that of Scudder (1994): a blank indicates that the species is rare in British Columbia but occurs elsewhere in Canada; an * indicates that the species occurs only in British Columbia in Canada, but is recorded from elsewhere in North America ; an ** indicates that the species is endemic to British Columbia; and n.a. indicates that status is not applicable. Introduced species (Buckle, pers. comm.) are designated “I” under origin.

Status	Taxon	Research site				Origin
		RP	CV	MC	MASS	
	AGELENIDAE					
	<i>Agelenopsis actuosa</i> (Gertsch & Ivie)	•				
	<i>Cybaeus signifer</i> Simon	•	•	•		
*	<i>Ethobuella tuonops</i> Chambelin & Ivie	•	•	•	•	
n.a.	<i>Tegenaria agrestis</i> (Walckenaer)	•				I
n.a.	<i>Tegenaria gigantea</i> Chamberlin & Ivie	•				I
	ANTRODIAETIDAE					
*	<i>Antrodiaetus pacificus</i> (Simon)	•	•	•	•	
	ANYPHAENIDAE					
	<i>Anyphaena aperta</i> (Banks)	•	•	•		
	ARANEIDAE					
n.a.	<i>Araneus diadematus</i> Clerck	•				I
	CLUBIONIDAE					
*	<i>Castianeira walsinghami</i> (O.P.-Cambridge)	•				
*	<i>Trachelas californicus</i> Banks	•				
	GNAPHOSIDAE					
*	<i>Sergiolus columbianus</i> (Emerton)	•				
	LINYPHIIDAE					
	<i>Bathyphantes diasosnemis</i> Fage			•	•	
*	<i>Bathyphantes orica</i> Ivie			•		
n.a.	<i>Lepthyphantes tenuis</i> (Blackwall)	•				I
*	<i>Linyphantes nehalem</i> Chamberlin & Ivie	•				
*	<i>Linyphantes orcinus</i> Chamberlin & Ivie	•	•	•		
*	<i>Linyphantes pualla</i> Chamberlin & Ivie		•	•		
	ERIGONIDAE					
*	<i>Walckenaeria columbia</i> Millidge		•		•	
	MECICOBOTHRIDAE					
*	<i>Hexura picea</i> Simon		•			
	PHILODROMIDAE					

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n.a.	<i>Philodromus dispar</i> Walckenaer	•	•		I
	THERIDIIDAE				
n.a.	<i>Enoplognatha latimana</i> Hippa & Oksala	•			I
n.a.	<i>Enoplognatha ovata</i> (Clerck)	•			I
n.a.	<i>Enoplognatha thoracica</i> (Hahn)	•			I
n.a.	<i>Theridion bimaculatum</i> (Linnaeus)	•		•	I
n.a.	<i>Theridion tinctum</i> (Walckenaer)	•			I
n.a.	<i>Theridion varians</i> Hahn	•			I

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