Arthropods of Canadian Grasslands

Volume 4:
Biodiversity and Systematics
Part 2






Edited by
Donna J. Giberson and Héctor A. Cárcamo

Biological Survey of Canada
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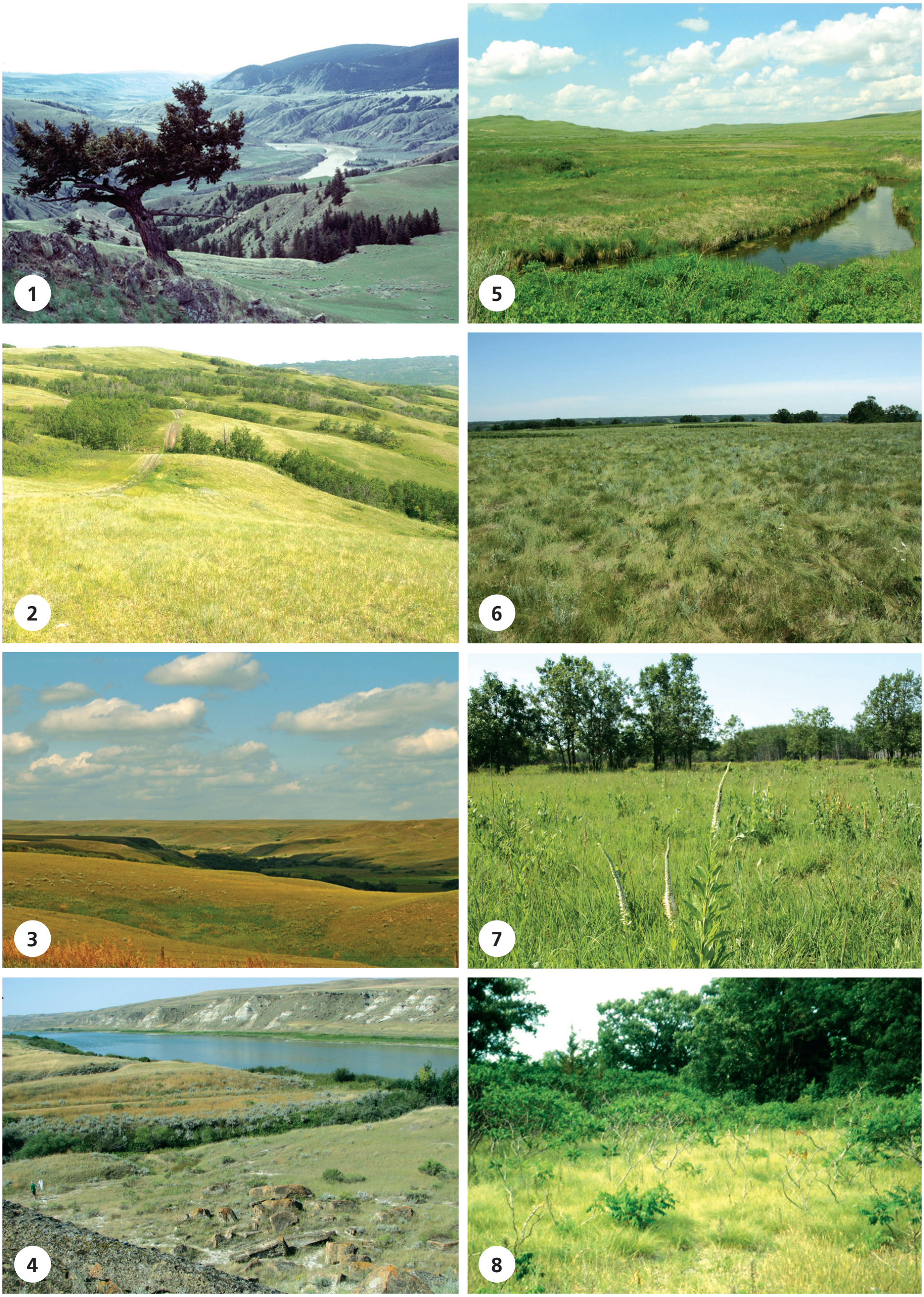

1. Fraser River at Chilcotin R. junction, BC (Photo: Robert Cannings); 2. Valley slope grassland at Misery Mountain, near Peace River, AB (Photo: Chris Schmidt); 3. Ranch lands along Highway 21 south of Cypress Hills, SK (Photo: Penny MacKinnon). 4. West of Bindloss, along the Red Deer River valley, AB (Photo: Mark Oliver); 5. Grassland National Park (East Block), in SE Saskatchewan (Photo: Henri Goulet); 6. Near St.-Lazare, MB (NW of Brandon) (Photo: Cary Hamel, Nature Conservancy of Canada); 7. Near Gardenton, MB (south of Winnipeg) (Photo: Cary Hamel, Nature Conservancy of Canada); 8. Near Belleville, ON (Photo: Andy Hamilton).

Arthropods of Canadian Grasslands (Volume 4): Biodiversity and Systematics, Part 2

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Preface

The Biological Survey of Canada (http://www.biology.ualberta.ca/bsc/bschome.htm) is a not-for-profit national organization that was established in 1977 to coordinate research on Canada's biota, particularly arthropods. Members of the Survey began planning the multi-volume *Arthropods of Canadian Grasslands* in the early 2000s to highlight the arthropods in grasslands. Grasslands, some of Canada's most endangered ecosystems, occur across Canada, but they reach their greatest expanse in the three Prairie Provinces. Other notable grassland regions occur in the interior of British Columbia, in the Peace River area of northern British Columbia and Alberta, and in parts of Yukon and southern Ontario. The arthropods (which include insects, mites, spiders, millipedes, and their relatives) contribute the bulk of animal diversity in most terrestrial habitats, but many groups remain poorly studied. The volumes in this series are intended to provide up-to-date information on arthropods, their habitats, and ecology for selected grasslands across the country.

Volume 1 of this series, *Ecology and Interactions in Grassland Habitats* (Shorthouse and Floate 2010), provides information on the geological history, physical geography, and climatic features of Canadian grasslands, providing a context for the ecological attributes and interactions of arthropods in natural grasslands. This volume also calls attention to the plight of disappearing grasslands and conservation efforts. Volume 2, *Inhabitants of a Changing Landscape* (Floate 2011), focuses on anthropogenic effects on grasslands and their arthropod fauna. It summarizes the fauna in modified grassland habitats such as agroecosystems and includes information on adventive (non-native) pest species, as well as those introduced for biological control. Volume 3, *Biodiversity and Systematics, Part 1* (Cárcamo and Giberson 2014), was intended to bring the series to a close by providing a taxonomic summary, including checklists, for selected arthropod taxa that occur in grasslands. Since it was clearly not possible to cover all arthropod groups, we chose to include a mix of groups comprising some for which very little is known, as well as some better known groups. Volume 3 covered the first 14 of these arthropod groups, with the remaining 11 covered in Volume 4. The two volumes together cover over 8,000 species. Individual chapters from all volumes are freely available online at http://www.biology.ualberta.ca/bsc/english/publications.htm.

Volume 4 focuses on Coleoptera (beetles), Diptera (flies) not covered in Volume 3, Lepidoptera (moths and butterflies), and Hymenoptera (ants, wasps, and bees). The opening chapter on ground beetles (Carabidae; Holliday *et al.*) combines an extensive regional taxonomic coverage of the group with case studies from across the prairie region of Canada. Three more Coleoptera (beetle) groups follow: click beetles and wireworms (Elateridae; van Herk and Vernon), darkling beetles (Tenebrionidae; Bouchard and Bousquet), and weevils (Dryophthoridae, Brachyceridae, Curculionidae; Anderson *et al.*). Chapters 5 and 6 focus on Lepidoptera: Pohl *et al.* treat the moths and butterflies in the Prairies Ecozone in Canada, while Schmidt *et al.* focus on the disjunct group of moths and butterflies that occupy the Peace River grasslands in northern British Columbia and Alberta. Diptera are represented in this volume by the robber flies (Chapter 7, Asilidae; Cannings). The book closes with four chapters on Hymenoptera. Chapter 8 covers the ants of Alberta and Saskatchewan (Formicidae; Glasier and Acorn). Chapters 9 and 10 summarize two parasitic wasp groups: (Ichneumonidae (Schwarzfeld) and Braconidae (Sharanowski *et al.*) of the Prairies Ecozone. Volume 4 concludes with a chapter on the bees (Hymenoptera: Apoidea, Apiformes; Sheffield *et al.*), comparing the Prairies Ecozone to other Canadian grasslands.

The checklists throughout Volumes 3 and 4 are the core of each chapter, bringing together for the first time extensive lists of taxa that are associated with specific Canadian grasslands. Depending on the authors' expertise, some treatments are highly taxonomic and biogeographical in nature, while others are more ecologically oriented, but authors have been encouraged to define specialized terms and write in an accessible format for a broad audience interested in grasslands and grassland species. Chapter length varies considerably, depending on how well the taxa have been studied and the diversity of the group. Regardless of length, each chapter provides an up-to-date, accessible snapshot of the current diversity of each taxon that can be used as a baseline for further taxonomic investigation and environmental benchmarks, or as the basis for more ecological study. To improve the readability of the chapters, taxonomic authorities are presented only in checklist tables and omitted from the text (except for taxa not listed in tables). We hope that these volumes will highlight the fascinating diversity of the arthropods and their key ecological roles in Canadian grasslands and will allow them to become better known to a wide audience.

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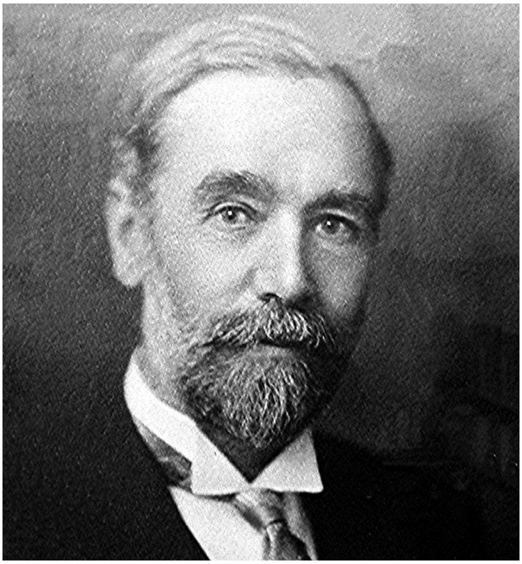

Copy of a photo hanging in the boardroom of the Department of Entomology at the University of Manitoba, taken in 1933 when Norman Criddle received an Honorary Diploma from the Manitoba Agricultural College. Photo courtesy of N. Holliday

The year 2013 was a landmark year for entomologists in the Canadian Prairies, since it marked 100 years of professional entomology in the region. Two influential entomologists celebrated milestones on the Prairies in 1913: Edgar Strickland founded the Dominion Entomological Laboratory in Lethbridge and Norman Criddle was appointed as Entomological Field Officer in Manitoba. These two scientists started an entomological legacy that would benefit several generations of Canadians. Therefore, we dedicate the two systematic entomology chapters in this book series to the memories of these men; Volume 3 was dedicated to E.H. Strickland, and Volume 4 is dedicated to N. Criddle.

Dedication

Norman Criddle (1875–1933)

Soon after I started my Master's work on aquatic insects at the University of Manitoba in the early 1980s, I was tempted away from my library research by a field trip to an iconic Manitoba place: the type locality for the stonefly *Capnia* (now *Capnura*) *manitoba*. That place was Aweme, and the type collector was Norman Criddle. I might have been forgiven then for thinking that Norman Criddle was an aquatic entomologist, since I was not then aware of his history. He is known to entomologists mainly for his extensive work on grasshoppers and other agricultural pests, but his interests were broad, covering all species of insects, as well as plants, birds, and mammals. He sent specimens and drawings to many experts for identification, and his painstaking notes and publications continue to be valuable resources today. His specimens of *C. manitoba* were sent to Peter Claassen at

Cornell University; interestingly, the paper in which *C. manitoba* was described (Claassen 1924) was published in *The Canadian Entomologist* in two parts, with a paper by Norman Criddle himself on the early stages of grasshoppers (Criddle 1924) sandwiched between the parts. It is a testament to his influence on entomology in the Prairies that workers in so many groups can relate to Norman Criddle's legacy.

Norman Criddle was born in Surrey, England, in 1875, and moved with his parents to Manitoba when he was seven. He was part of a large family and had a colourful family history (see articles by N.J. Holliday (2005, 2006) for details, and see the Virtual Museums of Canada website for photos of the Criddle/Vane family life). Despite the hard work associated with growing up on a homestead on the southern Manitoba prairie at this time, he and his family demonstrated a strong interest in science and nature, maintaining a weather station, feeding and observing birds, and collecting insects and plants. Although Norman participated in all of these extracurricular activities, his own description of his early life focused more on the hard work than on natural history or scientific activities:

> *"Came to Canada (Manitoba) in 1882. Worked and starved on a farm for the next eight years. Continued to work on a farm until 1905. Schooling, such as it was, provided at home; usually in the evenings during winter time. There was not time in summer. No opportunity for higher education was provided."* (Holliday 2005, p. 14)

It was during this period as a farm worker that he and one of his brothers (Harry Vane) began work on methods to control grasshoppers. After trying a number of different remedies, their breakthrough occurred in 1901 with the development of the "Criddle mixture" (Paris green (copper acetoarsenite), salt, and horse manure (or bran or sawdust)), which was used widely for grasshopper bait for the next 30 years.

Norman was an accomplished scientific illustrator and began drawing flowers and insects in his late teens. He exhibited some of these drawings at local fairs and also sent some to Ottawa to James Fletcher, Dominion Entomologist and Botanist, for identification. These were well received and led to a visit by Fletcher to the Criddle homestead in 1900, when Fletcher was in Manitoba to tour areas affected by grasshoppers. The development of the Criddle mixture and Norman's obvious talents for illustration prompted some temporary work with the Department of Agriculture (demonstrating the Criddle mixture and making coloured drawings of weeds and weed seeds). This latter project led to publications on farm weeds and pasture plants, with the illustrations provided by Norman Criddle (Clark and Fletcher 1906; Clark and Malte 1913). In 1912, he was recruited to set up a laboratory and take up a position as Entomology Field Officer for the Department of Agriculture. He started that position in the summer of 1913 and was appointed permanently in 1914.

Norman Criddle published over 125 scientific papers between 1907 and 1933, including 69 on entomology topics, 31 on birds, 7 on plants, 13 on mammals, and 7 on miscellaneous topics (see Gibson and Crawford 1933 for the complete list). His entomological papers ranged from works on tiger beetles and spiders to important works on the presence, control, and ecology of many insect pests, particularly grasshoppers. In addition to providing the first records for many insects on the Prairies, his work has provided important baseline data for present-day comparisons (see Chapter 1, Carabidae, for a good example of this). He sent countless insects to experts for identification, many of which were new to science, including the stonefly example given earlier. At least 30 of these were named after him, including one genus and 29 species (see Holliday 2005 for the list), and eight more were named for Aweme. Many of these are listed in the checklists of this volume, and Norman Criddle's collecting efforts have been specifically acknowledged in the chapters on Carabidae, Asilidae, and Ichneumonidae.

It is our honour to dedicate this book to the memory of Norman Criddle.
Donna Giberson and Héctor Cárcamo

References and Further Reading

Clark, G.H., and Fletcher, J. 1906. Farm Weeds of Canada, with Illustrations by Norman Criddle. Canada Department of Agriculture, Ottawa, Ontario. (Second edition (1909) available from http://www.biodiversitylibrary.org/item/65194 [accessed 24 January 2014].

Clark, G.H., and Malte, M.O. 1913. Fodder and Pasture Plants, with Illustrations by Norman Criddle. Canada Department of Agriculture, Ottawa, Ontario. Available from https://archive.org/download/fodderpasturepla1913cana/fodderpasturepla1913cana.pdf [accessed 24 January 2014].

Claassen, P.W. 1924. New species of North American Capniidae (Plecoptera). The Canadian Entomologist, **56**: 43–48, 54–57.

Criddle, A. 1973. Criddle-de-diddle-ensis. Privately printed, Winnipeg, Manitoba.

Criddle, N. 1924. Notes on the early stages of grasshoppers. The Canadian Entomologist, **56**: 49–53.

Gibson, A., and Crawford, H.G. 1933. Norman Criddle. The Canadian Entomologist, **65**: 193–200.

Holliday, N.J. 2005. Norman Criddle: pioneer entomologist of the Prairies. 2004 Heritage Lecture. Bulletin of the Entomological Society of Canada, **37**: 10–19.

Holliday, N.J. 2006. Norman Criddle: pioneer entomologist of the Prairies. Manitoba History, 51. Available from http://www.mhs.mb.ca/docs/mb_history/51/criddle_n.shtml [accessed 24 January 2014].

Roughley, R.E. 2000. Aweme, Manitoba—an important historical grasslands site. Arthropods of Canadian Grasslands Newsletter (Biological Survey of Canada), **6**: 6–12. Available from http://www.biology.ualberta.ca/bsc/pdf/aweme.pdf [accessed 24 January 2014].

Virtual Museums of Canada. The Criddle/Vane Legend and Legacy. Available from http://www.museevirtuel-virtualmuseum.ca/sgc-cms/histoires_de_chez_nous-community_memories/pm_v2.php?id=exhibit_home&fl=0&lg=English&ex=00000296 [accessed 24 January 2014].

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Chapter 1
Ground beetles (Coleoptera: Carabidae) of the Prairie Grasslands of Canada

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Abstract. Carabid beetles are among the best-known of Canada's insect families and are important indicators of environmental condition and change. Reasons for the relatively good level of knowledge include excellent taxonomic resources, a compendium of ecological information, and up-to-date checklists. The biology of carabid beetles is well understood in general terms, although for most species of the Prairies Ecozone, detailed studies of life cycles are lacking. Although pitfall traps are by far the most prevalent method of sampling, interpretation of trap catches without knowledge of life cycles can be misleading. Information from the literature on patterns of distribution, habitat use, and diet is tabulated for the 398 species of Carabidae (including Cicindelinae) reported to occur in the Prairies Ecozone, and more detailed information is presented on 15 tribes of particular interest. A brief summary is presented of 31 published and unpublished faunistic studies of carabid beetles in the Prairies Ecozone and in cultivated habitats in adjacent ecoregions. For 15 of these studies, relative abundance data are presented and discussed, and three studies, presenting previously unpublished information, are described in detail. An assessment of research gaps reveals that, in the Prairies Ecozone, there have been no studies of the carabid fauna of the Fescue Grassland or Cypress Upland ecoregions, or of Manitoba's Boreal Transition Ecoregion. Similarly, there have been no studies in the grasslands of the Peace River Boreal Plains of Alberta and British Columbia. Most faunistic studies of carabids have been in annual crop ecosystems. The carabid assemblages in grazing ecosystems, undisturbed native prairie, and woodland habitats are under-researched in the Prairies Ecozone. Of particular concern, given that 53% of the Prairies Ecozone species are associated with wetlands or water bodies, is the absence of faunistic studies of carabids in these disappearing habitats. Detailed biological studies of more carabid species are recommended. Such studies can serve as the basis for future conservation efforts and aid in the interpretation of trap catches. The prevalence of carabids in urban environments provides an opportunity to increase appreciation of arthropod diversity and importance among the influential urban electorate, thus paving the way for future habitat conservation.

Résumé. Les carabidés forment une des familles d'insectes les mieux connues du Canada et constituent des indicateurs importants de l'état de l'environnement et de son évolution. L'excellence des ressources taxonomiques, l'existence d'un recueil d'informations écologiques et une liste de contrôle à jour expliquent pourquoi ce groupe est relativement bien connu. Même si on connaît assez bien la biologie générale des carabidés, les cycles de vie de la plupart des espèces de l'écozone des prairies n'ont toujours pas fait l'objet d'études détaillées. Le recours aux pièges à fosse constitue de loin la méthode la plus fréquente d'échantillonnage, mais à défaut d'une connaissance du cycle de vie, l'interprétation des résultats de ce type d'échantillonnage peut être trompeuse. Ce chapitre compile les informations glanées dans la documentation scientifique sur les tendances de la répartition, l'utilisation de l'habitat et le régime alimentaire des 398 espèces de Carabidae (y compris les Cicindelinae) répertoriées dans l'écozone des prairies, en insistant sur 15 tribus d'intérêt particulier. Il résume brièvement 31 études publiées ou

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non portant sur les carabidés de l'écozone des prairies et des habitats cultivés des écorégions voisines. Il examine les données sur l'abondance relative présentées dans 15 de ces études, et décrit en détail les résultats jusqu'ici inédits de trois de ces études. Une évaluation des lacunes des connaissances révèle que les carabidés de deux écorégions de l'écozone des prairies — la prairie à fétuque et les hautes terres Cypress — et de l'écorégion de la transition boréale, au Manitoba, n'ont fait l'objet jusqu'ici d'aucune étude. Il en va de même pour les prairies de la rivière de la Paix, dans la plaine boréale de l'Alberta et de la Colombie-Britannique. La plupart des études ont été réalisées sur des écosystèmes faisant l'objet de cultures annuelles. Les communautés d'espèces de carabidés des écosystèmes de pâturage, des prairies indigènes non perturbées et des habitats boisés restent insuffisamment étudiées dans l'écozone des prairies. L'absence d'études sur la faune des carabidés des terres humides et des milieux aquatiques préoccupe particulièrement compte tenu du fait que ces habitats en voie de disparition abritent 53 % des espèces de l'écozone des prairies. On recommande qu'un nombre plus grand d'espèces de carabidés fassent l'objet d'études biologiques détaillées. De telles études peuvent servir de point de départ aux futurs efforts de conservation, et faciliter l'interprétation des résultats des échantillonnages effectués à l'aide de pièges à fosse. La présence généralisée des carabidés dans les milieux urbains offre l'occasion de promouvoir une plus grande appréciation de la diversité des arthropodes et de leur importance auprès de l'électorat urbain influent et de paver ainsi la voie aux futurs projets de conservation de l'habitat.

Introduction

Carabid beetles are among the best-studied arthropods in North America, and they have been extensively used as ecological indicator species. Two reasons for their popularity for study are that there are excellent taxonomic resources for Canadian species and that carabid beetles are easy to catch with pitfall traps. As ecological indicators, they have the property of being sensitive to environmental conditions and, because they have a general diet, their distribution is not simply a proxy for the distribution of their food. Depending upon species, diets of carabid beetles are broad and may span several trophic levels, thus enhancing the value of these insects as sensitive indicators of environmental disturbance.

The intent of this chapter is to present an overview of the current knowledge of the carabid beetles of the Prairies Ecozone of Canada, as defined by Shorthouse (2010*b*). The chapter places particular emphasis on the biodiversity of the group and highlights a number of faunistic studies of carabid beetles in the ecozone. Many of these studies are published in scientific journals, but several are unpublished theses of which most readers will be unaware. The chapter begins with a general introduction to the biology of the Carabidae, followed by a review gathered from published sources of the distribution and ecology of all species reported to have been collected in the Prairies Ecozone. Three detailed treatments of faunistic studies follow, and then we summarize all of the published and unpublished studies of the carabid fauna in the ecozone that are known to us. We conclude with an assessment of gaps in knowledge and suggest future actions to further knowledge and conservation of the carabid fauna.

Overview of Carabidae

Systematics and Taxonomy

The order Coleoptera, the beetles, is the most speciose order of insects on the planet. Adult beetles are characterized morphologically by the hardening of the forewings as elytra (Maddison 2000). There are four suborders of extant beetles, of which the largest two are the Polyphaga and the Adephaga. Their names are derived from the general characteristics of their diet, although members of the suborders are distinguished morphologically (Maddison 2000). Families of the Adephaga, the second largest suborder, are usually divided into the aquatic Hydradephaga and the terrestrial Geadephaga, and it is within the Geadephaga that the family Carabidae, the ground beetles, is placed (Bousquet 2012). Systematists do not agree on the division of Geadephaga into families, and Bousquet (2012) provides an excellent review of the subject. In this chapter, we have followed Bousquet (2012) in including the tiger beetles as a subfamily, Cicindelinae, within the family Carabidae, but have excluded the Rhysodidae and Trachypachidae from our treatment.

Within the Carabidae, the division into tribes (in the sense of Lindroth 1961–1969 and Bousquet 2012) is relatively stable, as is the generic composition of each tribe. However, even before the advent of molecular techniques, there was considerable debate about evolutionary relationships among tribes (Ball 1979) and, as summarized in Bousquet (2012), the incorporation of molecular information with older morphological studies has not yet resulted in consensus. Bousquet (2012) provides an up-to-date account of the status of classification and nomenclature of Carabidae in North America, and the reader is referred there for a comprehensive treatment of the topic. In this chapter, we have followed the nomenclature and tribal classification of Bousquet's (2012) catalogue. We have generally not referred to subspecies as, in many of the studies covered, beetles were not identified to the subspecific level. Among Carabidae, subspecific divisions are most developed for the Cicindelinae, and the reader is referred to specialist works on that subfamily for subspecific information.

Without doubt, the most important aid to identification of adult carabid beetles in the Prairies Ecozone is Lindroth (1961–1969), which, though published over 40 years ago, is still current for many carabid genera. Some genera have been revised, rendering Lindroth's treatment of them obsolete; however, these are relatively few. The genera *Agonum* (Liebherr 1994 and references therein) and *Amara* have been extensively revised (Hieke 2007 and references therein). Noonan has published revisions of several portions of the tribe Harpalini (Noonan 1985, 1991, 1996, 2001), as has Kavanaugh (1979, 1981, 1984) for the genus *Nebria*. In addition, there have been several revisions within the genus *Bembidion* (Erwin and Kavanaugh 1981; Maddison 2012 and references therein). Many of these revisions do not provide keys that aid in species identification; a simple and practical approach to identifying a carabid beetle is to use the keys of Lindroth (1961–1969), and then to consult Bousquet (2012) to determine whether there have been nomenclatural changes or revisions, and if so, to consult the literature cited therein. In contrast to the resources for adults, relatively few resources are available for identifying larvae of carabid beetles, and none are specific to the Prairies Ecozone. As a starting point, the reader can use van Emden (1942) and Kirk (1972*a*). Bousquet (2010), although dealing only with species of northeastern North America, provides splendidly illustrated keys to adults and larvae of carabids of that region, many of which also occur in the Prairie Provinces.

With the exception of Bousquet (2010), the resources so far mentioned do not aid in identification of tiger beetles. Wallis (1961), who was particularly knowledgeable about tiger beetles of the eastern Prairies, provides a key, natural history information, and illustrations for all Canadian Cicindelinae, although its nomenclature is somewhat dated. Pearson *et al.* (2006) provide a more up-to-date account of all the tiger beetles of the Prairies Ecozone, and Acorn (2001) and Hilchie (1985) are excellent accounts of those species and subspecies found in Alberta.

Carabid Biology

Adult carabid beetles are morphologically rather uniform, and there are several detailed accounts of the basic body plan (Lindroth 1961–1969; Thiele 1977; Ball and Bousquet 2000; Bousquet 2010) from which the following is abstracted. The antennae are filiform (thread-like) and 11-segmented; the mandibles are strong, project forward from the head, are more or less curved, and may be toothed. The prothorax (first thoracic segment) is usually broader than the head, but narrower than the abdomen and, when viewed from above, is the only thoracic segment visible, being followed posteriorly by the elytra. In most species, the elytra cover all or most of the upper surface of the abdomen, and they are usually striate. The legs are slender and the basal segments of the hind legs are fused to the metasternum (ventral plate of the third thoracic segment). All legs have five tarsal segments; frequently in males the tarsi of the forelegs are dilated. Reduction in the flight wings is common among Carabidae; some species are always flightless, whereas in others there is polymorphism in wing length.

Carabid females usually lay eggs individually in the ground or rotting wood, but some lay them in groups and guard them until the larvae hatch (Thiele 1977). With the exception of some parasitic forms, carabid larvae are elongate with sclerotized head capsules and forward-projecting mandibles (Fig. 1). They have three pairs of long thoracic legs, and a 10-segmented abdomen bearing urogomphi (terminal projections) (Lindroth 1961–1969). There are three larval instars in most carabid beetles (Bousquet 2010). Carabid pupae (Fig. 1) are seldom seen; they may be housed within a cell or cocoon, and they have soft, white cuticle and free appendage sheaths (Crowson 1981).

Most temperate region carabid beetles have a single defined breeding period in the year (Rivard 1964) and development from egg to reproduction takes one or more years, depending on species. Overwintering occurs either in the adult or larval stage (Thiele 1977), although in Canada, adult overwintering is most common (Lindroth 1961–1969). Most carabids can be characterized as either "spring breeders" or "autumn breeders." Spring breeders have a period of adult activity in the spring, associated with reproduction, and may have a second period of activity later in the year, when adults are feeding preparatory to hibernation; between the two activity periods, the insects are in the form of eggs, larvae, pupae, or inactive adults (Bousquet 2010). Autumn breeders are active in summer and fall, and reproduction occurs at this time; hibernation may occur either as a larva or an adult (Thiele 1977; Bousquet 2010). However, annual rhythms of activity, while they influence sampling efficiency, are not a good guide to physiological state and may vary geographically and between habitats (Thiele 1977).

Carabid beetles have a reputation for being predators, but this is frequently an oversimplification and often completely untrue. Determination of what carabid beetles eat in nature is complicated. For example, in some species, adults and larvae secrete digestive enzymes on to their food and ingest only fluids with no identifiable fragments (Thiele

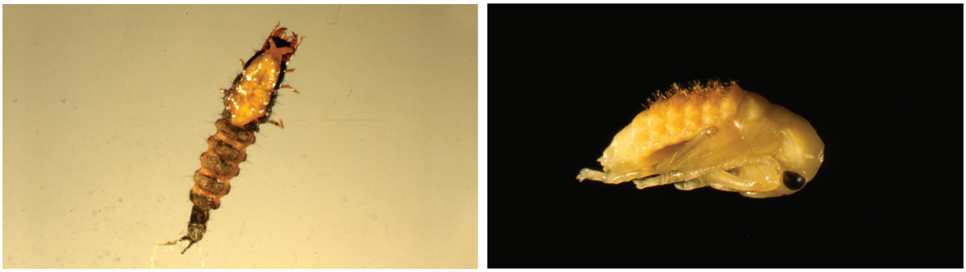


Fig. 1. (Left) A carabid larva on the verge of pupating. (Right) The resulting pupa. Photo credit: K. Floate, Agriculture and Agri-Food Canada, Lethbridge.

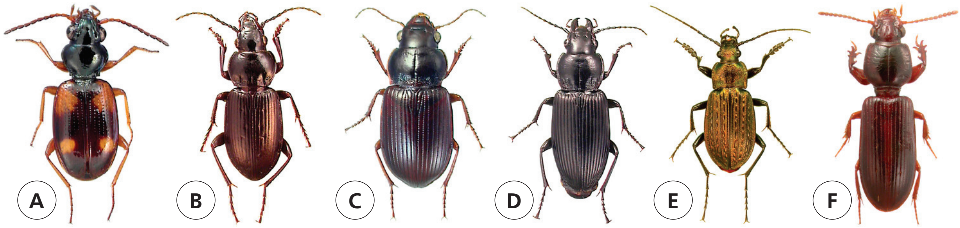


Fig. 2. A, *Bembidion quadrimaculatum* (typical length 3 mm). B, *Pterostichus adstrictus* (11 mm). C, *Amara avida* (9 mm). D, *Pterostichus melanarius* (16 mm). E, *Carabus granulatus* (20 mm). F, *Clivina fossor* (6 mm). Photo credit: H. Goulet, Agriculture and Agri-Food Canada, Ottawa.

1977). Laboratory feeding trials, in which candidate items are offered to beetles in a simple environment, reveal what beetles can eat, but not what they do eat in the wild. A combination of techniques, including direct observation and serological studies, shows that the majority of carabid adults are opportunist omnivores and consume dead or living invertebrates, seeds and other plant tissues, and fungi (Thiele 1977; Bousquet 2010). Notwithstanding this, some adult carabid beetles are carnivores specializing in a narrow range of prey items, and others are largely herbivorous (Johnson and Cameron 1969). These patterns will be discussed below with respect to major tribes inhabiting the Prairies Ecozone. Larvae are generally considered to be more carnivorous in diet (Thiele 1977), although some species appear to feed on microorganisms (Kirk 1972*b*). Known information on the diet of adults and larvae of species of North American Carabidae is summarized in Larochelle and Larivière (2003).

Some studies have suggested that predation by carabid beetles renders them important agents of natural biological control. For example, Frank (1971*b*) showed that in the laboratory, numerous carabids, such as *Bembidion quadrimaculatum* (Fig. 2A), readily consumed the eggs of the redbacked cutworm, *Euxoa ochrogaster* Guenée (Lepidoptera: Noctuidae). Serological tests of field-collected individuals showed that the larger species such as *Harpalus amputatus*, *Poecilus* (*Pterostichus*) *lucublandus*, and *Pterostichus adstrictus* (Fig. 2B) were common predators of the cutworm larvae. However, adults of species such as *Amara avida* (Fig. 2C) and *A. torrida* also gave positive serological tests for cutworms, even though the beetles were unable to kill the larvae. These adults likely scavenged larval remains left by larger predators. Frank concluded that the size of the carabid population was sufficiently large for there to be a significant impact on the cutworm population, but that carabids were not efficient at finding cutworms. Other studies have indicated that carabids may be important predators of pest grasshopper eggs (Songa and Holliday 1997) and pea leaf weevil, *Sitona lineatus* Linnaeus (Coleoptera: Curculionidae) (Vankosky *et al.* 2011). Whether or not carabids are important predators of immature cabbage maggot, *Delia radicum* (Linnaeus) (Diptera: Anthomyiidae), is unclear (Finch and Collier 2007). Mauduit (2012) concluded that *Pterostichus melanarius* (Fig. 2D) can help to prevent pest outbreaks of diamondback moth larvae, *Plutella xylostella* (Linnaeus) (Lepidoptera: Plutellidae), but only when larvae are knocked to the ground by heavy rainfall. Interpretation of the effect of carabids on pest populations is complicated by the possibility of intraguild predation and interference among carabids of different species (Prasad and Snyder 2004, 2006).

The majority of carabid adults and larvae are active on the surface of the ground or in litter and hide under cover or in burrows during daily or annual periods of inactivity (Thiele 1977). Larvae of some species are ambush predators that seldom leave their burrows (Bousquet 2010). Because of their opportunistic feeding habits, the habitat choice of most carabid beetles is not easily linked to patterns of food availability. Factors that are more influential on habitat selection are microclimate, such as degree of shading and moisture availability, and soil texture and chemistry (Lindroth 1961–1969; Thiele 1977). Although many carabid species are said to be associated with specific plants, this is seldom a functional relationship: The plant and the carabid share the same habitat requirements, and the plant is a more visible indicator that those requirements are provided by a specific habitat (Lindroth 1961–1969).

Methods of Sampling

Ideally, sampling methods for understanding the biodiversity of carabid beetles should accurately represent the numbers of each species in the system and reveal meaningful differences in carabid diversity and species composition that may be related to habitat type or manipulation. Unfortunately, these ideals are not attained by current techniques.

Active sampling of carabids by turning over stones and other objects under which the beetles shelter is a favoured collection technique (Lindroth 1961–1969). It works particularly well in open habitats, such as shorelines and dunes, where it may be possible to capture all of the individuals that are found in a shelter. Other active techniques include treading vegetation into water and using a net to catch flying or fast-running beetles. Such active techniques often depend on the skill, speed, and dexterity of the sampler. Successful collecting of a species by these methods often requires the sampler to develop a "search image" of the type of microhabitat used, and so focusing on such locations inevitably results in neglect of other locations within the habitat. Active collecting often introduces personal bias as to what is collected and what is ignored: Individuals of rare species are perhaps over-represented, and those of common species under-represented. Quantitative active sampling in which randomly located quadrats are searched for beetles (e.g., Hancock and Legg 2012), or soil (Holliday and Hagley 1979) or litter samples (e.g., Spence and Niemelä 1994) are taken and processed, can provide less biased samples, but are infrequently used because of the labour involved.

The most frequently used method of field sampling for carabid beetles is pitfall trapping, which is a type of passive trapping. Usually, in this method, a glass, plastic, or metal container is sunk into the ground so that its rim is flush with the surface, and unwary beetles may fall in. The frequency with which carabids fall into such a trap is dependent upon the number of beetles in the area, and by the level of their activity, which is influenced by the annual cycle of spring and fall breeders, as well as daily activity rhythms and weather, particularly temperature (Greenslade 1964). Larger beetles travel farther than smaller beetles and beetle movement is impeded by vegetation and litter; thus, traps tend to over-represent large carabid species, and catches are influenced by ground cover (Greenslade 1964; Luff 1975; Spence and Niemelä 1994). The dependence of catch on beetle density and activity has led to the term "activity density," which many users of pitfall traps (e.g., Bourassa *et al.* 2010; Hummel *et al.* 2012) use to describe the population characteristic that is estimated by trapping. Trap material, size, and shape (Luff 1975); time since trap deployment (Digweed *et al.* 1995); whether there is preservative (Greenslade and Greenslade 1971); and the nature of trap covers (Bell *et al.* 2014) are among other influences that determine which species will be caught and how the catch relates to population abundance in the area. Luff (1975) made recommendations on trap design, and Baars (1979) recommended that for studies of multiple species, the year-round operation of pitfall traps with calibrated catches of each species be combined with independently derived estimates of their density. Morris (2000) concluded that these recommendations allow comparisons of assemblages among British grassland habitats that have different levels of impedance to carabid movement. However, many of the recommendations of Luff (1975) and Baars (1979) are not practical in the context of the prairie climate, or for characterizing assemblages of the order of 50 carabid species. Notwithstanding these issues, almost all studies of carabid assemblages in the Prairies Ecozone have used pitfall traps, as they are far more cost-effective than alternatives. Some researchers have augmented their trap catch data with mark-recapture methods (e.g., Frank 1971*a*), or have calibrated them by using more quantitative techniques (e.g., Floate 1987). The choice of disregarding pitfall trap data is not sensible (Spence and Niemelä 1994), but an appreciation of the properties of such traps and the data they produce is essential if these traps are to provide insight into the assemblages that they sample.

Biodiversity of Carabidae of the Prairies Ecozone

Table 1 brings together published information on the range and habitat associations of the 398 species of carabid beetles that have, according to Bousquet (2012 and references therein), been found in the Prairies Ecozone. Habitat association information for the carabids other than tiger beetles is derived from the outstanding compilation of ecological information of Larochelle and Larivière (2003), which includes the insightful ecological notes of Lindroth (1961–1969). Ecological information for the tiger beetles is derived from the remaining sources listed in the Table 1 title.

Geographical Distribution

The carabid fauna of the Prairies Ecozone consists of 398 species in 72 genera in 28 tribes (Table 1). The numbers of species in the ecozone in each province are Alberta: 326, Saskatchewan: 318, and Manitoba: 327. Of these, 249 of species occur in all three provinces. Numbers of species occurring in only one of the three provinces are Alberta only: 28, Saskatchewan only: 6, and Manitoba only: 40. Finally, numbers of species recorded from two of the provinces but not from the third are Alberta and Saskatchewan: 37, Alberta and Manitoba: 12, and Saskatchewan and Manitoba: 26.

About 3% of carabid species in the Prairies Ecozone are adventive (Table 2); this is similar to the 2.6% of carabid species in North America north of Mexico that are adventive (Bousquet 2012), but somewhat lower than the 5.7% of Canadian carabid species that are adventive (Klimaszewski *et al.* 2012). The proportion of adventive species in the ecozone is considerably lower than the 14.3% in British Columbia (Spence and Spence 1988) and 10.7% in Atlantic Canada (Majka *et al.* 2007). The adventive taxa in the Prairies Ecozone include (Table 1) four species of *Amara,* two species of *Carabus* (*C. granulatus* (Fig. 2E) and *C. nemoralis*), *Pterostichus melanarius* (Fig. 2D), and *Clivina fossor* (Fig. 2F). Although two species of carabids have become established in North America after deliberate introduction for biological control of gypsy moth, *Lymantria dispar* Linnaeus (Lepidoptera: Erebidae), neither occur in the Prairies Ecozone (Bousquet 2012). Adventive species of *Bembidion* are also absent from the Prairies Ecozone, although this genus has the second largest number of adventive species in Canada (Klimaszewski *et al.* 2012).

Table 1. Summary of distribution and ecological information for species of carabid beetles recorded as occurring in the Prairies Ecozone. Assembled from information in Acorn (2001), Bousquet (2012), Larochelle and Larivière (2003), Lindroth (1961–1969), Pearson *et al.* (2006), and Wallis (1961) and references therein.

Tribe **Species**[1]	**Biogeographical Range (Adjacent Distribution)**[2]	**Prov. Rec.**[3]			**Habitat Association**[4]				**Recorded Habitats**[5]
		AB	**SK**	**MB**	**Shade**	**Moisture**	**Soil (Litter)**	**Vegetation (Examples)**	
Harpalini: *Acupalpus*									
A. canadensis Casey	Nea. (E)		X	X	Open–shaded	Wet, near water	Clay, mud (org. debris)	Dense	—
A. carus LeConte	Nea. (TC)		X	X	Shaded	Wet, near water	Clay (org. debris)	Dense	WL
A. meridianus (L.)	Adv. Pal. (W)	X			Open	Moist	Clay	Weeds	CL
A. nanellus Casey	Nea. (E)			X	Shaded	Wet, near water	(Org. debris)	Dense tall (rushes)	—
Harpalini: *Agonoleptus conjunctus* (Say)	Nea. (TC)	X	X	X	Open	Dry	Sandy	Sparse	PR, PA, CL, WL
Platynini: *Agonum*									
A. affine Kirby	Nea. (TC)	X	X	X	Open	Wet, near water	Mud, peat	Dense (sedges, moss)	—
A. anchomenoides Randall	Nea. (TC)	X	X	X	Open	Moist, near water	Clay, mud	Bare–sparse (rushes)	—
A. canadense Goulet	Nea. (E)			X	Open	Wet, swampy	—	Some (sedges, *Sphagnum*)	—
A. corvus (LeConte)	Nea. (Int)	X	X	X	Open	Wet, near water	Clay	Some (sedges, rushes)	—
A. cupreum Dejean	Nea. (TC)	X	X	X	Open	Dry	Sandy	Sparse (grass)	PA, CL
A. cupripenne (Say)	Nea. (TC)	X	X	X	Open	Dry	Gravel, sand	Thin	PA, CL, WL
A. decorum (Say)	Nea. (Int & W)		X	X	Shaded	Wet, near water	Clay	Dense (grass)	—
A. errans (Say)	Nea. (Int)	X	X	X	Open	Wet, often near water	Sand–clay, often sal.	Bare–sparse	PA, CL, WL
A. extensicolle (Say)	Nea. (E)		X	X	Open–shaded	Wet, water's edge	Sand, clay, mud	Bare–sparse	—
A. ferruginosum (Dejean)	Nea. (W)	X	X		Open–light shade	Wet, near water	Clay, mud	Dense emergent or floating (rushes, sedges)	—
A. gratiosum (Mannerheim)	Nea. (TC)	X	X	X	Open	Moist, near water	Often peaty	Some (sedges, moss)	WL
A. harrisii LeConte	Nea. (TC)	X	X	X	Open–light shade	Wet, near water	(Org. debris)	Dense (sedges, rushes)	WL
A. lutulentum (LeConte)	Nea. (TC)	X	X	X	Open	Wet, near water	Flooded	Dense emergent (rushes, sedges)	PA, WL
A. melanarium Dejean	Nea. (TC)	X	X	X	Open–shaded	Wet, water's edge	Clay (org. debris)	Some (rushes, sedges)	WL

A. moerens Dejean	Nea. (E)			X	Open–shaded	Wet, near water	(Org. debris)	Some (rushes, moss)	WL
A. muelleri (Herbst)	Adv. Pal. (TC)	X			Open	Dry	Clay	Some (grass, weeds)	PA, CL
A. mutatum Gemminger & Harold	Nea. (TC)	X	X	X	Open	Very wet, water's edge	Swampy	Moss carpets (*Sphagnum*)	—
A. nigriceps LeConte	Hol. (TC)	X	X	X	Open	Water's edge	Flooded	Dense emergent (sedges)	—
A. piceolum (LeConte)	Nea. (TC)	X	X	X	Shaded	Moist, upper littoral	Clay, sand, gravel	Bare–sparse (grass)	—
A. picicornoides Lindroth	Nea. (TC)	X	X	X	Shaded	Wet, near water	Clay, clay & sand	Sparse	—
A. placidum (Say)	Nea. (TC)	X	X	X	Open	Very dry	Sand	Covered (weeds)	PR, PA, CL, WL
A. propinquum (Gemminger & Harold)	Nea. (TC)	X	X	X	Open	Wet, near water	(Org. debris)	Mod. dense (sedges, moss)	PA, WL
A. quinquepunctatum Motschulsky	Hol. (Bor)	X	X	X	Open	Moist	Peaty	—	—
A. retractum LeConte	Nea. (TC)	X	X	X	Shaded	Moist	(Thick leaf litter)	—	WL
A. sordens Kirby	Nea. (TC)	X	X	X	Open–shaded	Moist, often near water	Sand (org. debris)	Mod. dense (sedges, grass)	WL
A. superioris Lindroth	Nea. (E)	X	X	X	Open	Wet, near water	Mud	Dense (rushes, sedges, moss)	—
A. suturale Say	Nea. (W)	X	X		Open	Wet, water's edge	Clay	Sparse	PA, CL
A. thoreyi Dejean	Hol. (TC)	X	X	X	Open	Wet, near water	Flooded or clay, mud	Dense emergent (rushes, sedges, moss)	—
A. trigeminum Lindroth	Nea. (E)			X	Shaded	Wet, near water	Clay, mud (org. debris)	Some (rushes, sedges, grass)	WL
Zabrini: *Amara*									
A. aenea (DeGeer)	Adv. Pal. (TC)	X		X	Open	Dry	Sandy	Some	CL
A. angustata (Say)	Nea. (Int)		X	X	Open	Moist		Meadow (grass)	PR, PA, CL, WL
A. apricaria (Paykull)	Adv. Pal. (TC)	X	X	X	Open	Dryish	Sand, loam	Some (weeds, grass)	CL
A. avida (Say)	Nea. (Int & E)	X	X	X	Open	Dry	Sandy	Some (weeds)	PA, CL
A. blanchardi Hayward	Nea. (GP*)	X	X		—	Near water	—	—	—

Tribe Species[1]	Biogeographical Range (Adjacent Distribution)[2]	Prov. Rec.[3]			Habitat Association[4]				Recorded Habitats[5]
		AB	SK	MB	Shade	Moisture	Soil (Litter)	Vegetation (Examples)	
A. carinata (LeConte)	Nea. (Int)	X	X	X	Open	Moist, often near alk. water	Sand, clay	Some	PA, CL
A. coelebs Hayward	Nea. (W)	X	X	X	Open	Dry	Sandy	Some (grass, wormwood)	PA, CL
A. confusa LeConte	Nea. (W)	X	X	X	Open	Dry	Clay & gravel	Some (grass)	CL
A. convexa LeConte	Nea. (TC)	X	X	X	Open	Dry	Sandy	Some (grass, weeds)	PR, PA, CL
A. cupreolata Putzeys	Nea. (TC)	X	X	X	Open	Dry	Sandy	Tall (weeds)	PR, PA, CL, WL
A. discors Kirby	Nea. (W)	X	X	X	Open	Dry	Sandy	Sparse	PA
A. ellipsis (Casey)	Nea. (TC)	X	X	X	Open	Dry	Sand, gravel	Some (grass, weeds)	PR, CL
A. erratica (Duftschmid)	Hol. (Bor)	X	X	X	Open	Dry	Sandy	Some (grass, weeds)	—
A. familiaris (Duftschmid)	Adv. Pal. (TC)	X	X	X	Open	Dry	Sand	Some (stitchwort, smartweed)	PA, CL, WL
A. farcta LeConte	Nea. (W)	X	X	X	Open	Dry, often near alk. water	Sand, loam	Some (weeds, grass)	PA, CL
A. flebilis (Casey)	Nea. (E)			X	—	—	—	—	—
A. lacustris LeConte	Nea. (TC)	X	X	X	Open	Dry, near water	Clay	Discontinuous (grass)	CL
A. laevipennis Kirby	Nea. (TC)	X	X	X	Open	Dry	Sandy	Sparse–mod. (grass)	CL
A. latior (Kirby)	Nea. (TC)	X	X	X	Open–shaded	Dryish	Sandy	Sparse	PA, CL, WL
A. littoralis Dejean	Hol. (TC)	X	X	X	Open	Dryish	Sandy	Rich discontinuous (weeds)	PA, CL, WL
A. lunicollis Schiødte	Hol. (TC)	X	X	X	Open	Dryish	Gravel, peat	Some (weeds)	CL, WL
A. musculis (Say)	Nea. (TC)	X	X	X	Open	Dry	Sandy	Sparse (goldenrod)	PA, CL, WL
A. neoscotica Casey	Nea. (E)	X	X	X	—	—	—	—	—
A. obesa (Say)	Nea. (TC)	X	X	X	Open–shaded	Dry	Sandy	Sparse	PA, CL
A. otiosa Casey	Nea. (E)			X	—	—	—	—	—
A. ovata Fabricius	Adv. Pal. (TC)	X			Open	Dry	Sand, gravel	Sparse	WL
A. pallipes Kirby	Nea. (TC)	X	X	X	Open	Moist, often near water	—	Meadow (grass)	CL, WL

A. patruelis Dejean	Nea. (TC)	X	X	X	Open	Dryish	Sandy	Sparse (weeds)	CL
A. pseudobrunnea Lindroth	Nea. (Bor)	X	X	X	Open–shaded	Dry	Sandy	Sparse	WL
A. quenseli (Schönherr)	Hol. (TC)	X	X	X	Open–shaded	Dry	Sandy	Sparse	CL
A. scitula Zimmermann	Nea. (W)	X	X	X	Open	Near alk. waters	Clay, often alk.	Some (grass)	CL
A. sinuosa (Casey)	Nea. (TC)	X	X	X	Open–shaded	Dry	Sand, gravel	Sparse, low	CL
A. tenax Casey	Nea. (W)	X	X	X	—	—	—	—	—
A. thoracica Hayward	Nea. (GP*)	X	X		Open	Dry	Sandy	Grass-covered	—
A. torrida (Panzer)	Hol. (TC)	X	X	X	Open–shaded	Dryish	—	Dense (grass, weeds)	CL
A. turbata Casey	Nea. (Int)	X	X		—	—	—	—	—
Harpalini:									
Amphasia sericea (T.W. Harris)	Nea. (E)		X	X	Open	Dry	Sandy	Mod.–dense	PA, CL
Platynini:									
Anchomenus aeneolus (LeConte)	Nea. (Mont)	X			Open	Wet, water's edge	Gravel, stony	Bare	—
Harpalini: *Anisodactylus*									
A. californicus Dejean	Nea. (W)	X			Open	Moist–wet, near water	Mud, clay, loam	Mod.–dense (grass, forbs)	CL
A. discoideus Dejean	Nea. (E)		X	X	Open	Wet, near water	Sand, silt & sand	Bare–sparse	CL
A. harrisii LeConte	Nea. (TC)	X	X	X	Open	Moist, near water	Clay, mud	Meadow-like	PR, PA, CL
A. kirbyi Lindroth	Nea. (E)			X	Open–shaded	Wet, near water	Sandy (org. debris)	Dense depressed (grass, sedges)	WL
A. merula (Germar)	Nea. (E)			X	Open	Very dry	Sandy	Sparse	PA, CL, WL
A. nigrita Dejean	Nea. (TC)	X	X	X	Open	Wet, near water	Sand & clay	Dense depressed (grass, sedges)	WL
A. pitychrous LeConte	Nea. (W)	X	X	X	Open	Moist–wet	—	Grass or forbs	WL
A. rusticus (Say)	Nea. (E)			X	Open	Dry	Sandy	Thin often tall (grass)	PA, CL, WL
A. sanctaecrucis (Fabricius)	Nea. (TC)	X	X	X	Open	Moist–wet	Sandy	Dense (grass)	PA, CL, WL
A. verticalis (LeConte)	Nea. (E)		X	X	Shaded	Moist–wet	Clay, mud (org. debris)	Flood-plain forest	WL
Lebiini:									
Apristus latens (LeConte)	Nea. (E)		X	X	Open	Dry, near water	Sand, gravel	Bare	—

Tribe Species[1]	Biogeographical Range (Adjacent Distribution)[2]	Prov. Rec.[3]			Habitat Association[4]				Recorded Habitats[5]
		AB	SK	MB	Shade	Moisture	Soil (Litter)	Vegetation (Examples)	
Lebiini:									
Axinopalpus biplagiatus (Dejean)	Nea. (E & S)	X	X	X	Open	Dry	Sandy	Sparse (grass)	PR, PA, CL
Licinini: *Badister*									
B. grandiceps Casey	Nea. (TC)	X		X	Shaded	Wet, near water	Clay, mud (org. debris)	Dense (rushes, sedges)	WL
B. neopulchellus Lindroth	Nea. (TC)	X	X	X	Shaded	Moist–wet, near water	Clay, mud (org. debris)	Dense tall (rushes, willows)	WL
B. obtusus LeConte	Nea. (TC)	X	X	X	Shaded	Moist	Gravel, stony (leaf litter)	—	CL, WL
B. parviceps Ball	Nea. (E)			X	Shaded	Moist, near water	(Thick leaf litter)	—	WL
B. transversus Casey	Nea. (E)			X	Shaded	Wet	Clay, mud (org. debris)	—	WL
Bembidiini: *Bembidion*									
B. acutifrons LeConte	Nea. (W)	X	X	X	Open	Wet, near water	Clay	Some (rushes, grass)	—
B. aeneicolle (LeConte)	Nea. (W)	X	X	X	Open	Moist, water's edge	Clay, feebly alk.	Sparse (halophytes)	—
B. balli Lindroth	Nea. (Endem)	X	X		Open	Wet, river banks	Sandy	Bare	—
B. bimaculatum (Kirby)	Nea. (Int & W)	X	X	X	Open	Moist, upper littoral	Clay	Sparse	CL
B. canadianum Casey	Nea. (Int)	X	X	X	Open	Moist–wet near water	Clay	Sparse–mod.	CL
B. carinula Chaudoir	Nea. (TC)	X	X	X	Open	Moist, water's edge	Sand	Bare	—
B. castor Lindroth	Nea. (E)	X	X	X	Open	Moist–wet, upper littoral	Sand & clay (org. debris)	Bare	—
B. chalceum Dejean	Nea. (TC)	X	X	X	Open	Moist, upper littoral	Gravel, coarse sand	Bare	—
B. cheyennense Casey	Nea. (E)	X	X	X	Open	Wet, near water	Clay, mud	Bare–sparse	CL
B. coloradense Hayward	Nea. (W)	X	X	X	Open	Wet, water's edge	Clay, occ. alk.	Sparse (sedges)	—

B. concolor (Kirby)	Nea. (TC)	X	X	X	Open	Wet, river & lake shores	Gravel, coarse sand	Bare	—
B. concretum Casey	Nea. (TC)	X	X	X	Open	Wet, near water	Mud, clay, peat (org. debris)	Dense (sedges, rushes, moss)	—
B. confusum Hayward	Nea. (E)	X	X	X	Open	Wet, water's edge	Sand, sand & clay	Bare	—
B. consimile Hayward	Nea. (GP)	X	X	X	Open	Moist, near water	Clay, sal.	Sparse (halophytes)	—
B. constricticolle Hayward	Nea. (GP)	X			—	—	—	—	—
B. cordatum (LeConte)	Nea. (E)		X	X	Open	Wet, water's edge	Sand & clay	Emergent	—
B. coxendix Say	Nea. (S)	X	X	X	Open	Moist, river banks	Sand, clay	Bare	—
B. dejectum Casey	Nea. (GP*)	X	X	X	Open	Moist, near sal. water	Sal. clay	Bare	—
B. diligens Casey	Nea. (GP*)	X	X	X	Open	Moist, near sal. water	Clay, mud	Bare–mod. dense (halophytes)	—
B. dorsale Say	Nea. (GP*)	X	X	X	Open–light shade	Moist, upper littoral	Clay	Bare	—
B. flohri Bates	Nea. (GP*)	X	X	X	Open	Moist, near sal. water	Sal. clay	Sparse (halophytes)	—
B. fortestriatum (Motschulsky)	Nea. (TC)	X	X	X	Open–light shade	Wet, near water	Clay, mud (org. debris)	Dense (sedges)	WL
B. foveum Motschulsky	Hol. (Bor)		X	X	Open	Water's edge	Sand & clay, sand & silt	Bare	—
B. frontale (LeConte)	Nea. (Int & E)		X	X	Shaded	Wet, near water	Org. clay (leaf litter)	Dense	—
B. gebleri Casey	Nea. (W)	X			Open	Moist river banks	Gravel	Bare	—
B. graphicum Casey	Nea. (Int)	X	X	X	Open	Wet, near water	Clay, alk. or sal.	Sparse (halophytes)	—
B. grapii Gyllenhal	Hol. (TC)	X	X	X	Open–shaded	Dryish	Gravel & sand	Sparse (tiny moss)	CL, WL
B. impotens Casey	Nea. (TC)		X	X	Open	Wet, near water	Clay, sand	Bare–sparse	—
B. inaequale Say	Nea. (TC)	X	X	X	Open	Wet, near water	Clay, clay & sand	Bare–sparse	—
B. incrematum LeConte	Nea. (TC)	X	X	X	Shaded	Wet, near water	Mud (org. debris)	Sparse	—
B. insulatum (LeConte)	Nea. (W)	X	X	X	Open	Moist	Alk. or sal. clay	Sparse (halophytes)	CL
B. intermedium (Kirby)	Nea. (Int)	X	X	X	Open	Moist–wet, near water	Clay, clay & sand	Bare–sparse (sedges, rushes)	—

Tribe Species[1]	Biogeographical Range (Adjacent Distribution)[2]	Prov. Rec.[3]			Habitat Association[4]				Recorded Habitats[5]
		AB	SK	MB	Shade	Moisture	Soil (Litter)	Vegetation (Examples)	
B. interventor Lindroth	Nea. (Int)	X	X	X	Open	Upper littoral, river banks	Sand & clay	Some	—
B. lachnophoroides Darlington	Nea. (Endem)	X	X		Open	Wet, water's edge	Coarse sand	Bare	—
B. lapponicum Zetterstedt	Hol. (W)	X	X		Open	Wet, river & lake shores	Sand, sand & clay	Bare	—
B. levettei Casey	Nea. (TC)	X	X	X	Open	Moist, near water	Sand, sand & clay	Bare–sparse	—
B. levigatum Say	Nea. (S)	X			Open	Moist–wet, river banks	Sand, sand & clay	Bare–sparse	—
B. mimus Hayward	Nea. (E)		X	X	Open–light shade	Moist, near water	Peat, sand, clay	Sparse with bare spots	CL
B. muscicola Hayward	Nea. (E)		X	X	Shaded	Moist, near water	Clay, mud (org. debris)	Some (sedges)	WL
B. mutatum Gemminger & Harold	Nea. (TC)	X	X	X	Open	Moist	Fine sand (org. debris)	Very sparse (tiny mosses)	PA, CL
B. nigripes (Kirby)	Hol. (TC)	X	X	X	Open	Moist–wet, near water	Clay, often sal. or alk.	Sparse (grass)	—
B. nitidicolle Bousquet	Nea. (GP)		X		—	—	Prairie dog mound	—	—
B. nitidum (Kirby)	Nea. (TC)	X	X	X	Open	Dry	Sandy	Sparse–mod. (wormwood, grass)	CL
B. nudipenne Lindroth	Nea. (GP)	X	X	X	Open	Dry	Sandy	Sparse	PA, CL
B. oberthueri Hayward	Nea. (E)	X	X	X	Open	Moist–wet, near water	Sand & clay	Sparse (rushes, horsetails)	—
B. obscurellum (Motschulsky)	Hol. (TC)	X	X	X	Open	Moist–wet, near water	Sand, clay, mud	Sparse	CL
B. obtusangulum LeConte	Nea. (GP*)	X	X	X	Open	Moist, upper littoral	Sal. clay	Some (halophytes)	—
B. obtusidens Fall	Nea. (GP & E)	X	X	X	Open	Moist near water	Sal. clay	Some (halophytes)	—
B. occultator Notman	Nea. (E)	X	X		Shaded	Wet, near water	Sand, clay (org. debris)	Low sparse (under alder, willow)	WL
B. patruele Dejean	Nea. (TC)	X	X	X	Open–shaded	Wet, near water	Clay, mud	Sparse (grass, sedges)	PA

B. petrosum Gebler	Hol. (TC)	X	X	X	Open	Moist–wet, near water	Sand, often stony, sal.	Bare–sparse	—
B. planatum (LeConte)	Nea. (W)	X			Open	Moist–wet, water's edge	Gravel, stony	Bare	—
B. planiusculum Mannerheim	Nea. (W)	X			Open–shaded	Moist, water's edge	Stony, gravelly	—	—
B. praecinctum LeConte	Nea. (GP*)	X	X	X	Open	Dry, upper littoral	Gravel, clay	—	—
B. praticola Lindroth	Nea. (TC)		X		Shaded	Moist, often near water	Clay, mud (leaf litter)	Some (sedges, grass, moss)	WL
B. pseudocautum Lindroth	Nea. (TC)	X	X	X	Shaded	Wet, near water	Clay	Dense (rushes, loosestrife)	WL
B. punctatostriatum Say	Nea. (W)	X	X	X	Open	Moist, near water	Sand & clay	Bare	—
B. quadrimaculatum (Linnaeus)	Nea. (TC)	X	X	X	Open	Dry	Fine sand, clay	Bare	CL, WL
B. quadrulum LeConte	Nea. (Mont)	X			Open	Moist–wet, near water	Sandy	—	—
B. rapidum (LeConte)	Nea. (E)	X	X	X	Open	Moist–wet, near water	Clay, mud, sand	Some	PA, CL, WL
B. recticolle LeConte	Nea. (W)	X			Open	Moist, near water	Gravel & sand, clay	Bare	—
B. roosevelti Pic	Nea. (GP*)	X	X	X	Open	Moist, distant from water	Alk.	Dense (grass)	—
B. rubiginosum LeConte	Nea. (GP)	X	X		Open	Moist, near alkali ponds	—	Some	—
B. rupicola (Kirby)	Nea. (Int)	X	X	X	Open	Very dry	Clay, loam, sand, gravel	Some	CL
B. salebratum (LeConte)	Nea. (Int & E)	X	X	X	Open	Moist–wet, near water	Gravel, sand, clay	Bare	—
B. salinarium Casey	Nea. (GP*)	X	X	X	Open	Wet, near alk. water	Sal., alk.	Bare–sparse	—
B. scopulinum (Kirby)	Hol. (TC)	X	X	X	Open–light shade	Moist–wet, near water	Clay, gravel	Bare–sparse	—
B. scudderi LeConte	Nea. (GP*)	X	X	X	Open	Moist, near sal. water	Sal. clay	Bare–sparse (halophytes)	—

Tribe Species[1]	Biogeographical Range (Adjacent Distribution)[2]	Prov. Rec.[3]			Habitat Association[4]				Recorded Habitats[5]
		AB	SK	MB	Shade	Moisture	Soil (Litter)	Vegetation (Examples)	
B. sejunctum Casey	Nea. (GP & Bor)	X	X		Open	Moist, near sal. water	Sal. fine sand	Bare	—
B. semipunctatum (Donovan)	Hol. (Bor)	X	X	X	Shaded	Moist, upper littoral	Sand & clay	Bare–sparse (horsetails)	—
B. sordidum (Kirby)	Nea. (GP & Bor)	X	X	X	Shaded	Moist, upper littoral	Clay	Sparse	—
B. texanum Chaudoir	Nea. (S)			X	Open–shaded	Moist–wet, near water	Gravel, gravel & clay	Some	WL
B. timidum (LeConte)	Nea. (Int & W)	X	X	X	Open	Moist, near water	Sand, clay, mud, peat (org. debris)	Bare patches in sparse veg.	PA, CL
B. transparens (Gebler)	Hol. (TC)	X	X	X	Open	Wet, near water	Clay, mud, peat (org. debris)	Dense (sedges, rushes, moss)	—
B. transversale Dejean	Nea. (TC)	X	X	X	Open–light shade	Moist–wet, water's edge	Gravel, coarse sand	Bare	—
B. umbratum (LeConte)	Nea. (W)	X	X		Shaded	Wet, near water	Clay & sand	Bare	—
B. versicolor (LeConte)	Nea. (TC)	X	X	X	Open–light shade	Moist, near water	Sand, clay, peat (org. debris)	Bare patches in sparse veg. (sedges)	CL
B. viridicolle (LaFerté-Sénectère)	Nea. (E)	X	X	X	Open	Wet, near water	Clay, alk. or sal.	Sparse (halophytes)	—
Elaphrini: *Blethisa*									
B. hudsonica Casey	Nea. (TC)	X	X	X	Open–shaded	Wet, near water	Mud, clay (org. debris)	Dense (rushes, sedges, moss)	—
B. julii LeConte	Nea. (E)	X	X	X	Open–shaded	Wet, near water	Mud	Bare patches in moss carpets	—
B. quadricollis Haldeman	Nea. (Int & E)	X	X	X	Open	Wet, near water	—	Floating moss (*Sphagnum*)	—
Brachinini: *Brachinus*									
B. cyanipennis Say	Nea. (E)			X	Open–shaded	Moist–wet, near water	Sand, gravel, clay, mud	—	WL
B. cyanochroaticus Erwin	Nea. (Int & E)		X	X	Open–light shade	Wet, near water	Sand, gravel, clay, mud	—	WL

B. fumans (Fabricius)	Nea. (Int & E)	X		X	Open–light shade	Wet, near water	Gravel & mud, occ. sal.	—	—
B. quadripennis Dejean	Nea. (Int)	X	X	X	—	Moist, often near water	—	—	CL
Harpalini: *Bradycellus*									
B. atrimedeus (Say)	Nea. (E)			X	Open	Wet, near water	Sand & silt (leaf litter)	Sparse (horsetails)	—
B. congener (LeConte)	Nea. (TC)	X	X	X	Open	Mod. wet	Clay, often sal.	Some (grass)	PA, CL
B. lecontei Csiki	Nea. (TC)	X	X	X	Open	Moist, near water	Clay	Patchy mats (grass, sedges, rushes)	CL
B. lugubris (LeConte)	Nea. (E)	X	X	X	Shaded	Moist–wet, near water	Often rich in humus	Bushes or trees	WL
B. neglectus (LeConte)	Nea. (TC)	X	X	X	Open	Dry	Gravel	Sparse, low	CL
B. nigerrimus Lindroth	Nea. (GP)	X	X		Open	Moist–wet, near water	Clay, often alk.	Some (sedges, grass, rushes)	CL
B. nigriceps LeConte	Nea. (E)			X	Open	Moist–wet, near water	Clay, mud, often sal.	Dense (grass, rushes)	CL
B. nigrinus (Dejean)	Nea. (TC)	X	X	X	Open–shaded	Moist, near water	Often rich in humus	Patchy (grass, sedges, rushes)	WL
B. semipubescens Lindroth	Nea. (E)			X	Shaded	Wet, near water	Often rich in humus	Bushes	WL
Sphodrini: *Calathus*									
C. advena (LeConte)	Nea. (Mont & E)	X	X		Shaded	Moist	(Org. debris)	Bare	WL
C. ingratus Dejean	Nea. (TC)	X	X	X	Open–shaded	Moist–dry	Often gravelly (leaf litter)	Sparse (grass)	CL, WL
Lebiini: *Calleida*									
C. punctata LeConte	Nea. (E)			X	Open	Moist	—	On herbs, shrubs, trees	PA, CL, WL
C. purpurea (Say)	Nea. (S)			X	—	—	—	On herbs, shrubs, trees	PR, WL
Carabini: *Calosoma*									
C. calidum (Fabricius)	Nea. (Int & E)	X	X	X	Open	Dry	Sandy	Bare or low plants, on trees	PA, CL, WL
C. frigidum Kirby	Nea. (TC)	X	X	X	Shaded	Dry	(Leaf litter)	On trees, shrubs	WL
C. lepidum LeConte	Nea. (GP)	X	X	X	Open	Dry	—	Some (grass)	PR, CL
C. luxatum Say	Nea. (GP*)	X	X		Open	Very dry	Sandy, clay, rock	Some (grass)	PR, WL

Tribe Species[1]	Biogeographical Range (Adjacent Distribution)[2]	Prov. Rec.[3]			Habitat Association[4]				Recorded Habitats[5]
		AB	SK	MB	Shade	Moisture	Soil (Litter)	Vegetation (Examples)	
C. moniliatum (LeConte)	Nea. (GP*)	X	X		Open	Dry	—	—	WL
C. obsoletum Say	Nea. (GP*)	X	X	X	Open	—	—	Some (grass, weeds)	PR, CL
Carabini: *Carabus*									
C. chamissonis Fischer von Waldheim	Nea. (Bor)	X	X	X	Open–shaded	Dry–moist	Stony (leaf litter)	Patchy (crowberry)	WL
C. granulatus Linnaeus	Adv. Pal. (TC)	X		X	Open–light shade	Dryish, near water	Clay	Some	CL, WL
C. maeander Fischer von Waldheim	Hol. (TC)	X	X	X	Open	Moist, usually near water	Clay, mud, peat	Mod.–dense (grass, sedges, rushes)	CL, WL
C. nemoralis Müller	Adv. Pal. (TC)	X	X		Open–shaded	Mod. moist	Clay	Some	CL, WL
C. serratus Say	Nea. (Int & E)	X	X	X	Open	Dry	Gravel, sand	Sparse	CL, WL
C. taedatus Fabricius	Nea. (TC)	X	X	X	Open	Dry	Gravel (leaf litter)	Thin, low	CL, WL
Chlaeniini: *Chlaenius*									
C. alternatus G.H. Horn	Nea. (TC)	X	X	X	Open	Wet, usually near water	Clay	Dense (sedges, rushes)	CL
C. harpalinus Eschscholtz	Nea. (W)	X			Shaded	Moist, near water	—	—	WL
C. lithophilus Say	Nea. (TC)	X	X	X	Open–shaded	Moist–wet, near water	Clay, mud, gravel, sand	Dense (grass)	—
C. nebraskensis LeConte	Nea. (GP)	X	X		Open	Moist, near water	—	—	—
C. pennsylvanicus Say	Nea. (TC)	X	X	X	Open–light shade	Wet, near water	Mud, clay (org. debris)	Bare patches in dense veg. (grass, sedges, rushes)	WL
C. purpuricollis Randall	Nea. (Int)	X	X	X	Open	Dry	Limestone, sand	Dense–sparse (grass, forbs, shrubs)	PR
C. sericeus (Forster)	Nea. (TC)	X	X	X	Open	Moist	Mud, gravel (org. debris)	Some (grass, sedges)	PA, CL, WL
C. solitarius Say	Nea. (GP)	X			Open	Moist, near water	Mud, sand	Bare	—
C. tomentosus (Say)	Nea. (E)	X	X	X	Open	Dry	Sandy	Some (grass, weeds)	PR, PA, CL, WL
C. tricolor Dejean	Nea. (E)	X	X		Open–shaded	Wet–moist	Gravel, sand, mud	—	PA, CL, WL

Cicindelini: *Cicindela*									
C. decemnotata Say	Nea. (GP*)	X	X		Open	—	Gravel, clay	Sparse (grass, sage brush)	PR
C. denikei Brown	Nea. (E)			X	—	—	Sand, gravel, rock	Clearings in conifer stands	—
C. duodecimguttata Dejean	Nea. (E)	X	X	X	Open	Moist, often at water's edge	Silt, sand, clay	Bare	—
C. formosa Say	Nea. (GP & E)	X	X	X	Open	Dry	Sand	Bare–sparse	—
C. fulgida Say	Nea. (GP*)	X	X	X	Open	Moist, near water	Sal. or alk.	Short, sparse (grass)	—
C. hirticollis Say	Nea. (TC)	X	X	X	Open	At water's edge	Sand	Bare	—
C. lengi Horn	Nea. (GP)	X	X	X	Open	Dry	Sand, sand & clay	Sparse, clearings in pine stands	—
C. limbalis Klug	Nea. (Int & E)	X	X	X	Open	—	Clay slopes	Bare–sparse	—
C. limbata Say	Nea. (GP)	X	X	X	Open	Dry	Sand	Bare–sparse	—
C. longilabris Say	Nea. (TC)	X	X	X	Open–shaded	—	Sand, gravel	Grassy, near conifers	—
C. nebraskana Casey	Nea. (Int)	X	X	X	Open	—	Clay	Bare, near sparse grass	PR
C. punctulata Olivier	Nea. (E)	X	X	X	Open	Dry	Sandy loam	Sparse (grass)	PR, CL
C. purpurea Olivier	Nea. (W)	X	X	X	Open	Dry	Clay, sand & clay	Bare, near grass	PR, CL
C. repanda Dejean	Nea. (TC)	X	X	X	Open	Moist, water's edge	Sand, mud, occ. alk.	—	—
C. scutellaris Say	Nea. (GP & E)	X	X	X	Open	Dry	Sandy	Very sparse (scurf pea)	PR
C. tranquebarica Herbst	Nea. (GP)	X	X	X	Open	Dry–moist	Clay, sand	Bare	PR
Clivinini: *Clivina*									
C. collaris (Herbst)	Adv. Pal. (TC)			X	Open	Moist	Rich in humus	Bare–sparse	CL
C. fossor (Linnaeus)	Adv. Pal. (TC)	X	X		Open–light shade	Moist–wet	Clay	Some	PA, CL, WL
Harpalini:									
Cratacanthus dubius (Palisot de Beauvois)	Nea. (S)	X	X		Open	Dry	Clay, sand	Some (grass)	PA, CL, WL
Cicindelini:									
Cylindera terricola (Say)	Nea. (Int)	X	X	X	Open	Dry–wet	Alk., sal.	Sparse (grass)	—
Lebiini: *Cymindis*									
C. borealis LeConte	Nea. (Int & E)	X	X	X	Open	Dry	Sandy	Short, sparse (grass)	CL

Tribe Species[1]	Biogeographical Range (Adjacent Distribution)[2]	Prov. Rec.[3]			Habitat Association[4]				Recorded Habitats[5]
		AB	SK	MB	Shade	Moisture	Soil (Litter)	Vegetation (Examples)	
C. cribricollis Dejean	Nea. (TC)	X	X	X	Open–light shade	Dry	Sandy (leaf litter)	Sparse (grass)	CL, WL
C. interior Lindroth	Nea. (GP)	X	X	X	—	—	—	—	—
C. neglecta Haldeman	Nea. (E)	X	X	X	Shaded	Dry	Sandy (thick leaf litter)	—	WL
C. pilosa Say	Nea. (E)			X	Open	Dry	Sandy	Sparse	PR, PA, CL, WL
C. planipennis LeConte	Nea. (W)	X	X	X	Open	Dry	Sandy	Sparse (grass)	PR, PA, CL
Licinini: *Dicaelus*									
D. laevipennis LeConte	Nea. (GP)	X			Open	Moist	—	—	—
D. sculptilis Say	Nea. (Int)		X	X	Open–shaded	Dry–moist	Clay, sand	Some	CL, WL
Harpalini:									
Dicheirotrichus cognatus (Gyllenhal)	Hol. (TC)	X	X	X	Open–light shade	Dry	Sandy	Sparse (grass, moss)	PA, CL, WL
Licinini: *Diplocheila*									
D. obtusa (LeConte)	Nea. (TC)	X	X	X	Open	Dry	Gravel, sand, stony, chalk	Sparse (grass)	PA, CL
D. oregona (Hatch)	Nea. (GP*)	X	X	X	Open	Moist, near water	Often alk.	—	—
D. striatopunctata (LeConte)	Nea. (Int & E)	X	X	X	Open–shaded	Wet, near water	Mud, clay (org. debris)	Tall, dense (rushes)	WL
D. undulata Carr	Nea. (S)	X		X	Open	Moist	Muddy or calcareous	Dense (sedges, grass, *Sphagnum*)	PR
Patrobini:									
Diplous aterrimus (Dejean)	Nea. (W)	X			Open–light shade	Moist, water's edge	Coarse gravel & stones	Bare	—
Lebiini:									
Dromius piceus Dejean	Nea. (TC)	X	X	X	Shaded	—	—	On tree trunks	WL
Dyschiriini: *Dyschirius*									
D. aratus LeConte	Nea. (GP*)	X		X	Open	Wet, near water	Sand & mud	Bare–sparse	—
D. campicola Lindroth	Nea. (GP*)	X		X	Open	Moist, near water	Sand, sand & silt, alk. or sal.	Bare–sparse	—
D. carrorum Bousquet	Nea. (Endem)			X	—	—	Sandy	—	—

D. criddlei Fall	Nea. (GP)			X	Open	Moist	Sal. or alk.	—	—
D. dejeanii Putzeys	Nea. (TC)	X	X	X	Open	Moist–wet, near water	Clay (org. debris)	Bare patches in depressed veg.	PA, CL, WL
D. globulosus (Say)	Nea. (TC)	X	X	X	Open	Moist	Sand, sand & clay	Bare–sparse (tiny mosses)	PA, CL
D. hiemalis Bousquet	Nea. (Bor)	X	X	X	Open	Moist	Peaty	—	—
D. interior Fall	Nea. (GP)	X	X	X	Open	Near water	Sand, sal. or alk.	Bare	—
D. longulus LeConte	Nea. (TC)	X	X	X	Open	Moist	Sand, gravel, clay (org. debris)	Sparse (grass, cinquefoil)	—
D. montanus LeConte	Nea. (Int)	X	X	X	—	Moist–wet, near water	Fine sand, silt & sand	Bare–sparse	—
D. pallipennis (Say)	Nea. (GP & E)	X	X		Open	Moist, upper littoral	Fine sand, often sal.	Bare–sparse	—
D. perversus Fall	Nea. (GP)	X		X	Open	Moist, near water	Sand, mud	Bare	—
D. pilosus LeConte	Nea. (E)			X	Open–light shade	Moist–wet, near water	Clay	Bare–sparse	—
D. planatus Lindroth	Nea. (GP)	X	X	X	Open	Dry	—	Sparse	—
D. politus (Dejean)	Hol. (TC)	X	X	X	Open	Moist, near water	Clay & sand	Sparse	—
D. quadrimaculatus Lindroth	Nea. (GP)	X	X	X	Open	Wet, upper littoral	Sand & clay	Bare–sparse (horsetails)	—
D. setosus LeConte	Nea. (TC)	X	X	X	Open	Moist	Sand, clay	Bare	—
D. sphaericollis (Say)	Nea. (TC)	X	X	X	Open	Moist–wet, water's edge	Sand & clay, often sal., alk.	Bare	—
D. tenuispinus Lindroth	Nea. (GP)	X			Open	—	—	Some (short grass)	PR
D. timidus Lindroth	Nea. (Endem)	X		X	—	—	—	—	—
D. truncatus LeConte	Nea. (Int)	X	X	X	Open	Moist, near water	Clay & sand	Bare	—
Bembidiini: *Elaphropus*									
E. anceps (LeConte)	Nea. (E)	X	X	X	Open	Dryish, often near water	Sand, sand & clay, mud	Bare–sparse	CL
E. incurvus (Say)	Nea. (TC)		X	X	Open	Dry, often near water	Sand, sand & clay	Bare–sparse	CL, WL
E. vernicatus (Casey)	Nea. (E)		X	X	Open	Moist–wet, often near water	Clay, mud, sand	Bare–sparse	CL

Tribe Species[1]	Biogeographical Range (Adjacent Distribution)[2]	Prov. Rec.[3]			Habitat Association[4]				Recorded Habitats[5]
		AB	SK	MB	Shade	Moisture	Soil (Litter)	Vegetation (Examples)	
Elaphrini: *Elaphrus*									
E. americanus Dejean	Nea. (TC)	X	X	X	Open	Moist–wet, near water	Sand, clay	Bare, bare patches in sparse veg.	—
E. californicus Mannerheim	Nea. (TC)	X	X	X	Open	Moist–wet, near water	Clay, occ. sal., alk.	Bare, bare patches in sparse veg.	PA
E. clairvillei Kirby	Nea. (TC)	X	X	X	Shaded	Wet, often distant from water	Mud, (org. debris)	Bare patches in veg.	PA, WL
E. fuliginosus Say	Nea. (E)	X		X	Open	Wet, near water	Sandy	Sparse	—
E. lecontei Crotch	Nea. (Int)	X	X	X	Open	Moist–wet, water's edge	Muddy, alk.	Bare	—
E. olivaceus LeConte	Nea. (Int & E)	X	X	X	Open	Wet, near water	Mud (org. debris)	Bare patches in dense veg. (sedges, rushes)	PA
E. purpurans Hausen	Nea. (W)	X			Shaded	Dry, upper littoral	Silt (leaf litter)	Bare	WL
Cicindelini: *Ellipsoptera*									
E. cuprascens (LeConte)	Nea. (GP)			X	Open	Usually at water's edge	Sand, loam, mud	Bare	—
E. lepida (Dejean)	Nea. (E)	X	X	X	Open	Dry	Sand	Bare–sparse (scurf pea)	—
E. nevadica (LeConte)	Nea. (GP)	X	X	X		Wet, often at water's edge	Mud, sal. or alk.	Sparse	—
Harpalini:									
Euryderus grossus (Say)	Nea. (Int)	X	X	X	Open	Dry	Sand	Some (grass)	PR, CL
Galeritini:									
Galerita janus (Fabricius)	Nea. (E)			X	Open–shaded	Moist	(Thick leaf litter)	—	PR, PA, CL, WL
Harpalini:									
Geopinus incrassatus (Dejean)	Nea. (E)	X	X	X	Open	Dry	Loose fine sand	Sparse	CL
Harpalini: *Harpalus*									
H. affinis (Schrank)	Adv. Pal. (TC)	X			Open	Dry	Sand	Covered with weeds	PA, CL, WL
H. amputatus Say	Nea. (W)	X	X	X	Open	Dry	Sandy	Some (grass)	PR, PA, CL, WL

H. animosus Casey	Nea. (GP & W)	X	X		Open	Dry	—	Some (grass)	PA
H. caliginosus (Fabricius)	Nea. (E)		X	X	Open	Dry	Sandy	Some (grass)	PR, PA, CL, WL
H. compar LeConte	Nea. (E)			X	Open	Dry	Sandy	Some (grass)	PR, PA, CL, WL
H. desertus LeConte	Nea. (GP & W)	X	X		Open	Dry	Sandy	Some (grass)	PR, PA, CL, WL
H. ellipsis LeConte	Nea. (GP)	X	X		Open	Dry	Sand, silt	Sparse (grass, forbs)	PA, WL
H. erraticus Say	Nea. (E)	X	X	X	Open	Dry	Fine sand	Bare–sparse	PA, CL, WL
H. erythropus Dejean	Nea. (E)			X	Open	Dry	Sand, clay	Some (grass)	PR, PA, CL, WL
H. faunus Say	Nea. (E)			X	Open	Dry	Sand	Some (grass)	PR, PA, CL, WL
H. fraternus LeConte	Nea. (W)	X	X	X	Open	Dry	Sandy	Sparse (grass)	PA, CL
H. fulvilabris Mannerheim	Nea. (TC)	X	X	X	Shaded	Dry	(Thick leaf litter)	Shaded by shrubs, trees	PA, WL
H. fuscipalpis Sturm	Hol. (TC)	X	X	X	Open	Dry	Sandy	Sparse	CL
H. herbivagus Say	Nea. (TC)	X	X	X	Open	Dry	Sandy	Sparse (grass, forbs)	PA, CL, WL
H. indigens Casey	Nea. (E)			X	Open	Dry	Sandy	Sparse (grass)	PR, PA, CL, WL
H. innocuus LeConte	Nea. (Int & W)	X	X		Open		Sand, gravel	Sparse (grass, forbs)	—
H. laevipes Zetterstedt	Hol. (TC)	X	X	X	Open–shaded	Dry	Sand; humus	Sparse (grass, shrubs)	CL, WL
H. laticeps LeConte	Nea. (TC)	X	X	X	Open–shaded	Dry	Sand, gravel	Sparse (grass, forbs)	WL
H. lewisi LeConte	Nea.(E)	X	X	X	Open	Dry	Sandy	Sparse	PA, CL, WL
H. megacephalus LeConte	Nea. (E)			X	Shaded	—	—	—	WL
H. nigritarsis C.R. Sahlberg	Hol. (TC)	X		X	Open	Dry	Gravel	Short, dense (grass)	PA
H. ochropus Kirby	Nea. (TC)	X	X	X	Open	Dry	Sandy	Sparse	—
H. opacipennis (Haldeman)	Nea. (TC)	X	X	X	Open	Dry	Sand, gravel	Sparse (grass)	PA, CL, WL
H. paratus Casey	Nea. (GP)	X	X		Open	Dry	Sand, sand & clay	Some (grass)	CL
H. pensylvanicus (DeGeer)	Nea. (TC)		X	X	Open	Dry	Sandy, sandy-loam	Mod. dense, tall	PA, CL, WL
H. plenalis Casey	Nea. (TC)		X	X	Open	Dry	Sandy	Sparse (grass)	PA

Tribe Species[1]	Biogeographical Range (Adjacent Distribution)[2]	Prov. Rec.[3]			Habitat Association[4]				Recorded Habitats[5]
		AB	SK	MB	Shade	Moisture	Soil (Litter)	Vegetation (Examples)	
H. reversus Casey	Nea. (E)	X	X	X	Open	Dry	Fine sand	Sparse (grass)	PA, CL, WL
H. somnulentus Dejean	Nea. (TC)	X	X	X	Open–shaded	Dryish	Gravel, sand	Some	PR, PA, CL, WL
H. ventralis LeConte	Nea. (GP)	X	X	X	Open	Dry	Sand, silt	Some (grass)	PA, CL, WL
Oodini:									
Lachnocrepis parallela (Say)	Nea. (E)			X	Shaded	Wet, flooded	Muddy (org. debris)	Dense tall (rushes)	—
Lebiini: *Lebia*									
L. atriceps LeConte	Nea. (GP)	X	X	X	—	—	—	—	—
L. atriventris Say	Nea. (E)	X	X	X	Open–light shade	Dry	—	On plants (goldenrod)	CL, WL
L. cyanipennis Dejean	Nea. (W)	X	X		—	—	—	On plant leaves	—
L. divisa LeConte	Nea. (GP)	X	X	X	—	—	—	On weeds	—
L. fuscata Dejean	Nea. (E)			X	Open–shaded	Moist	—	On flowering plants, shrubs, trees	PA, WL
L. guttula LeConte	Nea. (W)	X			—	Dry	—	On trees, forbs	—
L. moesta LeConte	Nea. (TC)	X	X	X	—	—	—	On flowering plants, shrubs, trees	WL
L. pleuritica LeConte	Nea. (E)		X		Open–light shade	Dry	—	On flowering plants, trees	WL
L. pulchella Dejean	Nea. (E)	X	X	X	Open	Dry	—	On flowering plants	PA, CL
L. pumila Dejean	Nea. (TC)	X	X	X	Open	Dryish	—	On flowering plants, bushes, trees	CL
L. solea Hentz	Nea. (E)		X	X	Open–light shade	Moist	—	On flowering plants, shrubs, trees	PA, CL, WL
L. tricolor Say	Nea. (E)			X	Light shade	Dryish	—	On flowering plants, shrubs, trees	WL
L. viridis Say	Nea. (TC)	X	X	X	Open–light shade	Dry–wet	—	On flowering plants, shrubs, trees	CL, WL
L. vittata (Fabricius)	Nea. (TC)	X	X	X	Open	Moist, near water	Often sandy	On flowering plants, shrubs	CL

Loricerini:									
Loricera pilicornis (Fabricius)	Hol. (TC)	X	X	X	Shaded	Wet, often near water	Muddy (org. debris)	Sparse tall, shading ground	PA, CL, WL
Lebiini: *Microlestes*									
M. curtipennis (Casey)	Nea. (GP*)	X	X		Open	Dry	Fine sand	Sparse (grass)	—
M. linearis (LeConte)	Nea. (TC)	X	X	X	Open	Dry	Fine sand	Sparse (grass)	PR, CL
Bembidiini:									
Mioptachys flavicauda (Say)	Nea. (TC)	X			—	—	—	Under loose tree bark	WL
Broscini:									
Miscodera arctica (Paykull)	Hol. (TC)	X	X	X	—	Dry	Sandy, sand & gravel	Short (moss, lichens)	WL
Nebriini: *Nebria*									
N. gebleri Dejean	Nea. (Mont)	X			—	Wet, water's edge	Stony	Bare	—
N. hudsonica LeConte	Nea. (Int)	X	X	X	Open	Wet, near water	Stony	Bare	—
N. lacustris Casey	Nea. (E)			X	Open–shaded	Wet, near water	Clay, sand, gravel, stony	Bare	—
N. obliqua LeConte	Nea. (W)	X	X		Open	Wet, near water	Gravel, stony, mud	—	—
Psydrini:									
Nomius pygmaeus (Dejean)	Hol. (TC)	X	X	X	Shaded	Moist	(Leaf litter)	Under loose bark, leaf litter	WL
Harpalini:									
Notiobia terminata (Say)	Nea. (E)		X		Open	Dry	Fine sand	Sparse	CL
Notiophilini: *Notiophilus*									
N. aquaticus (Linnaeus)	Hol. (TC)	X	X	X	Open	Dry	Gravel, sand	Sparse–mod.	CL
N. intermedius Lindroth	Nea. (E)			X	Open	Dry	Sandy	Sparse	—
N. semistriatus Say	Hol. (TC)	X		X	Open–light shade	Dry	Gravel, sand, peat	Sparse, thin (moss, lichen)	—
Omophrini: *Omophron*									
O. americanum Dejean	Nea. (E)	X	X	X	Open	Wet, near water	Sand, sand & clay, occ. sal.	Bare	—
O. ovale Horn	Nea. (W)	X	X		Open	Wet, near water	Sandy, sand & clay	Bare	—
O. robustum Horn	Nea. (Int)	X			Open	Wet, near water	Sandy, occ. alk.		—
O. tessellatum Say	Nea. (E)	X	X	X	Open	Wet, near water	Sand, clay, occ. sal.	Bare	—
Opisthiini:									
Opisthius richardsoni Kirby	Nea. (W)	X	X		Open	Wet, water's edge	Sand & clay	—	—

Tribe Species[1]	Biogeographical Range (Adjacent Distribution)[2]	Prov. Rec.[3]			Habitat Association[4]				Recorded Habitats[5]
		AB	SK	MB	Shade	Moisture	Soil (Litter)	Vegetation (Examples)	
Platynini:									
Oxypselaphus pusillus (LeConte)	Nea. (TC)	X	X	X	Shaded	Moist, near water	Muddy, clay (org. debris)	Some	WL
Pasimachini:									
Pasimachus elongatus LeConte	Nea. (GP)	X	X	X	Open	Dry	Sandy	Some (grass)	PA, CL, WL
Patrobini: *Patrobus*									
P. fossifrons (Eschscholtz)	Nea. (W)	X			Open	Moist, water's edge	Mud, clay, gravel	Bare–sparse	—
P. foveocollis (Eschscholtz)	Hol. (TC)	X	X	X	Light shade	Moist, often near water	(Leaf litter)	—	CL, WL
P. lecontei Chaudoir	Nea. (TC)	X	X	X	Open–light shade	Moist–wet	Clay	Some (sedges, grass)	CL
P. longicornis (Say)	Nea. (TC)	X	X	X	Open–shaded	Moist–wet, often near water	Clay	Dense	PA, CL, WL
P. septentrionis Dejean	Hol. (TC)	X	X	X	Open	Moist, often near water	Clay	Some (grass, sedges, moss)	—
P. stygicus Chaudoir	Hol. (TC)	X	X	X	Open	Wet, near water	Often peaty	Tall, dense (sedges, moss)	—
Lebiini:									
Philophuga viridis (LeConte)	Nea. (GP & W)	X	X	X	Open	Dry	Clay	Some (grass)	PR, CL
Harpalini:									
Piosoma setosum LeConte	Nea. (W)	X	X		Open	—	Sand, occ. clay	Some (grass)	PR, PA
Platynini: *Platynus*									
P. decentis (Say)	Nea. (TC)	X	X	X	Shaded	Moist, usually at water's edge	(Org. debris)	—	WL
P. mannerheimii (Dejean)	Hol. (TC)	X	X	X	Open–shaded	Wet	Peaty	Covered (*Sphagnum*, forbs)	WL
Patrobini:									
Platypatrobus lacustris Darlington	Nea. (E & Bor)	X	X	X	Open	Moist–wet, near water	Muddy, beaver houses	Bare	—

Pterostichini: *Poecilus*									
P. corvus (LeConte)	Nea. (Int)	X	X	X	Open	Dryish	Clay, occ. alk.	—	PR, CL
P. lucublandus (Say)	Nea. (TC)	X	X	X	Open–light shade	Dryish	Clay-loam, clay	Some (grass)	PR, PA, CL, WL
P. scitulus LeConte	Nea. (GP*)	X	X	X	Open	Moist	Clay	Some (grass)	CL
Pterostichini: *Pterostichus*									
P. adstrictus Eschscholtz	Hol. (TC)	X	X	X	Open–shaded	Moist–dry	Gravel & clay, gravel & humus, sand	Some (grass)	CL, WL
P. caudicalis (Say)	Nea. (TC)	X	X	X	Shaded	Wet, near water	Clay, mud (org. debris)	—	WL
P. commutabilis (Motschulsky)	Nea. (Int & E)		X	X	Open	Dryish	Sandy	Some (horsetails, reeds, grass)	PR, PA
P. corvinus (Dejean)	Nea. (Int & E)	X	X	X	Open–shaded	Wet, water's edge	Clay, mud (org. debris)	Dense (reeds, sedges, grass)	WL
P. femoralis (Kirby)	Nea. (Int)	X	X	X	Open–shaded	Moist–dry	Sand, clay	Mod.–dense (grass)	PR, PA, CL, WL
P. luctuosus (Dejean)	Nea. (TC)	X	X	X	Shaded	Wet, near water	Clay, mud (org. debris)	Some (reeds, willow)	WL
P. melanarius (Illiger)	Adv. Pal. (TC)	X	X	X	Open–light shade	Moist	Sand, clay	Mod.–dense	CL, WL
P. mutus (Say)	Nea. (E)			X	Open–light shade	Dryish	Gravel, sand, clay-loam (leaf litter)	Covered (grass)	CL, WL
P. novus Straneo	Nea. (E)			X	Open–shaded	Moist–dry	(Leaf litter)	Covered (grass)	WL
P. patruelis (Dejean)	Nea. (TC)	X	X	X	Open–light shade	Wet, near water	Clay, mud, peat (org. debris)	Covered (moss)	WL
P. pensylvanicus LeConte	Nea. (Int & E)	X	X	X	Shaded	Moist	Gravel (leaf litter)	—	WL
P. protractus LeConte	Nea. (Mont)	X			Open–shaded	Moist	—	—	WL
P. punctatissimus (Randall)	Nea. (TC Bor)	X	X	X	Shaded–open	Moist–dry	(Leaf litter, branches)	Shaded by shrubs, trees	WL
P. riparius (Dejean)	Nea. (Mont & Bor)	X			Shaded–open	Moist	Sand, gravel	—	—
Platynini: *Rhadine lindrothi* Barr	Nea. (GP)	X	X		—	—	Burrow & cracks in soil	—	CL
Cychrini: *Scaphinotus*									
S. elevatus (Fabricius)	Nea. (GP)			X	Open–shaded	Moist	—	—	CL, WL

Tribe Species[1]	Biogeographical Range (Adjacent Distribution)[2]	Prov. Rec.[3]			Habitat Association[4]				Recorded Habitats[5]
		AB	SK	MB	Shade	Moisture	Soil (Litter)	Vegetation (Examples)	
S. marginatus (Fischer von Waldheim)	Nea. (W)	X			Open–shaded	Moist	—	—	CL, WL
Clivinini:									
Schizogenius ferrugineus Putzeys	Nea. (E)		X		Open	Moist, near water	Sand, gravel	Bare	—
Harpalini: *Selenophorus*									
S. opalinus (LeConte)	Nea. (E)			X	Open	Dry	Sandy	Sparse patchy (grass, strawberry)	PR, PA, CL, WL
S. planipennis LeConte	Nea. (Int)	X	X	X	Open	Dry	Sandy	Sparse (grass)	PR, CL
Platynini: *Sericoda*									
S. bembidioides Kirby	Nea. (W)	X	X	X	Open–shaded	Moist	Often burnt	—	WL
S. obsoleta (Say)	Nea. (TC)	X	X	X	Open–shaded	Moist	Often burnt	—	WL
S. quadripunctata (DeGeer)	Hol. (TC)	X	X	X	Open–shaded	Moist	Often burnt	—	WL
Cychrini:									
Sphaeroderus nitidicollis Guérin-Méneville	Nea. (E)		X	X	Shaded	Moist–wet, often near water	(Leaf litter)	—	WL
Harpalini: *Stenolophus*									
S. comma (Fabricius)	Nea. (TC)	X	X	X	Open	Moist	Mostly sandy	Some	PA, CL
S. fuliginosus Dejean	Nea. (TC)	X	X	X	Open–light shade	Wet, near water	Clay (org. debris)	Thin, depressed (grass, sedges)	WL
S. lineola (Fabricius)	Nea. (E)	X	X	X	Open	Moist–dry	Sandy	Some	CL, WL
S. ochropezus (Say)	Nea. (E)		X	X	Open–shaded	Wet, near water	Clay, mud	Dense (grass, reeds)	WL
Pterostichini:									
Stereocerus haematopus (Dejean)	Hol. (TC Bor)	X	X	X	Shaded	Dry	Sand, gravel, scattered stones	Some (heath)	—
Lebiini:									
Syntomus americanus (Dejean)	Nea. (TC)	X	X	X	Open	Dry	Sandy	Sparse (dock)	PA, CL, WL

Sphodrini:									
Synuchus impunctatus (Say)	Nea. (TC)	X	X	X	Open–shaded	Dry	Sandy (leaf litter)	—	CL, WL
Bembidiini: *Tachys*									
T. bryanti Lindroth	Nea. (Endem)	X			—	—	—	—	—
T. halophilus Lindroth	Nea. (GP)	X	X	X	Open	Wet, near alk. water	Clay	Sparse (halophytes)	—
Bembidiini: *Tachyta*									
T. angulata Casey	Nea. (Int & E)	X	X	X	Open	—	—	—	WL
T. inornata (Say)	Nea. (Int & E)		X		Open	—	—	—	WL
T. kirbyi Casey	Nea. (Int & E)	X	X		Open	—	—	—	WL
Lebiini:									
Tecnophilus croceicollis (Ménétriés)	Nea. (GP)	X	X		Open	Dry	Alk. sand & clay	Sparse (halophytes)	—
Trechini:									
Trechus apicalis Motschulsky	Hol. (Int & E)	X	X	X	Shaded	Moist, often near water	Gravel, sand, peat (leaf litter)	Some	WL

[1] Some of the species in the table have a number of subspecies. Tabulated information is for only those subspecies occurring in the Prairies Ecozone.

[2] Biogeographical range abbreviations: Nea. = Nearctic, Pal. = Palearctic, Hol. = Holarctic, Adv. = Adventitious. Adjacent distribution abbreviations: TC = trans-Canadian (from [more-or-less] Pacific to Atlantic coast in Canada); Int = extends at least into Ontario and British Columbia, but not reaching the coasts; GP = extends south through the Great Plains states; GP* = GP and additionally dry grasslands of interior valleys of western Cordillera; S = extends south from the Prairies Ecozone and ranges more broadly than the Great Plains states; E = extends east from the Prairies Ecozone in Canada; W = extends west from the Prairies Ecozone in Canada; Bor = extends northward from the Prairies Ecozone; Mont = montane species; Endem = recorded only from the Prairie Provinces.

[3] Prov. Rec. = species recorded as occurring in each of the three Prairie Provinces.

[4] Typical habitat associations. Lack of an entry may indicate no preference or absence of information. Conventions: similar items separated by commas are alternatives, separated by en dashes indicate a range, and separated by & indicate a mixture. Abbreviations: alk. = alkaline, mod. = moderate(ly), occ. = occasionally, org. = organic, sal. = saline, veg. = vegetation.

[5] Recorded habitats indicate whether a species has been recorded from four common habitat types in the Prairies Ecozone: PR = prairie, PA = pasture, CL = cultivated land, WL = woodland or forest.

All of the adventive species in the ecozone were accidentally introduced from the Palearctic zoogeographical region, probably either in soil used as ship's ballast (Lindroth 1957), or, more recently, in soil associated with importation of plants (Spence and Spence 1988). Original introductions have occurred mostly on both coasts (Bousquet 2012), with subsequent inland spread either by flight or human agency (Spence and Spence 1988), the latter aided by the close association most of the adventive species have with anthropogenic habitats. Penetration from the coasts is not rapid; thus, although alien carabid species continue to arrive at the coasts (Bousquet 2012), the most recent North American arrival to have reached the Prairies Ecozone is *P. melanarius*, which was first detected in North America in 1926. *Pterostichus melanarius* reached Edmonton in 1959 (Lindroth 1961–1969; Bourassa *et al.* 2011), and by 2000, this species constituted about 80% of the catch in grasslands in the Edmonton region (Hartley *et al.* 2007). In Manitoba, *P. melanarius* had arrived by 1979 (Richardson 1982), and 20 years later, more than 60% of beetles caught in some crops were of this species (Uddin 2005). Adults of *P. melanarius* exhibit wing polymorphism and only the long-winged morph can fly; the distribution of wing morphs suggests that the species arrived in urban centres by human-aided transport and then dispersed by flight into surrounding areas (Niemelä and Spence 1999; Bourassa *et al.* 2011).The species is most numerous in urban and agricultural environments, but is also present in lower densities in natural forests. Although a few studies have suggested that *P. melanarius* could negatively affect native carabids, there is no consistent evidence of such effects in habitats in the Prairie Provinces (Niemelä *et al.* 1997; Niemelä and Spence 1999; Bourassa *et al.* 2011).

About 9% of the carabid species in the Prairies Ecozone have a Holarctic distribution, a percentage comparable to the 10.7% of carabid species in Atlantic Canada (Majka *et al.* 2007). Lindroth (1957) drew attention to the affinity of Holarctic carabid species for regions with tundra and boreal forest vegetation and considered this evidence for passage across the Bering land bridge. Most of the Holarctic species enumerated in Table 2 either also occur in the boreal forest to the north of the Prairies Ecozone or, more frequently, are trans-Canadian in boreal forest or tundra, with a distribution extending southward into the prairies. One notable exception to this pattern is *Bembidion quadrimaculatum* (Fig. 2A), which is a temperate region species, the distribution of which extends into the southern United States (Lindroth 1957; Bousquet 2012).

Table 2. Number of carabid species in the Prairies Ecozone classified by biogeographical range and adjacent distribution.

Biogeographical Range	Adjacent Distribution[1]								
	Trans-Canadian	Western	Interior	East	Boreal or Montane	Great Plains and GP*[2]	Endemic	Other[3]	Total
Adventive	11	1	0	0	0	0	0	0	12
Holarctic	29	1	0	0	4	0	0	2	36
Nearctic	105	36	24	78	8	53	5	41	350

[1] See footnote 2 of Table 1 for definitions of distributions.

[2] GP* = Great Plains and additionally dry grasslands of interior valleys of western Cordillera.

[3] Species that occur in combinations or other categories.

The remaining 88% of species are Nearctic species (Table 2). Of these, over one-third essentially range from the Pacific to the Atlantic coasts in Canada, while another third range either westward to the Pacific or eastward to the Atlantic. As prairie habitats are not found across the entire range of these species, it follows that the wide-ranging species are not prairie specialists. The same may be said of the 6% of species that are Nearctic with an "Interior" adjacent distribution. Only 13% of Prairies Ecozone species are restricted to the Great Plains states and provinces, or to these plus prairie-like habitats in the western mountain valleys. Five species from the Prairies Ecozone have not been collected outside the Prairie Provinces: three species of the tribe Bembidiini: *Bembidion balli*, *B. lachnophoroides* (Fig. 3A), and *Tachys bryanti*; and two Dyschiriini: *Dyschirius carrorum* and *D. timidus*. Of these, *B. lachnophoroides* has been known since 1926 and was once thought to be rare, but is now known from several widely dispersed localities (Bousquet 2012). The remaining endemic species were described after 1960, and two are known only from the holotype; further collections may reveal broader distributions of these species than are currently known.

It would be a mistake to conclude that the Prairies Ecozone endemic and Great Plains species are specialists of prairie habitats in the narrow sense, that is, dry areas dominated by grassy vegetation. Of the 46 of these species for which there is information on moisture requirements, only 30% are associated with dry or very dry habitats and the remainder require moist or wet habitats. Of this remainder, 57% occupy habitats associated with some form of standing water, and half of these species are in the tribe Bembidiini. Some moisture-associated species, identified in Table 1 as being at the "water's edge," are almost always within a few metres of standing water; among these are the endemic *B. lachnophoroides* and the Great Plains species *Ellipsoptera cuprascens*. Another frequent characteristic of habitats occupied by Great Plains or endemic species is the presence of salts: 62% of the moisture-associated species frequent saline or alkaline areas. Life histories and morphology of these species vary widely, however. Among the Great Plains species found in dry habitats are large, long-lived, flightless species (*Calosoma lepidum*, *C. luxatum*, *C. montiliatum*, and *Pasimachus elongatus* (Fig. 3B)) (Burgess and Collins 1917; Cress and Lawson 1971; Larochelle and Larivière 2003); moderate-sized (7–15 mm long) fully-winged species found among sparse vegetation (*Cincindela lengi*, *C. limbata* (Fig. 3C), *Harpalus ellipsis*, *H. paratus*, and *H. ventralis*) (Lindroth 1961–1969; Pearson *et al.* 2006); and small (<3.5 mm) species that may be long-winged (*Dyschirius planatus*) or wing dimorphic (*Microlestes curtipennis*) (Lindroth 1961–1969). Lifespan and flight

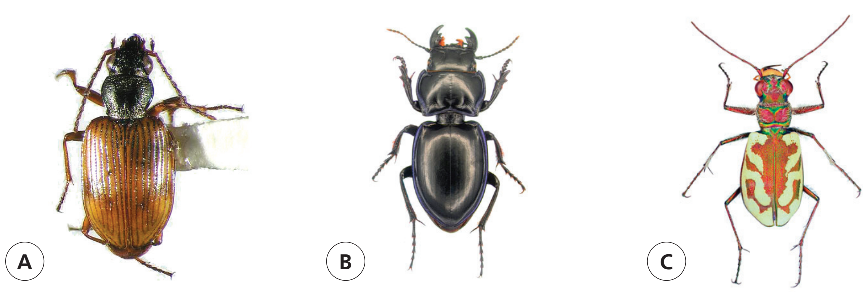


Fig. 3. A, *Bembidion lachnophoroides* (typical length 4.5 mm). B, *Pasimachus elongatus* (25 mm). C, *Cicindela limbata* (11 mm). Photo credits A: D. Shpeley, University of Alberta, Edmonton; B and C: H. Goulet, Agriculture and Agri-Food Canada, Ottawa.

capability influence the ability of species to respond to rapid environmental change and to colonize new habitats.

Habitat and Diet

The diversity of grassland, wetland, and forested habitats in the Prairies Ecozone (Shorthouse 2010*a*, 2010*b*) is reflected in the habitat associations not only of the Great Plains and Prairies Ecozone endemic species, but in those of the carabid fauna as a whole. Table 3 summarizes the habitat associations in Table 1 for tribes represented by more than 10 species in the ecozone, and the parallel Table 4 provides a summary of the knowledge of dietary information about adults of these tribes. Diets of larvae of the carabids in the ecozone are not well enough known for breakdown by tribe: There is information on 92 species (of which 86 have carnivorous larvae), but only 11 of these reports are based on field data. The previous assertion that most carabid adults are omnivorous is not well supported by data in Table 4, where carnivory is most common, and insects are the most frequently identified food item. This difference may result from the nature of the data summarized in Table 4. Dietary classes established from laboratory studies depend upon the range of items offered to beetles. In the field, it may be easier to identify compact items such as insects and seeds as they are being consumed by a beetle than it is to recognize more amorphous entities such as fungal hyphae and plant tissues. Tables 3 and 4 will be used in a brief survey of "lifestyles" of the major groups of carabid beetles in the Prairies Ecozone.

Three of the tribes tabulated are associated with bare or sparsely vegetated areas near water. One of these is the most speciose tribe, the Bembidiini, 78 species of which belong to the genus *Bembidion* and the remainder to three genera that were treated by Lindroth (1961–1969) within the single genus *Tachys*. All members of the tribe are small (<9 mm) and adults of most of them are active runners. They are not species of grasslands, but some are common in cultivated fields; the various subspecies of *B. quadrimaculatum* (Fig. 2A) are often dominant in such habitats in northwest Europe and North America (Luff 2002). The distribution of many Bembidiini depends on the nature of the substrate; some are associated with saline or alkaline sites. Information on larvae is relatively sparse, probably because of their small size. All *Bembidion* for which there is information are carnivorous; most feed on living or dead insects, and some of those found in cultivated areas are considered important predators of pest insect eggs. The Dyschiriini are similar in size range and habitat associations to the Bembidiini and are represented by 21 species in the ecozone, all in the genus *Dyschirius* (Fig. 4A). The forelegs of adult *Dyschirius* are adapted for burrowing in the waterside substrates that the beetles inhabit, and some species are associated with rove beetles of the genus *Bledius* (Coleoptera: Staphylinidae). As with the Bembidiini, there is little information about the diet of the Prairies Ecozone *Dyschirius*, but all members of the genus are considered to be predatory (Lindroth 1961–1969). The Elaphrini are represented by three species of *Blethisa* and seven species of *Elaphrus* (Fig. 4B) in the Prairies Ecozone. Elaphrini are even more exclusively confined to areas near water than are the previous two tribes. Adults range from 6 to 18 mm and have notably prominent eyes. For *Elaphrus*, the large eyes may be an adaptation to catch flies and other active insects, which they do while running rapidly on bare patches among vegetation. The habitat of *Blethisa* is more densely vegetated and their larvae are closely associated with water (Lindroth 1961–1969).

The members of the tribes Chlaeniini and Licinini also occur mostly near water, but are less clearly associated with open areas than the tribes mentioned above. The Chlaeniini

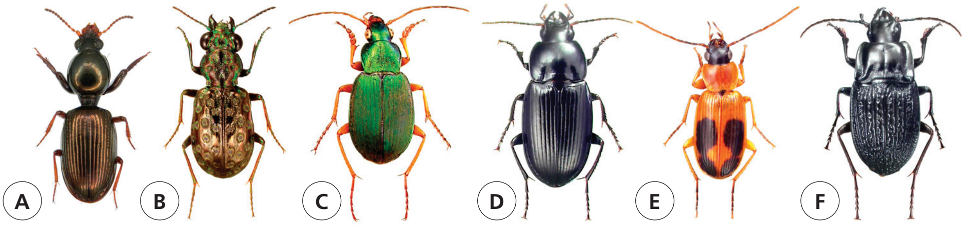


Fig. 4. A, *Dyschirius sphaericollis* (typical length 5 mm). B, *Elaphrus fuliginosus* (10 mm). C, *Chlaenius sericeus* (14 mm). D, *Diplocheila obtusa* (11 mm). E, *Badister neopulchellus* (6 mm). F, *Dicaelus sculptilis* (17 mm). Photo credit: H. Goulet, Agriculture and Agri-Food Canada, Ottawa.

is represented by the genus *Chlaenius* (Fig. 4C), containing moderate-sized (8–18 mm) beetles that are active runners and fliers; several species are associated with dense vegetation and occur in agricultural and woodland habitats. The Licinini of the ecozone comprise three genera whose general habitat associations grade from vegetated sites near water in open areas (*Diplocheila*: four species, length 10–18 mm, Fig. 4D) to moist shady forested sites (*Badister*: four species, length 3–6 mm, Fig. 4E). Adults of both genera can fly, whereas those of the third genus (*Dicaelus*: two species, length 14–20 mm, Fig. 4F) are flightless. Dietary information is sparse for both Chlaeniini and Licinini; most are classed as carnivores and (where field data are known) insects are commonly consumed; two species eat slugs or snails.

The tribe Pterostichini of Lindroth (1961–1969) is now split into two tribes, the Platynini and the Pterostichini (Bousquet 2012), and within the Platynini, Lindroth's concept of the genus *Agonum* is now considerably changed (Liebherr 1994 and references therein). The Platynini are usually associated with water, or at least with moist habitats, and many of them are found in shaded, densely vegetated or woodland habitats. In the Prairies Ecozone, the tribe includes six genera: *Agonum* (29 species, Fig. 5A), *Sericoda* (three species), *Platynus* (two species), *Anchomenus* (one species), *Oxypselaphus* (one species), and *Rhadine* (one species). Adult platynines generally have a narrow head and prothorax, broad elytra, and slender appendages; most are between 5 and 10 mm long, although the *Platynus* in the ecozone can reach 14 mm. Platynine adults are active runners and many can fly. Most are carnivorous and field data indicate that they eat insects; some are considered important predators of agricultural insect pests (Floate *et al.* 1990). Members of *Sericoda* are attracted to recently burned forest areas (Holliday 1984) and occur in the Mixed Grassland and Aspen Parkland ecoregions (Hooper and Larson 2012). The Pterostichini in the Prairies Ecozone include the genera *Pterostichus* (14 species, Fig. 2B and D), *Poecilus* (three species), and *Stereocerus* (one species). Adult beetles are stout, ranging in length from 6 to 20 mm, and have relatively short appendages; many have reduced flight wings, although several common species can fly, or exhibit wing-length polymorphism. Few are strongly associated with water and many are forest or woodland species; virtually all are associated with densely vegetated habitats, and the *Poecilus* and several of the most abundant *Pterostichus* in the ecozone frequent cultivated fields. Both adults and larvae of most species are carnivorous and field data indicate that they eat insects. *Poecilus lucublandus* is unusually diverse in its habitat associations and in its diet: Larvae are carnivores, but adults consume insects, plants, and fungi.

Table 3. Summary of habitat association information in Table 1 for the 12 most speciose tribes and for all species of carabids recorded from the Prairies Ecozone.

Tribe	Number of Species	Percentage of Species Associated with Habitat Condition[1]										Percentage of Species Recorded in Selected Habitats[2]			
		Light Level		Moisture Level		Saline or Alkaline Habitat	Substrate Utilization[2]		Vegetation						
									Density						
		Open	Shade	Dry	Moist-Wet		Clay/Silt	Sand/Gravel	Bare–Sparse	Some-Dense	On Plants	Prairie	Pasture	Cultiv-ated	Wood-land
Bembidiini	87	77	11	10	90	24	61	68	80	20	0	0	6	21	16
Harpalini	66	76	11	62	37	5	31	86	46	54	0	22	52	65	59
Platynini	37	51	22	11	89	3	68	53	29	71	0	3	22	19	49
Zabrini	36	80	0	90	10	11	15	100	42	58	0	11	36	69	28
Lebiini	30	61	9	78	17	8	15	100	32	4	64	20	27	50	47
Dyschiriini	21	85	0	6	94	24	44	81	94	6	0	5	10	10	5
Cicindelini	20	94	0	54	31	27	41	100	100	0	0	30	0	10	0
Pterostichini	18	17	22	28	50	6	60	73	0	100	0	22	17	39	72
Carabini	12	67	8	73	18	0	50	88	30	60	10	25	8	67	83
Licinini	11	36	45	9	82	10	71	57	20	80	0	0	9	27	64
Chlaeniini	10	60	10	20	80	0	38	100	29	71	0	20	30	40	50
Elaphrini	10	60	20	10	90	22	100	50	89	11	0	0	30	0	20
All species	**398**	**66**	**12**	**35**	**62**	**13**	**45**	**84**	**57**	**38**	**6**	**11**	**22**	**37**	**38**

[1] Percentages are of species for which there are data and may not add to 100%, as some lesser used habitat conditions are omitted in some categories. Number of species for which there were data that averaged 90–95% of species for shade and moisture attributes, 70% for substrate data, and 76% for vegetation data.

[2] Percentages are of all species recorded in the ecozone. Species may have been recorded in more than one habitat type and so percentages may sum to >100%.

Table 4. Summary of dietary information for adults of the 12 most speciose tribes and of all species of carabids recorded from the Prairies Ecozone.

Tribe	Total Number of Species	Number of Species with Adults in Dietary Class				Number of Species with Adults Recorded to Consume Items in the Field					
		N[1]	Carnivore	Omnivore	Herbivore	N[1]	Insects	Molluscs	Seeds	Plant Parts other than Seeds	Fungi
Bembidiini	87	20	19	0	1	17	16	0	0	1	0
Harpalini	66	44	17	17	10	29	22	0	16	11	4
Platynini	37	20	18	1	1	7	7	0	0	0	0
Zabrini	36	22	12	8	2	18	15	0	6	6	1
Lebiini	30	13	10	3	0	7	7	0	0	1	1
Dyschiriini	21	3	3	0	0	3	3	0	0	0	0
Cicindelini[2]	20	20	19	1	0	20	20	0	0	1	0
Pterostichini	18	16	16	1	0	7	7	0	0	1	1
Carabini	12	10	9	1	0	6	6	2	0	0	0
Licinini	11	4	3	1	0	2	1	1	0	0	0
Chlaeniini	10	6	5	1	0	3	3	1	0	0	1
Elaphrini	10	10	10	0	0	3	3	0	0	0	0
All species	**398**	**201**	**144**	**37**	**14**	**118**	**104**	**6**	**26**	**23**	**8**

[1] Number of species for which data are available.

[2] With the exception of data for Cicindelini, all data are species-specific information from Larochelle and Larivière (2003). Data for Cicindelini are derived from general subfamily level statements augmented with specific information where available in Acorn (2001) and Pearson *et al.* (2006).

The Carabini are among the largest carabids inhabiting the Prairies Ecozone, where they are represented by six species of *Calosoma* (length 13–27 mm) and six species of *Carabus* (length 12–26 mm), including two adventive species. Among the *Calosoma, C. calidum* (Fig. 5B), *C. frigidum,* and *C. obsoletum* are capable of flight. All other members of the tribe in the ecozone are flightless, although many can run well. Lindroth (1961–1969) considered more flight-capable *Calosoma* to be climbers of trees, where they consume caterpillars, but this behaviour has not been recorded for *C. obsoletum*, and *C. calidum* is a poor climber (Burgess and Collins 1917). Caterpillars and other insects are considered the main dietary item of *Calosoma*, whereas molluscs and insects are eaten by *Carabus* (Fig. 2E); larvae are also carnivorous. Most members of the tribe are found in open, relatively dry habitats and are frequently found in cultivated or woodland areas when there are abundant caterpillars or other food to attract them; as a result, several species are considered to be beneficial predators.

The Cychrini are almost all restricted to forested regions (Lindroth 1961–1969; Bousquet 2012), but three species, *Scaphinotus elevatus*, *S. marginatus*, and *Sphaeroderus nitidicollis* (Fig. 5C), occur in the Prairies Ecozone (Table 1). Adult beetles of this tribe exhibit among the most extreme morphological adaptations seen within the temperate carabid fauna. They have narrow heads and long, protruding mandibles that enable them to penetrate far into snail shells to feed.

The Lebiini of the Prairies Ecozone include *Lebia* (14 species), *Cymindis* (six species), *Calleida* (two species), *Microlestes* (two species), and six genera represented by a single species. The majority of the species are associated with open dry habitats with coarse-textured soils. Adults of *Cymindis* live on the ground among sparse vegetation, whereas those of both *Calleida* and *Lebia* climb flowering plants (frequently goldenrod) and trees, where they prey on insects (Larochelle and Larivière 2003), and at least some consume nectar (H. Goulet, pers. comm.). Members of the genus *Lebia* are strongly associated with chrysomelid beetles; the adults prey on chrysomelids on plants, and the larvae are parasites of chrysomelid pupae (Weber *et al.* 2006).

Lebia are not the only parasitic carabids: Three carabid tribes include species that are parasitoids—the Brachinini, Lebiini, and Peleciini. Among these, the parasitic lifestyle is best known for *Brachinus*, *Lebia*, and the African genus *Lebistina*. Four species of *Brachinus* and 14 species of *Lebia* are reported from the Prairies Ecozone (Table 1). In all known cases, adult females lay eggs in the habitat of hosts, and free-living first instar larvae hatch and search their immediate environment to locate and feed as ectoparasitoids on a suitable host. During feeding, the larvae moult from one to four times to develop into a non-feeding larval (pre-pupal) stage. In the pre-pupal stage, they moult up to twice more. Pupation occurs beside the remains of the host. Reported hosts are pupae of beetles, with the exception of a species of Peleciini, which has been reared on immature millipedes (Salt 1928). Hosts of *Lebia* are species of Chrysomelidae (Weber *et al.* 2008). Most research on this genus is limited to *L. grandis*, a native North American species that is ectoparasitic on pupae of the Colorado potato beetle, *Leptinotarsa decemlineata* (Say) (Coleoptera: Chrysomelidae), and congeneric species (Weber *et al.* 2006). *Lebia grandis* is unknown from the Prairie Provinces, but *L. viridis* (Fig. 5D) occurs in the Prairies Ecozone. *Lebia viridis* is also associated with the Colorado potato beetle and so may, like *L. grandis* in other regions, provide important natural biological control of this pest. Hosts of *Brachinus* include species of Dytiscidae, Gyrinidae, Hydrophilidae, and Carabidae (Saska and Honek, 2004). Adult *Brachinus* are commonly called "bombardier beetles" because of their ability to produce and direct a noxious spray from their abdomens toward predators (Eisner and Aneshansley 1999).

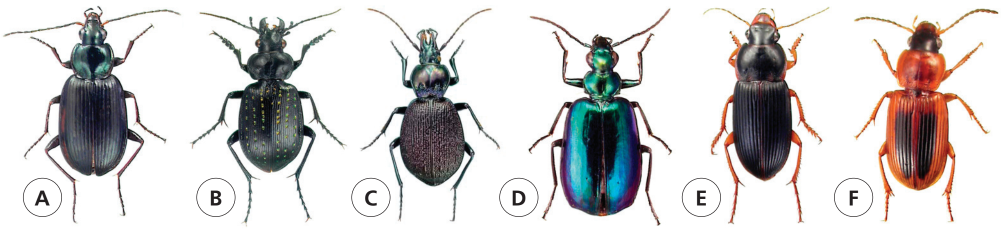


Fig. 5. A, *Agonum placidum* (typical length 8 mm). B, *Calosoma calidum* (22 mm). C, *Sphaeroderus nitidicollis* (16 mm). D, *Lebia viridis* (6 mm). E, *Harpalus pensylvanicus* (13 mm). F, *Stenolophus comma* (6 mm). Photo credit: H. Goulet, Agriculture and Agri-Food Canada, Ottawa.

The tribes Harpalini and Zabrini have many representatives in the Prairies Ecozone. There are 10 genera of Harpalini in the ecozone, of which *Harpalus* (29 species, Fig. 5E), *Anisodactylus* (10 species), *Bradycellus* (nine species), and *Stenolophus* (four species, Fig. 5F) are the most speciose. *Harpalus* and *Anisodactylus* are of similar general appearance, and most in the ecozone are of moderate to large size (6–15 mm, with a few *Harpalus* reaching 26 mm in length). *Bradycellus* (3–6 mm) and *Stenolophus* (5–9 mm) are smaller and usually bicoloured. Zabrini is represented by 36 species of the genus *Amara* (Fig. 2C), many of which have a tapered pronotum in the adult (with the base the same width as the elytra), giving them a streamlined outline. The adult length of most species within the ecozone lies between 6 and 12 mm. From an ecological point of view, Harpalini and Zabrini have much in common: They frequent open dry habitats with coarse substrates, and many are recorded from prairie, pasture, and cultivated land. They are also the two tribes in which herbivory and omnivory are common: Adults of species in both tribes eat seeds, fruits, and other plant parts, although many of them will also consume insects. The few records of larval diet suggest that those of Zabrini are predominantly carnivorous, and that may also be the case for Harpalini. However, larvae of *Harpalus pensylvanicus* (Fig. 5E) and *H. erraticus* cache grass seeds in the sides of their burrows (Kirk 1972*b*), and Larochelle and Larivière (2003) inferred that these seeds are larval food. This inference was not made by Kirk (1972*b*), who concluded that the larvae of these species, as well as those of *Stenolophus comma* (Fig. 5F), graze on microorganisms that penetrate the walls of their burrows (Kirk 1973, 1974, 1975*a*).

The Cicindelinae, or tiger beetles, of the Prairies Ecozone include 13 species in the genus *Cicindela* (Fig. 3C), three species of *Ellipsoptera*, and a single species of *Cylindera*. Although numerous subspecies are recognized for some of these, our treatment does not consider the subspecies level. Tiger beetles inhabit open, sparsely vegetated areas, with different species occupying water-side, often alkaline, habitats through to dry bare sand dunes (Hilchie 1985). The adults are relatively large with sickle-shaped, multiply toothed mandibles, long running legs, and large eyes; they are active during the day, particularly when it is hot and sunny (Pearson *et al.* 2006). Sparsely vegetated habitats suit their mode of hunting for food, which consists of short sprints to run down moving insects. Larvae also are carnivorous; they construct burrows and lie in wait for prey with their head capsule and prothorax level with the surface of the ground. This type of larval feeding behaviour also occurs in another specialist of open habitats, *Pasimachus elongatus* (tribe Pasimachini, Fig. 3B); however, adults of that species have different habits: They are nocturnal predators that shelter during the day (Erwin 2011).

Selected Faunistic Studies in the Prairies Ecozone

We define a faunistic study as a community ecology investigation to document the assemblage of species in terms of its richness and relative composition. In the last three decades, these studies have often been called "biodiversity" studies. Here, we present a detailed description of three new studies of the carabid fauna, each containing previously unpublished elements. In the following section, we present an overview, by province and ecoregion, of all the biodiversity studies of which we are aware.

Carabids of the Boreal Transition: Nipawin, Saskatchewan — K. D. Floate

The Boreal Transition Ecoregion of the Boreal Plains Ecozone shares many characteristics with the Aspen Parkland Ecoregion, which is the northernmost extent of the Prairies Ecozone (Shorthouse 2010*b*). In its undisturbed state, the southern part of the Boreal Transition is characterized by expanses of plains and northern fescue grasslands spotted with patches of aspen, *Populus tremuloides* Michx. (Salicaceae). However, much of the region has been converted to monocultures of cereal and oilseed crops that are common to regions farther south, albeit with different soil and climatic conditions. The carabid fauna of agricultural lands in the Boreal Transition Ecoregion in Saskatchewan was examined in a series of studies that included an assessment of the contact and residual toxicity of insecticides applied to crops (Floate *et al.* 1989), the role of carabids as natural enemies of the orange wheat blossom midge (*Sitodiplosis mosellana* Géhin) (Diptera: Cecidomyiidae) (Floate *et al.* 1990), and the diversity of endemic faunas (Floate 1987).

For the diversity study, pitfall traps were operated at five sites spanning a range of soil types (sandy loam, silty loam, silty clay, clay loam, clay) along a 32 km transect between the communities of Gronlid and Aylsham, Saskatchewan, about 220 km northeast of Saskatoon (see Table 5, Fig. 6). Each site was a 100 m^2 plot located within a field along or near the field margin. In the year that preceded the study, the fields that housed the plots were seeded to wheat. Each plot was seeded to wheat in 1984 and 1985, but the

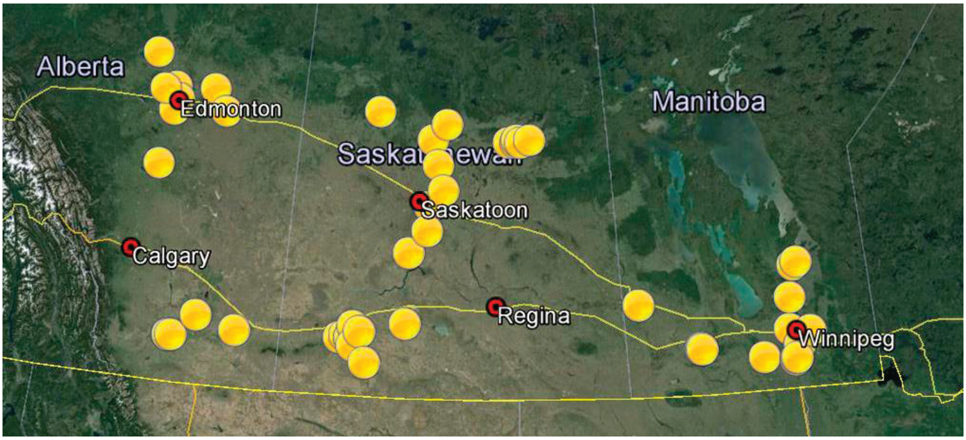


Fig. 6. Map showing locations for carabid faunistic studies in the Prairies Ecozone and adjacent areas. Map data: Google, Data SIO, NOAA, U.S. Navy, NGA, GEBCO. An online, interactive version of this map is available by opening the kmz file available at: https://sites.google.com/site/dungins/Carabid%20study%20sites.kmz?attredirects=0&d=1

surrounding field was either seeded to canola, barley, flax, or alfalfa or left in summer fallow, depending on site and year.

Four traps were operated continuously at each site and were emptied weekly from 1 June to 28 August in 1984, and from 8 May to 26 September in 1985. The two-year catch comprised 13,982 beetles, representing at least 74 species in 23 genera (Table 6). In each year, the dominant species were *Bembidion quadrimaculatum*, *B. obscurellum*, *Poecilus* (*Pterostichus*) *corvus*, and *Agonum placidum*, which collectively comprised 67 and 62% of the beetles recovered in 1984 (n = 5,290) and 1985 (n = 8,692), respectively.

The abundance of these and other species differed across sites in each year (Floate 1987: Appendix 2). For example, *B. obscurellum* (n = 1,698) was recovered at all but one site, whereas *Sphaeroderus nitidicollis* (n = 3) was recovered at a single site. Numbers of *S. nitidicollis* were too few to ascribe to a given site characteristic. However, at the site where *B. obscurellum* was absent, there was a central depression and permeability of the clay soil was low. This resulted in standing surface water at the site for several weeks in the spring of both study years, a phenomenon absent at the other four sites. Thus, species differences among sites partially reflected differences in soil type. Crop canopy in adjacent fields almost certainly influenced the movement of beetles into and out of the plots: Crop canopy was absent (summer fallow), moderate (e.g., barley), or dense (e.g., alfalfa). In addition to the surrounding crops, the density and type of weeds within plots would have affected trap catches. For example, weed control was effective at all sites in 1984, but was ineffective in 1985. This was particularly evident at one site that became thickly infested with chickweed, *Stellaria media* (L.) (Caryophyllaceae). Although wheat was planted at the site in both years, the habitat below the crop canopy was more shaded and humid in 1985, and this may help explain the observed shift from 1984 to 1985 of fewer *Bembidion* and more *Agonum*, *Poecilus*, and *Pterostichus*.

Because pitfall trap catches of a species may not reflect its density (see "Methods of Sampling," above), beetles were counted in soil samples taken on three dates in 1984 and five dates in 1985 to better assess densities (Floate *et al.* 1990). Twelve and nine species were recovered from samples collected in 1984 and 1985, respectively, with six of 15 species recovered in both years. Estimates of total densities of carabids ranged from 0.5 to 39.4 beetles/m^2 and, unlike in pitfall traps, considerable numbers of carabid larvae (up to 29.8/m^2) were recovered. *Bembidion timidum* had the highest density (reaching 17.5/m^2) followed by *B. quadrimaculatum* and *B. obscurellum*. Although common in pitfall trap catches, *A. placidum* occurred in low numbers (<1.3/m^2) in soil samples on only two sampling dates, and *P. corvus* was never found in soil samples. Similar disparities between rank order of species in soil samples and concurrent pitfall trap catches have been attributed to species-specific efficiency of the sample techniques and to life-cycle-related periods of enhanced or suppressed surface activity (Holliday and Hagley 1979). Most species were present at densities of <1 beetle/m^2, similar to densities found by Thiele (1977) and Basedow (1973).

A Century of Carabidae of Aweme, Manitoba — D.A. Pollock

Aweme, Manitoba, has a unique history of insect collection that can provide insights into faunal change over a more extended period than for any other locality within the Prairies Ecozone. Here we report previously unpublished research that examines the Carabidae of Aweme over the course of more than a century of data collection. The carabid fauna before 1960 was characterized by using museum specimens. The author's (DAP) sampling in the 1990s, and that of Stjernberg (2011) in 2005–2006, provides information on the assemblage in recent years.

Table 5. Summary of carabid biodiversity studies in the Prairies Ecozone; for further details see text.

Source	Dates of Study	Location(s)[1] Latitude (N) Longitude (W)	Ecoregion(s)	Habitat(s)	Description
Alberta					
Frank 1971*a*	1967–1968	Calahoo 53.7157° -113.9589°	Boreal-Transition of the Boreal Plains Ecozone	Annual cereal field	Pitfall and mark-recapture study with information on seasonal patterns of catch.
Griffiths 1985	1984	Morinville 53.7636° -113.6470° 53.7640° -113.6438°	Boreal-Transition of the Boreal Plains Ecozone	Agroecosystem: fallow after canola	Pitfall traps and emergence traps to assess potential predators of cabbage maggot, *Delia radicum.*
Cárcamo 1995	1991	Neerlandia 54.32° -114.36°	Boreal-Transition of the Boreal Plains Ecozone	Barley fields	Pitfall trap study of effects of tillage regime on carabid beetles.
Cárcamo 1992; Cárcamo & Spence 1994; Cárcamo *et al.* 1995	1990–1991	Ellerslie 53.567° -113.517°	Aspen Parkland	Agroecosystems: cultivated fields, hay meadow	Pitfall trap study of effect of agronomic practices on carabid fauna.
Hummel *et al.* 2012	2005–2006	Ellerslie, Lacombe 53.567° -113.517° 52.4504° -113.7462°	Aspen Parkland	Agroecosystems: wheat, canola and intercrops	Pitfall trap study of effect of intercropping on carabid fauna.
Hartley *et al.* 2007	2000	Edmonton 53.7874° -112.5281°	Aspen Parkland	Grassland	Pitfall trap study along urban-rural gradient comparing carabids of graveyards with undisturbed grassland.
S. Kulkarni & L.M. Dosdall unpublished	2011	Leduc, Vegreville 53.3666° -113.5959° 53.4205° -112.1277°	Aspen Parkland	Canola fields	Pitfall trap study comparing carabid assemblages in two locations.
Butts *et al.* 2003	1993–1995	Lacombe, Lethbridge 52.4504° -113.7462° 49.7039° -112.7732°	Aspen Parkland, Moist Mixed Grassland	Research plots: canola, cereals or peas and intercrops	Pitfall trap study of effect of intercropping on carabid assemblages.
Broatch 2008	2003–2005	Lacombe 52.4504° -113.7462°	Aspen Parkland	Canola plots	Pitfall trap study to assess root maggot (*Delia*) and beneficial insect dynamics.in response to weed populations in canola
H. Cárcamo & S. Bourassa unpublished	1999–2001	Lethbridge 49.7043° -112.6918°	Moist mixed grassland	Canola plots	Pitfall trapping study of insecticide spraying and carabids
Floate *et al.* 2007	2000–2003	Lethbridge 49.7043° -112.6918°	Moist mixed grassland	Corn plots	Pitfall trapping study to investigate effect of *Bt* corn on carabid populations.
Bourassa *et al.* 2010	2004–2005	Lethbridge 49.7043° -112.6918°	Moist mixed grassland	Corn plots	Pitfall trapping study to investigate effect of crop rotation and herbicide tolerance in corn on carabid populations.

A. Mauduit, L.M. Dosdall, & H. Cárcamo unpublished	2012	Lethbridge 49.6973° -112.7573°	Moist mixed grassland	Canola and winter wheat plots, grass border	Pitfall trapping to investigate potential predators of diamondback moth, *Plutella xylostella.*
D.L. Johnson unpublished	1995	Suffield 49.8714° -111.1131°	Mixed grassland	Short grass prairie	Pitfall trapping to characterize fauna in grassland reserve.
Bourassa *et al.* 2008	2000, 2003–2005	Vauxhall 50.0555° -112.1304°	Mixed grassland	Wheat, bean and potato plots	Pitfall trapping to investigate effects of agroecosystem management on carabid assemblages.
H. Cárcamo unpublished	2002	Vauxhall 50.0555° -112.1304°	Mixed grassland	Canola plots	Pitfall trapping to characterize carabid fauna.
Saskatchewan					
Doane 1981	1975–1976	Clavet 52.0333° -106.4000°	Moist mixed grassland	Spring wheat field, grassy field margin	Pitfall trapping study. Comparison of species composition and diversity between habitats.
Melnychuk *et al.* 2003	1994–1996	Central – south SK 53.5842° -107.8692° 53.1356° -106.3853° 53.4011° -106.0172° 52.7189° -106.2169° 50.1358° -106.8847° 50.0689° -108.1683° 51.6333° -106.4333° 52.3006° -106.0508°	Aspen parkland, Moist mixed grassland, Mixed grassland	Agro-ecosystems (annual-grain, diversified grain-forage) with high versus organic inputs	Pitfall trapping study. Effect of different cropping systems and inputs in agro-ecosystems on species composition and diversity.
Bell *et al.* (2014)	2011	Elbow 51.2720° -106.8803°	Moist mixed grassland	Tame pasture dominated by alfalfa and crested wheatgrass	Pitfall trapping study. Effect of trap design on species recovery.
Floate 1987	1984–1985	Northeast SK 53.1110° -104.3555° 53.1110° -104.1606° 53.1545° -104.1362° 53.1110° -104.0386° 53.1546° -103.7948°	Boreal-Transition of the Boreal Plains Ecozone	Wheat fields	Pitfall trapping study. Diversity of carabids to assess their role as natural enemies of orange wheat blossom midge, *Sitodiplosis mosellana*.
Pepper 1999	1995	Southwest SK 49.8804° -108.4962° 49.8805° -108.2232° 49.9167° -108.3500° 49.7640° -108.1616° 49.8949° -108.2232° 49.9833° -108.0000° 49.5000° -107.8300°	Mixed grassland	Native grassland	Pitfall trapping study. Effect of grassland fragmentation and grazing intensity on species composition and diversity.

Source	Dates of Study	Location(s)[1] Latitude (N) Longitude (W)	Ecoregion(s)	Habitat(s)	Description
Manitoba					
Roughley *et al.* 2006	1998–2000	St. Charles Rifle Range 49.9111° -97.3393°	Lake Manitoba Plain	Tallgrass prairie, aspen forest	Pitfall trapping of relict prairie to compare assemblages in the grassland and forest.
Roughley *et al.* 2010	1997–2000	St. Charles Rifle Range 49.9111° -97.3393°	Lake Manitoba Plain	Tallgrass prairie	Pitfall trapping to assess effect of time of burning on carabid assemblages
Richardson 1982	1979–1980	Glenlea Research Farm 49.6475° -97.1274°	Lake Manitoba Plain	Agroecosystems, weedy plots	Pitfall trapping to compare effects of tillage, herbicide and mowing methods of vegetation management.
Humble 2001	1995 & 1999	Glenlea Research Farm 49.6402° -97.1416°	Lake Manitoba Plain	Agroecosystems: flax, seeded prairie grasses	Pitfall trapping to compare effects of rotation and fertilizer and herbicide inputs.
Songa 1994	1992–1993	Aubigny 49.4505° -97.2212° 49.4505° -97.2439° 49.4199° -97.2627°	Lake Manitoba Plain	Uncultivated roadsides	Pitfall trapping in grasshopper egg beds in spring and fall.
Hawkins-Bowman 2006	1999–2000	Carman 49.4966° -98.0355°	Lake Manitoba Plain	Canola plots	Pitfall trapping in canola plots with different pre-seeding tillage treatments and seeding rates.
Uddin 2005	1999–2001	Interlake & eastern MB 1999: 49.867° -96.817° 50.417° -97.250° 2000–2001: 50.933° -97.083° 50.983° -96.983°	Lake Manitoba Plain Interlake Plain of Boreal Plains Ecozone	Commerical alfalfa fields	Pitfall trapping in alfalfa fields to compare carabid assemblages in fields managed for hay production and seed production.
This chapter	1900–1999	Aweme 49.7085° -99.6028°	Aspen Parkland	Tallgrass prairie, mixed grass prairie, aspen groves, probably others	Assessment of a century of carabid faunal change based on museum specimens (1900–1959) and pitfall trapping (1990s)
Bird 1930	1928	Birtle 50.428° -101.079°	Aspen Parkland	Ecotone from tallgrass prairie to mature aspen	Quantitative sampling of insects in vegetation and soil at two-week intervals.
Stjernberg 2011 and this chapter	2005–2006	Yellow Quill Mixed Grass Prairie Preserve 49.6871° -99.6096° 49.6871° -99.5868° 49.6842° -99.5590° 49.7018° -99.5700°	Aspen parkland	Mixed grass prairie	Pitfall trapping study. Effect of cattle grazing (first three sites) and timing of grazing (fourth site) on species composition and diversity.

[1] Latitude and longitude are given to the number of decimal places that appear appropriate given the precision of information in the original report.

Aweme: The Place

Today, the geographical place name "Aweme" will be found on few Manitoba maps, at least partly because Aweme refers to a homestead rather than to an actual town or village. There would never have been an Aweme had it not been for the pioneering activities of the Criddle family, who emigrated from England, settling in this area of southwest Manitoba in 1882. Percy Criddle, the patriarch of the family, brought two family groups to the area: his wife Alice with whom he had four children (the Criddles), and his former common-law wife, Elise, and their five children (the Vanes). Percy and Alice's eldest son, Norman Criddle (1875–1933), became well-known as an entomologist and a botanist and was the first professional entomologist in Manitoba. Norman's presence at Aweme ensured that the insect fauna of the locality would be relatively well-known. In the early decades of the 20th century, Aweme was a famous collecting locality, and thousands of specimens collected there found their way into the hands and under the microscopes of many well-known entomologists. The homestead was finally abandoned by the Criddles in 1960 and is now preserved as the Criddle/Vane Homestead Provincial Park (http://www.gov.mb.ca/conservation/parks/popular_parks/western/criddle.html).

The centre of activity at Aweme was the main house, called "St. Albans" by Percy Criddle, located about 30 km southeast of Brandon (Table 5, Fig. 6) at an elevation of about 366 m above sea level. There are many insects labelled simply as "Aweme" (more on this below), and it is difficult to ascertain exactly what "Aweme" meant to the collectors of these insects. Presumably, it was the area within walking distance of St. Albans, but it is unknown how far a particular collector could get from the house and still be collecting at "Aweme." For the present study, only specimens labelled "Aweme" were examined.

Aweme: The "Early" Collectors

Because of Norman Criddle's residence at Aweme, the building of the Dominion Entomological Laboratory there in 1915, and the constant stream of specimens sent to experts for identification, the locality became a "must see" and the centre of collection activity for entomologists travelling in the area. The earliest documented specimen of ground beetle collected at Aweme is from 14 May 1900—a specimen of *Poecilus lucublandus* collected by Norman. From the early 1900s to about the middle of the 1930s, the insect fauna at Aweme, including the ground beetles, was constantly sampled by a number of collectors or entomologists, including Norman's brothers Evelyn (specimens from 1905 to 1958), Talbot (1908 to 1921), and Stuart (1908 to 1952) Criddle. Other early collectors of Aweme carabids were Dominion Entomologist J. Fletcher (1903–1907); research assistants P.N. Vroom (1920–1921), H.A. Robertson (1920–1922), R.H. Handford (1920–1930), and R.M. White (1922–1927); and amateur entomologists L.H. Roberts (1918–1921) and J.B. Wallis (1908–1957). Wallis wrote "The Cicindelidae of Canada" (Wallis 1961), which was dedicated to his wife and to his "lifelong companions the Criddles of Aweme." Carl Lindroth, in preparation for his work on the entire carabid fauna of Canada and Alaska (Lindroth 1961–1969), collected at Aweme in company with G.E. Ball in 1956. Specimens from these early collectors were designated as the type specimens (with Aweme, therefore, as the type locality) for four subspecies-rank taxa and five species-rank taxa of Carabidae (from 1902 to 1924). Of these, only one is still a valid (subspecies) taxon: *Cicindela lengi versuta* Casey (Bousquet 2012).

Aweme: The Collections

Given the small size of the Dominion Entomological Laboratory, it is unlikely that Norman Criddle maintained a large collection of specimens at Aweme, but many specimens were

Table 6. Carabid assemblages in selected major studies in the Prairies Ecozone showing ACFOR ratings of numbers of each species relative to the total sample size: A: Abundant (≥50% of total), C: Common (≥5%, <50%), F: Frequent (≥0.5%, <5%), O: Occasional (≥0.05%, <0.5%), R: Rare (<0.05%).

Species	Frank 1971*a*[1]	Carcamo *et al.* 1995[1]	Floate *et al.* 2007[1]	Bourassa *et al.* 2008[1]	Broatch 2008	Bourassa *et al.* 2010[1]	Floate 1987[1]	Bell *et al.* 2014	Doane 1981[1]	Melynchuk *et al.* 2003[1]	Pepper (1999)	Pollock: Aweme (This Chapter)		Stjern-berg 2011	Uddin 2005[1]	Richard-son 1982[1]
												1900-59	1990-9			
[3] N =	?[2]	14785	13319	12813	14025	11913	13982	1520	8741	2241	449	1254	1266	8858	30536	19751
Acupalpus canadensis Casey	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
Agonoleptus conjunctus (Say)	—	—	—	—	—	—	—	—	R	—	C	O	F	O	—	—
Agonum affine Kirby	—	—	R	—	—	—	—	—	—	—	—	O	—	—	—	—
A. anchomenoides Randall	—	—	—	—	—	—	F	—	—	—	—	F	—	—	—	—
A. corvus (LeConte)	—	—	—	O	R	O	R	—	O	—	—	F	—	—	O	—
A. cupreum Dejean	F	C	R	F	F	R	F	C	O	F	C	—	F	C	C	—
A. cupripenne (Say)	X	—	—	—	R	—	O	—	O	—	O	O	—	O	R	—
A. decorum (Say)	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
A.errans (Say)	—	—	—	—	—	—	—	—	—	—	—	F	—	R	—	—
A. gratiosum (Mannerheim)	—	—	—	—	—	—	R	—	—	—	—	F	—	R	O	—
A. harrisii LeConte	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
A. lutulentum (LeConte)	—	—	—	—	—	—	O	—	—	—	—	F	—	—	—	—
A. melanarium Dejean	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
A. nigriceps LeConte	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
A. piceolum (LeConte)	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—
A. placidum (Say)	F	F	C	F	C	F	C	—	O	C	—	F	C	F	F	—
A. propinquum (Gemminger & Harold)	—	—	—	—	R	—	—	—	—	—	—	O	—	R	—	—

A. retractum LeConte	X	—	—	—	—	—	—	—	—	—	—	F	C	R	R	—
A. sordens Kirby	—	R	—	—	R	—	—	—	—	—	—	F	—	—	R	—
A. thoreyi Dejean	—	—	—	—	—	—	—	—	R	—	—	O	—	—	R	—
A. trigeminum Lindroth	—	—	—	—	—	—	—	—	—	—	—	—	O	O	—	—
Amara aenea (DeGeer)	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—
A. aeneopolita Casey	—	—	—	—	R	—	—	—	—	—	—	—	—	—	—	—
A. angustata (Say)	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
A. apricaria (Paykull)	X	O	F	F	O	F	F	—	F	F	O	O	O	—	R	C
A. avida (Say)	F	O	—	—	—	—	O	—	—	—	—	O	—	—	R	C
A. carinata (LeConte)	—	—	C	C	—	C	F	O	C	F	F	O	—	—	R	F
A. coelebs Hayward	—	—	—	—	—	—	—	—	O	—	—	F	F	O	R	—
A. confusa LeConte	—	—	—	R	R	—	—	—	O	O	—	—	—	—	—	—
A. convexa LeConte	X	—	R	R	R	—	—	—	O	R	—	F	O	F	—	—
A. cupreolata Putzeys	X	O		R			R	O	O	R	F	O	F		F	—
A. discors Kirby	—	—	—	R	—	—	—	—	—	—	O	O	—	—	—	—
A. ellipsis (Casey)	X	O	—	R	—	R	—	—	F	—	—	O	—	F	R	—
A. familiaris (Duftschmid)	—	—	—	—	O	—	—	—	—	—	—	—	—	R	—	—
A. farcta LeConte	X	F	F	C	F	A	F	—	C	F	C	O	—	F	O	F
A. lacustris LeConte	X	—	—	O	F	—	R	—	C	F	—	—	—	—	R	R
A. laevipennis Kirby	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
A. latior (Kirby)	X	O	R	O	R	F	O	—	F	F	F	F	O	R	—	—
A. littoralis Dejean	X	O	R	O	F	F	—	O	O	C	O	O	—	O	F	O
A. lunicollis Schiødte	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—
A. musculis (Say)	—	—	—	—	—	—	—	—	O	—	—	F	—	—	—	—

Species	Frank 1971*a*[1]	Carcamo *et al.* 1995[1]	Floate *et al.* 2007[1]	Bourassa *et al.* 2008[1]	Broatch 2008	Bourassa *et al.* 2010[1]	Floate 1987[1]	Bell *et al.* 2014	Doane 1981[1]	Melynchuk *et al.* 2003[1]	Pepper (1999)	Pollock: Aweme (This Chapter) 1900-59	Pollock: Aweme (This Chapter) 1990-9	Stjern-berg 2011	Uddin 2005[1]	Richard-son 1982[1]
A. obesa (Say)	X	R	R	O	O	O	R	C	F	F	C	O	—	F	O	—
A. otiosa Casey	—	—	—	—	—	—	O	—	—	—	—	—	—	—	—	—
A. pallipes Kirby	X	—	—	—	R	—	R	—	O	—	—	O	—	R	—	—
A. patruelis Dejean	X	—	—	—	R	R	R	—	O	—	—	O	—	—	R	—
A. quenseli (Schönherr)	X	O	F	O	F	F	F	O	F	F	—	O	O	O	R	—
A. scitula Zimmermann	—	—	—	—	R	—	—	—	F	—	—	—	—	—	—	—
A. sinuosa (Casey)	X	—	—	—	—	—	—	—	—	—	—	—	—	R	R	—
A. tenax Casey	—	—	—	—	—	—	—	—	—	—	—	—	—	F	—	—
A. torrida (Panzer)	F	—	—	O	C	—	—	F	R	O	—	—	—	—	F	—
Anisodactylus discoideus Dejean	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
A. harrisii LeConte,	—	—	—	—	—	—	—	—	—	—	—	O	—	—	O	—
A. merula (Germar)	—	—	—	—	—	—	—	—	—	—	—	O	F	O	—	—
A. nigrita Dejean	—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	—
A. rusticus (Say)	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—
A. sanctaecrucis (Fabricius)	—	—	—	—	—	—	O	—	F	—	—	O	—	—	R	C
Axinopalpus biplagiatus (Dejean)	—	—	—	R	—	—	—	—	—	—	—	—	—	—	—	—
Badister neopulchellus Lindroth				R	—	—	—	—	—	—	—	F	—	—	—	—
B. obtusus LeConte	X	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
Bembidion acutifrons LeConte	—	—	—	R	—	—	—	—	R	—	—	—	—	—	—	—
B. aeneicolle (LeConte)	—	—	—	—	—	—	—	—	R	—	—	O	—	—	—	—

B. bimaculatum (Kirby)	F	F	R	O	O	O	F	—	F	O	—	F	—	—	—	—
B. canadianum Casey	X	F	—	—	R	—	R	—	R	R	—	—	—	—	R	—
B. castor Lindroth	—	—	—	O	—	—	—	—	—	—	—	—	—	—	—	—
B. chalceum Dejean	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
B. cheyennense Casey	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
B. coloradense Hayward	—	—	—	R	R	—	O	—	R	—	—	O	—	—	—	—
B. concolor (Kirby)	—	—	—	R	—	—	—	—	—	—	—	O	—	—	—	—
B. concretum Casey	—	—	—	—	—	—	—	—	R	—	—	O	—	—	—	—
B. confusum Hayward	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
B. cordatum (LeConte)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—
B. coxendix Say	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
B. flohri Bates	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
B. fortestriatum (Motschulsky)	—	—	—	—	—	—	—	—	—	—	—	O	—	—	R	—
B. frontale (LeConte)	—	—	—	—	—	—	—	—	—	—	—	O	—	—	R	—
B. graphicum Casey	—	—	—	—	—	—	—	—	—	—	—	O	O	—	—	—
B. grapii Gyllenhal	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B. impotens Casey	—	—	—	—	—	—	—	—	—	—	F	O	—	—	—	—
B. inaequale Say	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
B. incrematum LeConte	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
B. insulatum (LeConte)	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
B. intermedium (Kirby)	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
B. interventor Lindroth	—	—	—	—	—	—	R	—	—	—	—	O	—	—	—	—

Species	Frank 1971*a*[1]	Carcamo *et al.* 1995[1]	Floate *et al.* 2007[1]	Bourassa *et al.* 2008[1]	Broatch 2008	Bourassa *et al.* 2010[1]	Floate 1987[1]	Bell *et al.* 2014	Doane 1981[1]	Melynchuk *et al.* 2003[1]	Pepper (1999)	Pollock: Aweme (This Chapter)		Stjern-berg 2011	Uddin 2005[1]	Richard-son 1982[1]
												1900-59	1990-9			
B. levettei Casey	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
B. mimus Hayward	—	—	—	—	—	—	—	—	—	—	—	O	O	—	—	—
B. muscicola Hayward	—	—	—	—	—	—	—	—	R	—	—	F	—	R	—	—
B. mutatum Gemminger & Harold	X	F	—	—	—	—	O	—	O	O	—	O	—	O	—	—
B. nigripes (Kirby)	—	—	—	—	R	—	—	—	O	R	—	O	—	—	R	—
B. nitidum (Kirby)	F	O	R	O		O	C	O	F	C	F	F	—	F	R	—
B. nudipenne Lindroth	X	—	R	R	R	O	F	—	O	O	—	—	—	—	—	F
B. oberthueri Hayward	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
B. obscurellum (Motschulsky)	C	O	F	F	R	F	C	—	C	C	—	F	—	R	O	—
B. obtusangulum LeConte	—	—	—	—	R	—	—	—	R	—	—	O	—	—	—	—
B. obtusidens Fall	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
B. patruele Dejean	—	—	—	—	—	—	—	—	—	—	—	F	—	—	R	—
B. petrosum Gebler	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
B. praecinctum LeConte	—	—	—	—	R	—	—	—	—	—	—	—	—	—	—	—
B. pseudocautum Lindroth	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
B. quadrimaculatum (Linnaeus)	C	C	C	C	F	C	C	F	C	C	O	—	—	O	F	R
B. rapidum (LeConte)	X	—	R	R	—	R	R	—	—	O	—	F	—	R	R	—
B. roosevelti Pic	—	—	—	—	—	—	—	—	O	—	—	—	—	—	—	—
B. rupicola (Kirby)	C	F	—	F	F	F	F	—	R	—	—	O	—	—	O	—

B. salebratum (LeConte)	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
B. salinarium Casey	—	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—
B. scopulinum (Kirby)	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
B. scudderi LeConte	—	—	—	R	R	—	—	—	—	—	—	O	—	—	—	—
B. sordidum (Kirby)	—	—	—	—	—	—	O	—	—	—	—	F	—	—	—	—
B. timidum (LeConte)	—	O	F	F	—	C	F	—	F	F	—	O	—	—	—	—
B. transparens (Gebler)	—	—	—	—	—	—	—	—	—	—	—	O	—	—	R	—
B. transversale Dejean	—	—	—	—	—	—	—	—	—	O	—	O	—	—	—	—
B. versicolor (LeConte)	X	—	—	—	—	—	—	—	—	F	—	F	—	—	—	—
B. viridicolle (LaFerté-Sénectere)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—
Blethisa hudsonica Casey	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
B. quadricollis Haldeman	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
Brachinus fumans (Fabricius)	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
B. quadripennis Dejean	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
Bradycellus congener (LeConte)	X	—	R	O	R	O	—	—	O	O	—	O	—	—	—	F
B. lecontei Csiki	X	—	—	—	—		R	—	R	—	—	O	O	—	—	—
B. lugubris (LeConte)	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—	—
B. nigerrimus Lindroth	—	—	—	—	—	—	O	—	O	—	—	—	—	—	—	—
Calathus ingratus Dejean	X	R	—	O	R	—	R	O	O	O	O	F	F	—	R	—

Species	Frank 1971*a*[1]	Carcamo *et al.* 1995[1]	Floate *et al.* 2007[1]	Bourassa *et al.* 2008[1]	Broatch 2008	Bourassa *et al.* 2010[1]	Floate 1987[1]	Bell *et al.* 2014	Doane 1981[1]	Melynchuk *et al.* 2003[1]	Pepper (1999)	Pollock: Aweme (This Chapter)		Stjern-berg 2011	Uddin 2005[1]	Richard-son 1982[1]
												1900-59	1990-9			
Calleida purpurea (Say)	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—
Calosoma calidum (Fabricius)	X	O	—	—	O	—	F	—	—	O	—	F	F	C	O	R
C. frigidum Kirby	—	—	—	—	—	—	—	—	—	—	—	F	F	F	—	—
C. lepidum LeConte	—	—	—	—	—	—	—	—	O	O	F	O	—	O	—	—
C. obsoletum Say	—	—	—	O	—	—	—	—	R	O	—	—	—	—	—	—
Carabus granulatus Linnaeus	—	—	—	—	F	—	—	—	—	—	—	—	—	—	R	—
C. maeander Fischer von Waldheim	X	—	—	—	—	—	—	O	—	—	—	O	—	—	—	—
C. nemoralis Müller	—	—	—	—	R	—	—	—	—	—	—	—	—	—	—	—
C. serratus Say	X	F	—	—	R	—	R	—	O	—	—	O	F	O	R	—
C. taedatus Fabricius	X	O	—	—	—	—	R	F	O	—	—	O	F	F	O	—
Chlaenius alternatus Horn	X	—	—	—	R	—	—	—	R	—	—	O	—	—	R	—
C. lithophilus Say	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
C. pennsylvanicus Say	—	—	—	—	—	—	—	—	O	—	—	F	O	R	R	—
C. purpuricollis Randall	—	R	—	—	—	—	R	O	—	—	—	O	O	F	—	—
C. sericeus (Forster)	—	—	R	O	—	O	O	O	O	—	—	F	—	R	R	—
C. tomentosus (Say)	—	—	—	—	—	—	—	—	—	—	—	O	F	F	—	—
Cicindela duodecimguttata Dejean	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
C. formosa Say	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
C. hirticollis Say	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—

C. lengi Horn	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
C. limbalis Klug	X	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
C. limbata Say	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
C. longilabris Say	—	—	—	—	—	—	—	—	—	—	—	O	—	F	—	—
C. nebraskana Casey	—	—	—	—	—	—	—	O	—	—	C	F	—	F	—	—
C. punctulata Olivier	—	—	—	—	—	—	—	—	—	—	—	F	O	O	—	—
C. purpurea Oliver	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
C. repanda Dejean	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
C. scutellaris Say	—	—	—	—	—	—	—	—	—	—	—	F	—	R	—	—
C. tranquebarica Herbst	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
Clivina fossor (Linnaeus)	—	—	—	R	C	—	—	—	—	—	—	—	—	—	—	—
Cylindera terricola (Say)	—	—	—	—	—	—	—	O	—	—	—	O	—	—	—	—
Cymindis borealis LeConte	—	—	—	R	—	—	—	—	O	—	—	—	—	F	R	—
C. cribricollis Dejean	X	R	—	R	R	—	R	F	O	—	F	O	—	O	—	—
C. neglecta Haldeman	—	—	—	—	—	—	—	O	—	—	—	O	—	—	—	—
C. pilosa Say	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—
C. planipennis LeConte	X	—	—	—	—	—	—	—	O	—	—	F	O	O	—	—
Dicaelus sculptilis Say	—	—	—	—	—	—	R	—	—	—	—	O	—	—	R	—
Dicheirotrichus cognatus (Gyllenhal)	X	O	—	—	O	—	—	—	R	—	—	O	—	—	R	—
Diplocheila obtusa (LeConte)	—	—	—	—	R	R	R	O	—	—	—	O	—	O	R	—
D. oregona (Hatch)	—	—	—	R	—	—	—	—	—	—	—	—	—	—	—	—

Species	Frank 1971*a*[1]	Carcamo *et al.* 1995[1]	Floate *et al.* 2007[1]	Bourassa *et al.* 2008[1]	Broatch 2008	Bourassa *et al.* 2010[1]	Floate 1987[1]	Bell *et al.* 2014	Doane 1981[1]	Melynchuk *et al.* 2003[1]	Pepper (1999)	Pollock: Aweme (This Chapter)		Stjern-berg 2011	Uddin 2005[1]	Richard-son 1982[1]
												1900-59	1990-9			
D. striatopunctata (LeConte)	—	—	—	—	—	—	R	—	O	R	—	O	—	—	—	—
Dyschirius campicola Lindroth	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
D. dejeanii Putzeys	—	—	—	—	—	—	—	—	R	—	—	F	—	—	—	—
D. globulosus (Say)	—	O	—	—	—	—	O	—	—	R	O	O	—	—	R	—
D. montanus LeConte	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
D. pilosus LeConte	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
D. planatus Lindroth	—	—	—	—	—	—	—	F	—	—	—	—	—	—	—	—
D. politus (Dejean)	—	—	—	—	—	—	—	—	—	—	—	O	—	—	R	—
D. quadrimaculatus Lindroth	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
D. setosus LeConte	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
D. sphaericollis (Say)	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
D. timidus Lindroth	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
D. truncatus LeConte	—	—	—	—	—	—	R	—	—	—	—	F	—	—	—	—
Elaphropus incurvus (Say)	—	—	—	—	—	—	—	—	—	—	—	F	O	—	—	—
E. vernicatus (Casey)	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
Elaphrus americanus Dejean	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
E. californicus Mannerheim	—	—	—	—	—	—	R	—	O	—	—	—	—	—	—	—
E. clairvillei Kirby	—	—	—	—	—	—	R	—	—	—	—	O	—	—	—	—
E. lecontei Crotch	—	—	—	R	—	—	—	—	R	—	—	O	—	—	—	—

E. olivaceus LeConte	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
Ellipsoptera lepida (Dejean)	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
Euryderus grossus (Say)	—	—	—	—	—	—	—	—	R	O	—	F	O	R	—	—
Geopinus incrassatus (Dejean)	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
Harpalus affinis (Schrank)	—	—	—	—	O	—	—	—	—	—	—	—	—	—	—	—
H. amputatus Say	C	R	F	F	F	F	O	—	F	F	O	F	—	—	R	F
H. caliginosus (Fabricius)	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
H. desertus LeConte	X	—	—	—	—	—	—	—	R	—	F	—	—	—	—	—
H. ellipsis LeConte	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—	—
H. erraticus Say	—	—	—	—	—	—	—	—	—	—	—	—	O	—	R	—
H. erythropus Dejean	—	—	—	—	—	—	—	—	—	—	—	—	—	R	R	—
H. faunus Say	—	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—
H. fraternus LeConte	—	O	R	O	O	R	—	—	—	—	O	O	—	—	—	—
H. fulvilabris Mannerheim	—	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—
H. fuscipalpis Sturm	X	—	—	O	O	O	—	—	O	F	F	O	—	R	—	—
H. herbivagus Say	—	O	—	F	—	F	O	—	C	F	F	F	F	O	O	F
H. laevipes Zetterstedt	—	—	—	—	—	—	—	—	—	—	—	O	—	—	R	—
H. laticeps LeConte	—	—	—	—	—	—	R	—	—	—	—	O	—	—	—	—
H. lewisii LeConte	—	—	—	—	—	—	R	—	—	—	—	O	—	R	R	—
H. megacephalus LeConte	—	—	—	—	—	—	—	—	—	—	—	—	—	O	R	—
H. nigritarsis Sahlberg	—	—	—	R	—	—	—	—	—	—	—	—	—	O	—	—

Species	Frank 1971*a*[1]	Carcamo *et al.* 1995[1]	Floate *et al.* 2007[1]	Bourassa *et al.* 2008[1]	Broatch 2008	Bourassa *et al.* 2010[1]	Floate 1987[1]	Bell *et al.* 2014	Doane 1981[1]	Melynchuk *et al.* 2003[1]	Pepper (1999)	Pollock: Aweme (This Chapter)		Stjern-berg 2011	Uddin 2005[1]	Richard-son 1982[1]
												1900-59	1990-9			
H. ochropus Kirby	—	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—
H. opacipennis (Haldeman)	—	—	—	—	—	—	R	O	O	O	O	O	O	O	R	—
H. paratus Casey	—	—	—	O	—	—	—	—	—	—	—	—	—	—	—	—
H. pensylvanicus (DeGeer)	—	—	—	—	—	—	O	—	—	—	—	O	F	O	O	F
H. plenalis Casey	—	—	—	—	—	—	—	—	—	—	—	O	—	R	—	—
H. reversus Casey	X	—	R	F	—	F	O	O	O	F	F	O	O	—	R	—
H. somnulentus Dejean	F	O	—	R	R	R	O	F	O	—	F	O	—	O	O	—
H. ventralis LeConte	—	—	—	O	—	R	R	F	O	—	F	—	—	O	—	—
Lebia atriceps LeConte	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
L. atriventris Say	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
L. fuscata Dejean	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
L. moesta LeConte	—	—	—	—	—	—	—	—	—	—	—	O	—	R	R	—
L. pumila Dejean	—	—	—	—	—	—	—	—	—	—	—	O	—	—	R	—
L. solea Hentz	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
L. viridis Say	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
L. vittata (Fabricius)	—	—	—	R	—	—	—	—	—	—	—	F	—	—	—	—
Loricera pilicornis (Fabricius)	X	R	R	R	—	—	R	—	R	—	—	O	—	R	—	—
Microlestes curtipennis (Casey)	—	—	—	—	—	—	—	—	—	—	C	—	—	—	—	—
M. linearis (LeConte)			F	F	O	C	O		O	F	—	—	—	—	—	—
Notiophilus aquaticus (Linnaeus)	X	F	—	—	F	—	R	—	O	—	—	O	—	R	O	—
N. semistriatus Say	X	—	—	—	—	—	—	—	—	—	—	O	—	—	R	—

Omophron americanum Dejean	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
O. tessellatum Say	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
Oxypselaphus pusillus (LeConte)	—	—	—	—	—	—	—	—	—	—	—	O	—	—	F	—
Pasimachus elongatus LeConte	—	—	—	R	—	—	—	—	—	—	—	F	F	C	—	—
Patrobus lecontei Chaudoir	X	—	—	—	R	—	R	—	O	—	—	—	—	—	—	—
P. longicornis (Say)	—	—	—	—	—	—	R	—	—	R	—	—	—	—	—	—
P. septentrionis Dejean	—	—	—	—	R	—	—	—	—	—	—	—	—	—	—	—
P. stygicus Chaudoir	—	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—
Philophuga viridis (LeConte)	—	—	—	—	—	—	—	—	—	—	O	F	—	F	—	—
Piosoma setosum LeConte	—	—	—	R	R	—	—	O	—	—	—	—	—	—	—	—
Platynus decentis (Say)	—	—	—	—	—	—	—	—	—	—	—	F	F	R	R	—
P. mannerheimii (Dejean)	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
Poecilus corvus (LeConte)	O	R	C	C	R	C	C	—	O	F	—	O	—	R	C	C
P. lucublandus (Say)	F	C	—	F	F	F	F	F	C	F	F	F	O	F	C	—
P. scitulus LeConte	—	—	—	O	—	—	—	—	—	R	—	—	—	—	—	—
Pterostichus adstrictus Eschscholtz	F	C	R	O	F	R	F	—	R	O	—	O	—	—	O	—
P. caudicalis (Say)	—	—	—	—	—	—	O	—	—	—	—	O	—	—	R	—
P. commutabilis (Motschulsky)	—	—	—	—	—	—	—	—	—	—	—	O	—	—	R	—
P. corvinus (Dejean)	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
P. femoralis (Kirby)	X	—	—	O	—	—	F	O	O	O	F	O	F	F	F	R

Species	Frank 1971*a*[1]	Carcamo *et al.* 1995[1]	Floate *et al.* 2007[1]	Bourassa *et al.* 2008[1]	Broatch 2008	Bourassa *et al.* 2010[1]	Floate 1987[1]	Bell *et al.* 2014	Doane 1981[1]	Melynchuk *et al.* 2003[1]	Pepper (1999)	Pollock: Aweme (This Chapter)		Stjern-berg 2011	Uddin 2005[1]	Richard-son 1982[1]
												1900-59	1990-9			
P. luctuosus (Dejean)	—	—	—	—	—	—	—	—	O	—	—	O	—	—	R	R
P. melanarius (Illiger)	—	C	C	C	A	C	—	—	—	—	—	—	O	O	A	—
P. mutus (Say)	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—
P. novus Straneo	—	—	—	—	—	—	—	—	—	—	—	O	—	R	—	—
P. patruelis (Dejean)	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—
P. pensylvanicus LeConte	—	O	—	—	—	—	—	—	R	—	—	O	C	R	O	—
P. riparius (Dejean)	—	—	—	—	R	—	—	—	—	—	—	—	—	—	—	—
Sericoda bembidioides Kirby	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
S. obsoleta (Say)	—	—	—	—		—	—	—	—	—	—	—	—	R	R	—
S. quadripunctata (DeGeer)	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sphaeroderus nitidicollis Guérin-Méneville	—	—	—	—	—	—	R	—	—	—	—	—	—	—	—	—
Stenolophus comma (Fabricius)	X	—	—	C	—	O	O	—	O	—	—	F	O	—	O	F
S. fuliginosus Dejean	—	—	—	—	—	—	R	—	—	—	—	—	—	—	—	—
S. lineola (Fabricius)	—	—	—	—	—	—	—	—	—	—	—	O	—	—	—	—
Syntomus americanus (Dejean)	X	—	—	—	—	R	O	C	O	F	C	F	F	F	R	—
Synuchus impunctatus (Say)	X	O	—	—	—	—	—	—	—	—	—	—	C	O	—	—
Trechus apicalis Motschulsky	—	—	—	—	—	—	—	—	—	—	—	F	—	—	—	—

[1] Study in which tiger beetles (Cicindelini) were not recorded.

[2] Frank (1971*a*) does not provide information on total catch, but used mark-recapture methods to estimate density of common species. These densities were used for calculating ACFOR classifications. Species that were recorded as present in this study, but for which there is no density estimate, are identified with "X."

[3] Total number of individuals from which the ACFOR classes were calculated.

donated or sent to various insect collections throughout North America. For this study, 2,527 specimens with an "Aweme" locality label were examined from four collections: Museum of Comparative Zoology (Harvard University, Cambridge, Massachusetts), Canadian National Collection of Insects (Ottawa, Ontario), Wallis/Roughley Museum of Entomology (University of Manitoba, Winnipeg, Manitoba), and Lethbridge Research Centre (Agriculture and Agri-Food Canada, Lethbridge, Alberta). This is by no means an exhaustive list, but it does provide a good sampling of carabid collecting activity at Aweme before 1960. More recent material was obtained through two seasons of pitfall and pan trapping by DAP around Aweme proper (1992 and 1999), as well as from pitfall trapping in 2005 and 2006 in sites about 2 km south of Aweme that were part of a study on grazing effects on ground beetles and spiders (Stjernberg 2011).

Carabids were determined to species, and then sorted into collection intervals by decade, as follows: 1: 1900–1909; 2: 1910–1919; 3: 1920–1929; 4: 1930–1939; 5: 1940–1949; 6: 1950–1959; 7: 1990s. Collection intervals 1–4 were considered "old," 5–6 "middle," and 7 "recent." Although appearing to be somewhat arbitrary, they correspond to three different collecting "eras" at Aweme. "Old" specimens (1,124) were collected during the time when Norman Criddle lived at Aweme; he certainly did not collect all specimens himself. In fact, his two assistants collected the majority of specimens in collection interval 3, likely due to Norman Criddle's official commitments elsewhere and his failing health (Holliday 2005). "Middle" specimens (130) were taken during a period of drastically reduced collecting activity at Aweme, but include those collected during Carl Lindroth's visit in 1956. The "recent" interval (7) pertains to the most recent concerted efforts to collect ground beetles at Aweme. These efforts were fairly narrow chronologically, but the trapping yielded 1,273 specimens. Finally, for comparison purposes, 1,899 specimens caught in 2005–2006 in pitfall traps in an ungrazed area of the Yellow Quill Mixed Grass Prairie Preserve (Stjernberg 2011) have been added as interval 8.

Comparisons between the old and the new collection data must be interpreted cautiously because of differences in collection method and the incomplete record from early collections. For example, it can be assumed that most, if not all, of the specimens from intervals 1–6 were collected by hand, rather than trapped as they were in intervals 7–8. Because of the biases of these two techniques, as discussed above, it is not surprising that the ratio of number of species to number of individuals is less than 1:4 for intervals 1–6 and more than 1:30 for intervals 7 and 8 (Table 7). Small beetles, such as species of *Bembidion* and *Bradycellus*, are relatively poorly represented in the pitfall trap catches of intervals 7–8, where catches of the most frequently caught *Bembidion* ranked 37th; in contrast, four species of *Bembidion* were within the 20 most frequently collected species in intervals 1–6. Additionally, although the author (DAP) examined only a portion of specimens collected during the early time intervals (those deposited in the four museum collections), all specimens collected during intervals 7 and 8 were recorded. If we assume that the early sampling gives an accurate representation of the species present (if not actual abundances of each species), then comparisons between old and new samples perhaps become more reasonable.

The Aweme Carabid Fauna as a Whole

The 199 species-group carabid taxa collected from Aweme (Table 6) represent 54% of species known from Manitoba, 39% of species from the Prairie Provinces (Alberta, Saskatchewan, Manitoba), and 22% of Canadian species (Bousquet 2012). Among the 43 genera represented at Aweme, the top five are *Bembidion* (44 spp.), *Agonum* (18 spp.), *Amara* (17 spp.), *Harpalus* (14 spp.), and *Pterostichus* (10 spp.). Eighteen genera are represented by a single species.

Only two of the 199 species reported from Aweme have been identified as adventive species in North America, and those species were not recorded until later time intervals. *Pterostichus melanarius* and *Amara apricaria* have been collected at Aweme, representing only 4% of adventives in all of Canada (Bousquet 2012) and a small subset of those in the ecozone (Table 2). The two adventive species are known from only four specimens, all of which were collected in intervals 6 and 7. The only specimen of *P. melanarius* is a full-winged individual, perhaps indicative of a recent arrival (Niemelä and Spence 1999; Bourassa *et al.* 2011); *P. melanarius* has been in Manitoba since at least 1979 (Richardson 1982).

Biogeographically, most of the Carabidae of Aweme represent widespread species; 127 species are known from all provinces from British Columbia to Ontario. However, there are several seeming prairie "specialist" species, that is, found in Canada only in Alberta, Saskatchewan, and Manitoba. These include *Bembidion coxendix*, *Calosoma lepidum*, several species and subspecies of *Cicindela*, *Dyschirius quadrimaculatus*, *Lebia atriceps*, and *Pasimachus elongatus*. There are several species whose Aweme record represents the western extent of their geographical ranges: *Agonum trigeminum*, *Anisodactylus merula*, *Cicindela formosa generosa* Dejean, *C. scutellaris lecontei* Haldeman, *Dyschirius pilosus*, and *Pterostichus novus*.

Why then are the Carabidae of Aweme so diverse? Two answers to this question seem apparent. First, the fairly constant collecting effort for over 40 years meant that even species whose emergence may be episodic, or that inhabit "rare" microhabitats, would be collected. The second explanation, which is not mutually exclusive of the first, is that the Aweme locality is diverse biogeographically, geologically, and botanically (Bird 1927, 1961). Within walking distance of St. Albans are remnant tallgrass and mixedgrass prairie; stands of *Populus tremuloides*, *Quercus macrocarpa* Michx. (Fagaceae), and *Picea glauca* (Moench) Voss (Pinaceae) (Shorthouse 2010*b*); river bottom forest (Shay 1984); tamarack swamps; and active dunes and sand hills (Bird 1927). That Norman Criddle had this backdrop of great habitat diversity in his backyard, and was a great collector, has made Aweme a notable centre for carabid diversity in the Canadian Prairies.

Aweme Carabids: Then and Now

Although it is difficult to compare Norman Criddle's hand-collected carabid fauna from 1900 to 1930 to that of mass-collected specimens from 1992 to 2006, the existence of this long-term record of ground beetle activity from a relatively small geographical area leads to some intriguing patterns. For example, that the recent studies did not re-collect many of the "old" species seems less important than the fact that some of the very common "new species" were seemingly rare or absent in the Criddle era at Aweme (Table 7). Thus, the appearance of new species between the two intervals may indicate changes in the carabid assemblages over the collecting period.

Temporal changes to the ground beetle fauna, if they have occurred, could be due to concurrent changes in the environment, since carabid beetles are quite sensitive to abiotic environmental factors (Thiele 1977; Landry 1994). Table 7 shows the 30 most frequently collected carabid species from Aweme, sorted into the various collection intervals. The six taxa of tiger beetles that figure prominently among early collections were not re-collected as a result of differences in collecting method between intervals 1–6 and 7. Another species among the top 30 may have been missed in recent collections because of differences in the

Table 7. The 30 most frequently collected species of carabid beetles, and totals for collections in the Aweme locality over eight periods of sampling.

Species	**Interval**									
	1 1900–9	2 1910–9	3 1920–9	**Total Old**	4 1930–9	5 1940–9	6 1950–9	**Total Mid**	7 1990–9 **Total New**	8 2000–9 **Total YQ**[1]
Agonum retractum	1	1	2	4	—	—	9	9	258	1
Pterostichus pensylvanicus	—	1	1	2	—	—	—	—	260	—
Agonum placidum	3	—	9	12	—	—	—	—	176	10
Synuchus impunctatus	—	—	—	—	—	—	—	—	97	4
Amara cupreolata	—	—	2	2	—	—	—	—	61	—
Ellipsoptera lepida	3	43	14	60	—	1	—	1	—	—
Amara coelebs	1	6	7	14	—	—	—	—	37	5
Harpalus pensylvanicus	—	—	4	4	—	—	—	—	44	2
Calathus ingratus	7	1	1	9	—	—	—	—	36	—
Chlaenius tomentosus	—	—	1	1	1	—	1	2	40	6
Syntomus americanus	1	—	5	6	—	—	4	4	31	98
Pasimachus elongatus	5	1	4	10	1	—	3	4	25	93
Carabus taedatus	4	1	—	5	—	—	—	—	27	27
Cicindela scutellaris	5	11	9	25	—	2	4	6	—	—
Platynus decentis	—	4	7	11	—	—	—	—	17	—
Amara convexa	—	5	17	22	—	—	1	1	4	4
Calosoma frigidum	3	7	3	13	—	—	—	—	14	6
Bembidion obscurellum	2	1	19	22	—	—	3	3	—	—
Harpalus herbivagus	—	2	8	10	—	—	—	—	15	3
Lebia vittata	1	10	14	25	—	—	—	—	—	—
Anisodactylus merula	—	—	—	—	—	—	1	1	22	—
Badister neopulchellus	2	7	14	23	—	—	—	—	—	—
Calosoma calidum	4	5	1	10	1	—	—	1	12	798
Cicindela limbata	9	6	6	21	2	—	—	2	—	—
Euryderus grossus	2	12	2	16	—	2	1	3	4	—
Carabus serratus	2	1	2	5	1	—	—	1	15	12
Cicindela lengi	2	5	13	20	—	—	—	—	—	—
Bembidion nitidum	6	11	2	19	1	—	—	1	—	2
Cicindela tranquebarica	6	2	4	12	—	2	7	9	—	—
Cicindela formosa	2	4	6	12	—	6	2	8	—	—
Total species	**89**	**103**	**153**	**186**	**14**	**8**	**38**	**53**	**42**	**47**
Total individuals	**224**	**309**	**574**	**1107**	**16**	**24**	**107**	**147**	**1266**	**1899**

[1] Ungrazed sites in Yellow Quill Mixed Grass Prairie Preserve study (Stjernberg 2011 and this chapter).

types of habitat sampled: *Badister neopulchellus* was collected at least 23 times from 1900 to 1929, but was not collected in intervals 7–8. This species is associated with moist or wet habitats near water (Table 1). Other hygrophilous taxa, not collected frequently enough to appear in Table 7, formed a higher proportion of the carabid collections in intervals 1–3 than in intervals 7–8; these include hygrophilous species of *Agonum* and *Chlaenius*, and species of *Blethisa* and *Omophron*. Few of these taxa, other than xerophilous members of *Agonum* and *Chlaenius*, were re-collected in more recent studies. Three species that were frequently collected in recent studies, but were either absent or infrequent in intervals 1–6, are *Amara cupreolata*, *Anisodactylus merula*, and *Chlaenius tomentosus*, which are associated with dry sandy habitats (Table 1). Interestingly, only one of these species—*C. tomentosus*—was collected by Stjernberg (2011) on the adjacent Yellow Quill Prairie. The 10 most frequently collected species in interval 7 are either dry ground or forest inhabitants. This change in carabid assemblages (excluding the tiger beetles) from one showing a preference for wet habitats to one showing preference for drier habitats may relate to changes in environmental characteristics in the Aweme area. In the 1990s, there was no permanent water at the Aweme site; however, Bird (1927) summarized conditions in the area in 1924–1926 and recorded the presence of tamarack swamps. In the 1880s, water levels near Aweme were 3 m higher than in the 1920s (Bird 1927) and there were ponds close to St. Albans (Criddle 1973). It seems that the Aweme area is subject to great fluctuations in moisture, and during intervals 1–3, it was much wetter than it was during intervals 7–8.

In addition to changes in water availability, the carabid fauna has been influenced by the amount of forest cover. Bird (1927) stated that the forest cover of the immediate area was subject to change, depending on fluctuations in the water level. Several of the "top 30" species that are important in recent collections but missing or rare in early collections are forest species, which indicates increased forest cover at Aweme. For example, 260 specimens of *Pterostichus pensylvanicus* were taken during interval 7, while there were only two individuals collected from 1910 to 1929. Similarly, while no specimens of *Synuchus impuncatus* were collected from 1900 to 1959, 97 individuals were collected during interval 7. Individuals of both species are found associated with thick leaf litter in forest habitats (Larochelle and Larivière 2003). *Agonum retractum* is also a true forest species (Larochelle and Larivière 2003), with only 13 specimens collected from 1900 to 1959, but 258 caught in pitfall traps in interval 7.

The most recent concerted effort to collect ground beetles from the Aweme area was made by Stjernberg (2011) during a two-year study on the Yellow Quill Mixed Grass Prairie Preserve. The data for the three most abundant species collected in the ungrazed areas of her study reveal differences from the carabids of Aweme proper. For example, nearly 800 specimens of *Calosoma calidum* were taken, while only 23 have been collected at Aweme (all year intervals). The second most abundant species was *Agonum cupreum*, with 334 specimens; only nine specimens are known from Aweme. Lastly, though only three specimens of *Chlaenius purpuricollis* are known from Aweme (including a single specimen from interval 7), Stjernberg (2011) recorded 129 from ungrazed areas of her study sites. The latter species was long considered to be rare (Lindroth 1961–1969), but recent collections (e.g., Roughley *et al.* 2006) suggest that although somewhat local, individuals can be fairly common at these localized sites. The habitat requirements of *C. purpuricollis* are difficult to define, as it has been associated with limestone alvar pavements and grasslands, as well as vegetated sandy sites (Bouchard and Wheeler 1997; Larochelle and Larivière 2003).

Aweme Carabids: Summary

The Aweme area (including nearby Treesbank and Onah) has been a natural laboratory for natural history investigations since 1900, especially those spearheaded by Norman Criddle and his assistants. The combination of over 100 years of collecting at the site, and the varied habitats from which specimens were collected, has created a special record of carabid presence at Aweme. Moisture, forest cover, and agricultural activities, all of which have changed appreciably since the Criddles established Aweme, have all been tracked by ground beetles with similarly varied ecological requirements. Despite biases from comparing assemblages from the earlier, hand-collected specimens to the more recent material collected by pitfall traps, some trends are apparent. The recent Aweme carabids are represented by far fewer hygrophilous taxa than that of the first half of the previous century. In addition, reforestation of the homestead has led to increased abundances of typically forest-inhabiting species. Although Aweme has long since disappeared from maps of Manitoba, the thousands of insect specimens with the "Aweme" locality label have created one of the best-known insect-collecting localities in Canada.

Effect of Grazing on Carabids in Mixedgrass Prairie — A. Stjernberg

In 2005 and 2006, the effect of cattle grazing on carabid assemblages was studied in the Yellow Quill Mixed Grass Prairie Preserve, located about 30 km southeast of Brandon (Fig. 6) in southwest Manitoba (Stjernberg 2011). A twice-over grazing regime had been used on the Preserve for several years before the study. In this regime, there is a spring grazing period of approximately two weeks and then a period of rest for the paddock, followed by a fall grazing period lasting about one month.

Responses to Grazing

The effect of grazing was studied in three native mixedgrass prairie paddocks (192–256 ha) that had received a twice-over grazing regime since summer 2000. Each paddock included a 1 ha exclosure, established in 2000, to provide an ungrazed area. In both study years, a herd of three bulls and 75 cow/calf pairs was introduced to the first paddock in June for the spring graze and then moved in succession to the second and third paddock. Spring grazing was completed in the third paddock in mid-July, and the herd was returned to the first paddock for fall grazing and moved in succession through the second and third paddock; fall grazing was completed in the third paddock in October. Twenty-five pitfall traps were installed in each of the grazed and ungrazed areas of each paddock and operated from 2 June to 27 October 2005 and 3 May to 26 October 2006, with traps emptied weekly. Some portions of the grazed areas had stands of aspen, *Populus tremuloides*, and traps were not placed in these areas, so that their environment more closely corresponded to the treeless ungrazed areas. Despite various defences, the cattle interfered with the traps and so only catches when cattle were absent from a paddock could be analyzed. For analysis, catches for each paddock were divided into before-, between-, and after-grazing trapping periods. Because the same herd was used for all grazing, these trapping periods overlapped and were not identical for all paddocks, but were the same for the grazed and ungrazed areas within each paddock. To deal with these and other intrinsic differences of the paddocks, treatment was nested within paddocks in both univariate and multivariate statistical analyses.

Meteorological data and information on ground cover and vegetation were collected during the study. For the before- and between-grazing trapping periods, temperatures averaged about 1.5 °C lower in 2005 than in 2006, and there was about twice as much rain in 2005 than in 2006, with much of it falling in June 2005 (Environment Canada 2013). In

September and October 2005, temperatures averaged about 2 °C higher and precipitation was about one-third of that for the same period in 2006. In the grazed areas of the paddocks, vegetation was cropped quite short and, relative to ungrazed areas, there were significantly higher levels of soil compaction and fewer plant species (Stjernberg 2011). The most common ground covers were grasses of the genus *Stipa*, big bluestem, *Andropogon gerardii* (Vitman) (Graminae), *Juniperus horizontalis* (Moench) (Cupressaceae), leafy spurge, *Euphorbia esula* (L.) (Euphorbiaceae), litter, and bare ground. Of these, the percentages of *Stipa* and litter cover were consistently higher in ungrazed areas than in grazed areas (Stjernberg 2011).

The relative frequency of catches of all species is shown in Table 6, which includes catches when cattle were present in the pastures, but data were analyzed only for 3,902 individuals of 66 species of carabid beetles that were caught during the trapping periods when cattle were absent. Numbers of individuals and species, as well as a diversity index, were subjected to nested analysis of variance. In these analyses, the number of individuals was affected by seasonal patterns of beetles (Table 8), but also by duration of the trapping period, which varied among paddocks. As commonly occurs, the number of species was positively correlated with the numbers of individuals (r = 0.7), and so number of species also depended on duration of trapping period. Duration of trapping period was variable and dictated by experimental logistics: Thus neither number of individuals nor number of species is a reliable indicator of the carabid assemblage. For this reason, log series α was used as a measure of diversity, as it is a species richness index that is relatively independent of the number of individuals contributing to the sample (Taylor *et al.* 1976). Nested analysis of variance of α in the before-grazing trapping period showed that diversity was higher in 2006 than in 2005 (F = 57.8; df = 1,2; P < 0.05), likely because the earlier start to trapping in 2006 allowed for collection of species that were no longer active by the start of trapping in 2005. There was no significant difference between years in the between- or after-grazing periods. Log series α was significantly higher in grazed than in ungrazed treatments before (F = 42.5; df = 3,2; P < 0.05) and between (F = 29.8; df = 3,2; P < 0.05) grazing periods; after grazing, a similar trend was evident, but not significant (F = 67.4; df = 2,1; P = 0.09). Higher carabid diversity in grazed areas may be due to habitat heterogeneity. Dietary selection and patchy deposition of excreta by grazing animals can increase heterogeneity of soil factors and plant architecture (Knapp *et al.* 1999; Rook and Tallowin 2003; Zahn *et al.* 2007). Zahn *et al.* (2007) caution that elevated arthropod diversity and habitat heterogeneity is dependent upon stocking rate, and both decline under intensive grazing.

Table 8. Mean (± SEM) number of individuals and species and log series in collections of carabid beetles from 25 pitfall traps in grazed and ungrazed areas of three paddocks before, between, and after the two grazing periods in a twice-over grazing system.

Period	Year	Number of Individuals		Number of Species		Log Series α	
		Ungrazed	Grazed	Ungrazed	Grazed	Ungrazed	Grazed
Before	2005	71.0 ± 31.6	199.0 ± 79.7	8.3 ± 0.9	14.3 ± 3.3	2.93 ± 0.65	3.76 ± 0.55
	2006	217.0 ± 56.2	249.3 ± 127.5	15.0 ± 1.7	18.7 ± 1.2	3.70 ± 0.31	5.28 ± 0.59
Between	2005	168.3 ± 22.1	124.3 ± 25.8	17.7 ± 2.8	17.3 ± 3.4	5.05 ± 1.02	5.48 ± 1.04
	2006	114.0 ± 5.1	64.7 ± 13.6	13. 7 ± 2.6	16.7 ± 2.3	4.12 ± 1.00	7.38 ± 0.88
After	2005	52.5 ± 25.5	29.0 ± 11.0	10.5 ± 4.5	9.5 ± 0.5	3.96 ± 1.57	5.72 ± 1.44
	2006	28.0 ± 18.1	10.7 ± 3.8	5.7 ± 2.2	5.7 ± 1.8	2.53 ± 0.43	4.99 ± 1.17

The most frequently caught species of carabid beetles (Table 9) varied among trapping periods and between grazing treatments. Variation among trapping periods was no doubt related to species-specific seasonal patterns of activity (Thiele 1977). Although Table 9 indicates that species such as *Amara ellipsis*, *Bembidion nitidum*, *Cicindela longilabris*, and *C. nebraskana* were caught almost exclusively in grazed areas, it is unwise to conclude that all of these species are responding to grazing alone. Almost all catches of *A. ellipsis* and of *B. nitidum* were from the grazed area of different single pastures in a single year, and so the preference could be for grazed areas in general, or for a habitat requirement that was provided only in one pasture in one year.

To detect consistent responses of carabid assemblages to grazing treatment while controlling for differences among paddocks, we used principal components and redundancy analysis ordination methods (ter Braak 1990; ter Braak and Looman 1994). Data were logarithmically transformed, paddock was used as a nesting covariate, and Monte Carlo permutation tests were used to assess the significance of treatment effects in redundancy analysis. In the before-grazing trapping period, grazing treatment affected the assemblage (P = 0.01), and did so in different ways in each year (P = 0.02). As seen in the "Before" panel of Fig. 7, the polygon enveloping grazed samples does not overlap that for ungrazed samples in ordination space, indicating that the grazing treatment produced distinctly different assemblages. The distance separating the centroids for grazed and ungrazed treatments in 2005 was greater than for 2006, showing that carabid assemblages in grazed and ungrazed areas were more similar in 2006 than in the cooler, wetter 2005. The species vectors suggest that *Chlaenius purpuricollis* was more frequently caught in the ungrazed treatment, but this association was not significant; *Poecilus lucublandus* was significantly associated with the ungrazed treatment in 2006 (Table 9). Vectors for all other species in the ordination diagram suggest higher catches in the grazed treatment, and for four species (Table 9) this association was significant. In the trapping period between grazing, assemblages were affected by grazing treatment (P = 0.01) in the same way each year. The clear separation of envelopes surrounding ungrazed and grazed sites (Fig. 7) indicates distinctly different assemblages, and the ungrazed assemblage is characterized by higher catches of five species (Table 9). In the trapping period after grazing, the effect of grazing differed significantly between years (P = 0.02), with the disposition of treatment centroids and envelopes surrounding samples (Fig. 7) indicating that carabid assemblages in grazed and ungrazed areas were more similar in 2006. Although catches were rather low after grazing, *Agonum cupreum* was significantly associated with the ungrazed treatment and *Amara obesa* with the grazed treatment in both years, and two other species showed significant associations with grazing treatment in 2005 (Table 9).

The most frequently caught species was *Calosoma calidum*, which is most active in spring and is associated with open areas (Epstein and Kuhlman 1990); it seldom climbs trees (Lindroth 1961–1969). Although its most commonly reported food is caterpillars, it also eats grasshoppers and scarab beetles (Larochelle and Larivière 2003), which occurred frequently in the paddocks (Stjernberg 2011). This is a large and mobile beetle, and its association with the grazed area in the before-grazing trapping period, and with the ungrazed area in the between-grazing trapping period, may reflect movements in response to prey availability. Further support for the hypothesis that prey availability influenced habitat associations of *C. calidum* comes from the closeness of its species vector to those for *Chlaenius tomentosus* and *Pasimachus elongatus* for the trapping period before grazing (Fig. 7). All three species have similar diets (Larochelle and Larivière 2003), and so could be expected to respond similarly to the distribution of their prey.

Table 9. Total numbers of the most frequently caught carabid beetles in the grazed and ungrazed areas of three paddocks in trapping periods before, between, and after the two periods of grazing in a twice-over grazing system. Numbers in bold in a grazing regime column indicate a significant positive association with that regime in one or both study years, as indicated by redundancy analysis.

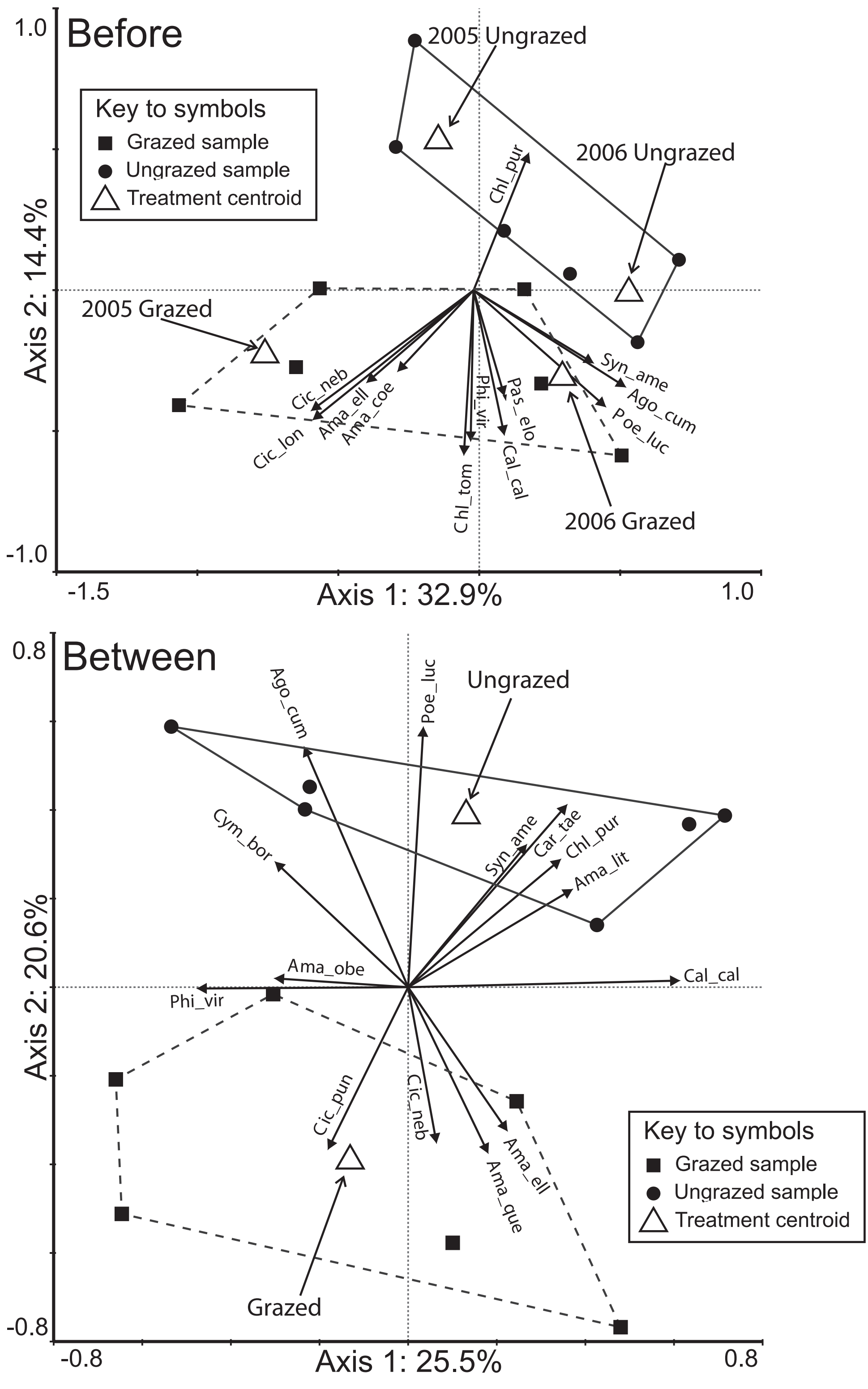
Before			Between			After		
Species	Catch/75 Traps		Species	Catch/75 Traps		Species	Catch/75 Traps	
	Grazed	Ungrazed		Grazed	Ungrazed		Grazed	Ungrazed
Calosoma calidum (Fabricius)	**653**	429	*Calosoma calidum* (Fabricius)	244	**368**	*Agonum cupreum* Dejean	8	**69**
Agonum cupreum Dejean	159	153	*Agonum cupreum* Dejean	14	**112**	*Cymindis borealis* LeConte	24	30
Syntomus americanus (Dejean)	32	76	*Amara obesa* (Say)	71	34	*Pterostichus femoralis* (Kirby)	10	**34**
Pasimachus elongatus LeConte	72	33	*Chlaenius purpuricollis* Randall	7	**87**	*Amara obesa* (Say)	**17**	6
Poecilus lucublandus (Say)	34	**63**	*Pasimachus elongatus* LeConte	44	48	*Pasimachus elongatus* LeConte	1	12
Cicindela nebraskana Casey	**73**	1	*Poecilus lucublandus* (Say)	7	**44**	*Syntomus americanus* (Dejean)	1	10
Bembidion nitidum (Kirby)	62	1	*Cymindis borealis* LeConte	5	39	*Cymindis planipennis* LeConte	8	1
Amara ellipsis LeConte	48	0	*Carabus taedatus* Fabricius	1	**25**	*Amara quenseli* (Schönherr)	**4**	1
Chlaenius purpuricollis Randall	6	38	*Amara ellipsis* LeConte	24	1	*Poecilus lucublandus* (Say)	0	5
Cicindela longilabris Say	**35**	0	*Philophuga viridis* (LeConte)	16	9	*Chlaenius purpuricollis* Randall	0	4
Amara convexa LeConte	26	3	*Cicindela punctulata* Olivier	21	0	—	—	—
Amara coelebs Hayward	**24**	3	*Syntomus americanus* (Dejean)	3	12	—	—	—
Individuals	1345	864		567	847		90	189
Species	35	29		45	41		21	24
Total species	40			55			30	

Several species responded consistently to grazing treatments. Three species of *Cicindela* were caught frequently in the grazed areas, but seldom or never in the ungrazed areas (Fig. 7, Table 9). These predators sprint to capture unwary passing or alighting insects (Acorn 2001), and so may find it easier to move and hunt in the shorter vegetation and bare areas that result from grazing. One of these species, *C. nebraskana*, has an association with patches of dried cattle dung (Acorn 2001). Dung pats are characteristic daytime shelters for adults of several other species that were associated with grazed areas, including *Pasimachus elongatus*, *Harpalus opacipennis*, and *H. ventralis* (Larochelle and Larivière 2003), although catches of the latter two were too few for them to appear in Fig. 7 or Table 9. Both larvae and adults of *P. elongatus* shelter under dung pats, and the two-year life cycle and restricted dispersal of this species (Cress and Lawson 1971) result in it slowly increasing in abundance over the years following livestock introduction. Several species of *Amara* were caught more frequently in the grazed areas (Fig. 7, Table 9); these species occur in sparse vegetation in open habitats. In contrast, the habitat of *A. littoralis* is characterized by rich vegetation (Larochelle and Larivière 2003), and between grazing periods, this species was associated with ungrazed areas (Fig. 7). *Poecilus lucublandus* and *Pterostichus femoralis* were also associated with ungrazed areas, and their characteristic habitats include less open and more vegetated sites (Larochelle and Larivière 2003).

Effect of Time of Grazing

An experiment was conducted to determine whether timing of grazing was an important determinant of carabid assemblages. This experiment was carried out in a single 128 ha paddock that had been grazed season long until 1999, but not grazed for five years before the experiment. Nine cow/calf pairs grazed in the paddock in 2005 and 11 cow/calf pairs and a bull grazed in the paddock in 2006. Treatments were spring grazing, fall grazing, or spring and fall grazing at times corresponding to those in the previous experiment. Treatments were applied to 100 × 800 m areas by controlling cattle access with electric fences. There were 25 pitfall traps in each treated area, and in the two years of the study, these caught 2,811 individuals representing 50 species. The assemblages of carabids were distinctly different in each trapping period, as illustrated by the separation of polygons enveloping samples from trapping periods in the principal components analysis (Fig. 8). Ordinations were dominated by the trapping period before grazing, in which 86% of all beetles were caught. Only 41 individuals were caught in the trapping period after grazing—an insufficient number to draw conclusions.

Within the before- and between-grazing trapping periods, the spacing of sample points in Fig. 8 shows that assemblages differed more between years than among times of grazing within years. Nevertheless, Monte Carlo permutations in redundancy analysis showed that these between-year effects were not statistically significant ($P = 0.12$). If there were responses to grazing, one would expect points for the sites in the before-grazing trapping period to be more widely separated for 2006, after one cycle of grazing treatments, than for 2005, when treatments had not yet started. The before-grazing assemblage in the fall grazing treatment in 2006 did differ from the remaining five assemblages, because 205 *Calosoma frigidum* were caught in two traps in this treatment area in this trapping period. Only 23 *C. frigidum* were caught in the remaining 73 traps in the trapping period, and only five were caught in 2005. Adults of *C. frigidum* are normally associated with trees and swiftly congregate in response to outbreaks of defoliating caterpillars (Burgess and Collins 1917; Larochelle and Larivière 2003); some aspen trees occurred in the area of this experiment, but it is not known whether there was an outbreak of defoliators on them in spring 2006. In


Before
Key to symbols
Grazed sample
Ungrazed sample
Treatment centroid
2005 Ungrazed
2006 Ungrazed
2005 Grazed
2006 Grazed
Chl_pur
Syn_ame
Ago_cum
Poe_luc
Pas_elo
Cal_cal
Phi_vir
Chl_tom
Cic_neb
Cic_lon
Ama_ell
Ama_coe
Axis 2: 14.4%
Axis 1: 32.9%
1.0
-1.0
-1.5
1.0
Between
Ungrazed
Grazed
Ago_cum
Poe_luc
Cym_bor
Syn_ame
Car_tae
Chl_pur
Ama_lit
Ama_obe
Phi_vir
Cal_cal
Cic_pun
Cic_neb
Ama_ell
Ama_que
Key to symbols
Grazed sample
Ungrazed sample
Treatment centroid
Axis 2: 20.6%
Axis 1: 25.5%
0.8
-0.8
-0.8
0.8

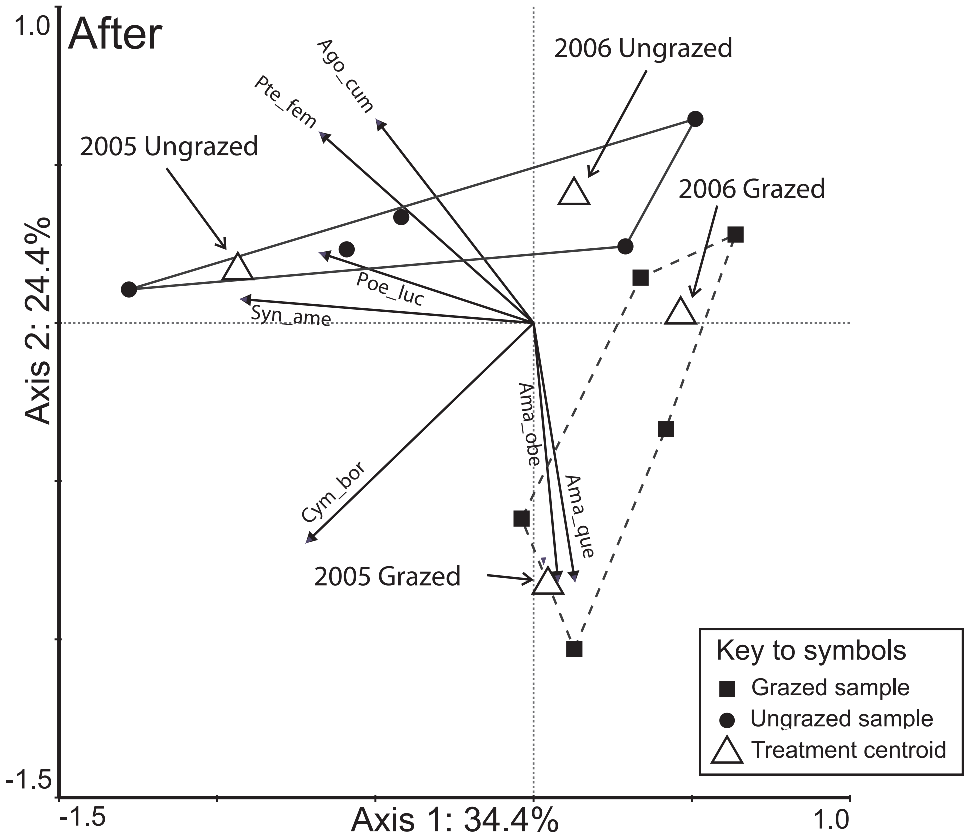


Fig. 7. Patterns of carabid assemblages in trapping periods before, between, and after grazing in 2005 and 2006 as revealed by redundancy analysis. All samples from the same grazing treatment are enveloped in a polygon, and the centroids (= the average position in ordination space) for significantly different treatments are indicated by triangles. Frequently caught species that had strong associations with the ordination axes are represented by labelled vectors (arrows) indicating direction of increasing catches. Abbreviations for species: Ago_cum = *Agonum cupreum*, Ama_coe = *Amara coelebs*, Ama_ell = *A. ellipsis*, Ama_lit = *A. littoralis*, Ama_obe = *A. obesa*, Ama_que = *A. quenseli*, Cal_cal = *Calosoma calidum*, Car_tae = *Carabus taedatus*, Chl_pur = *Chlaenius purpuricollis*, Chl_tom = *C. tomentosus*, Cic_lon = *Cicindela longilabris*, Cic_neb = *C. nebraskana*, Cic_pun = *C. punctulata*, Cym_bor = *Cyminidis borealis*, Pas_elo = *Pasimachus elongatus,* Phi_vir = *Philophuga viridis*, Poe_luc = *Poecilus lucublandus*, Pte_fem = *Pterostichus femoralis*, Syn_ame = *Syntomus americanus.*

the between-grazing trapping period in 2005, no grazing had yet occurred in the fall grazing treatment, but in Fig. 8, the point for this treatment lies between those for 2005 samples that had recently received spring grazing. Therefore, we conclude that time of grazing does not strongly affect carabid assemblages in the early years of a grazing regime and that effects of grazing do not appear immediately after grazing begins. This apparently contrasts with the findings of a study in Swedish pastures, where carabids responded to timing of grazing within one year of treatment initiation (Lenoir and Lennartsson 2010). Unlike our analysis of assemblage composition, the Swedish conclusion was based on total catch, which is directly influenced by the increased pitfall trap efficiency associated with grazing-induced reductions in vegetation height and density (Greenslade 1964; Morris 2000).

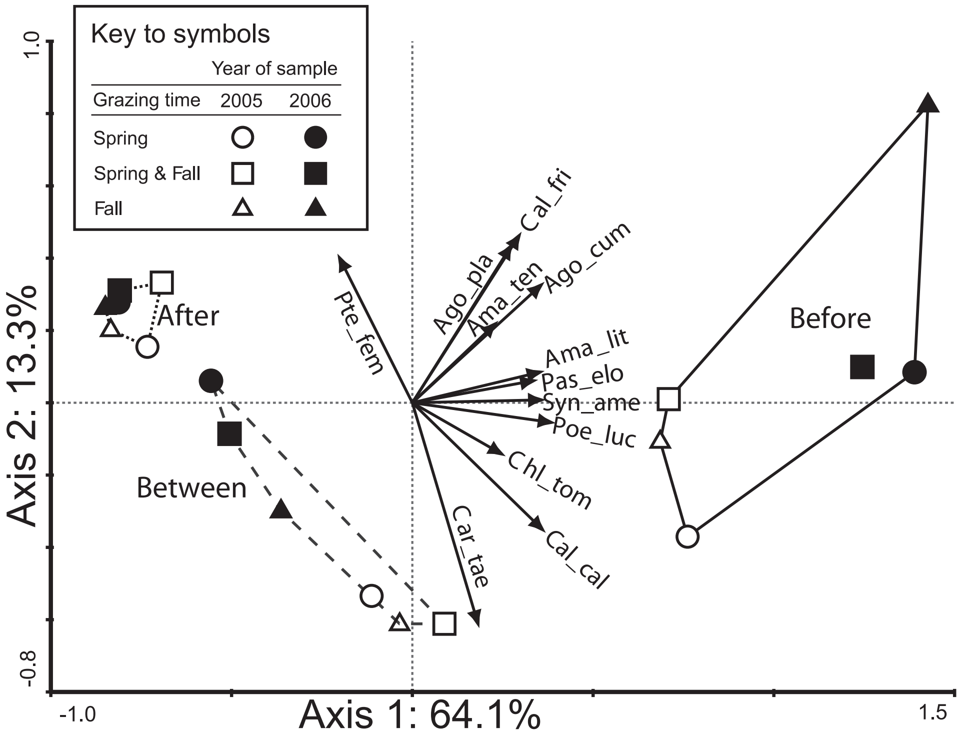


Fig. 8. Effect of grazing time on the carabid beetle assemblages in trapping periods before, between, and after grazing in 2005 and 2006 as revealed by principal components analysis. All samples from the same trapping period are enveloped in a polygon. Frequently caught species that had strong associations with the ordination axes are represented by labelled vectors (arrows) indicating direction of increasing catches. Abbreviations for species: Ago_cum = *Agonum cupreum*, Ago_pla = *A. placidum*, Ama_lit = *Amara littoralis*, Ama_ten = *A. tenax*, Cal_cal = *Calosoma calidum*, Cal_fri = *C. frigidum,* Car_tae = *Carabus taedatus*, Chl_tom = *Chlaenius tomentosus*, Pas_elo = *Pasimachus elongatus,* Poe_luc = *Poecilus lucublandus*, Pte_fem = *Pterostichus femoralis*, Syn_ame = *Syntomus americanus.*

Synthesis

Recent studies of the relationships of carabid assemblages to grazing have focused on the influence of grazing intensity (Batáry *et al.* 2007; Báldi *et al.* 2013), timing (Lenoir and Lennartsson 2010), or livestock species (Dennis *et al.* 1997; García *et al.* 2010). Many of these studies have been extensive rather than detailed, and only a few have compared grazed and ungrazed treatments in replicated experimental systems. Carabid and staphylinid beetle assemblages are affected by sheep and cattle grazing in upland grassland systems (Dennis *et al.* 1997), and grazing is second to hydrology in influence on carabid assemblages in a wetland karst environment (Moran *et al.* 2012). Although none of the published experimental studies have been in prairie ecosystems, our results are broadly similar to those in these vastly different ecosystems. In mixedgrass prairie, rotational grazing of cattle resulted in a distinct and more diverse assemblage of carabid beetles than in ungrazed areas, and catches of several species were more frequent in grazed areas. As grazing is a common land use in the Prairies Ecozone, a better understanding of its effect on arthropod diversity and community ecology is needed.

A Survey of Carabid Studies in the Region

In this section, we survey, by province and ecoregion, all the formal published and unpublished diversity studies of carabids in the Prairies Ecozone of which we are aware. In addition to those studies that are within the ecozone, we have included a number of studies from cultivated habitats in adjacent ecozones because such habitats have much in common with grassland ecosystems. Although there have been carabid diversity studies in forest ecosystems, these are not included in our treatment. We summarize species patterns for each study. For selected large studies, we also provide inventories of carabid species (Table 6), with relative numbers represented by using a modification of the ACFOR classification system (http://www.glaucus.org.uk/watch3.htm#STANDARD%20ACFOR). The ACFOR designations and criteria used are as follows:

Designation	Abbreviation	Proportion of Total Collection (%)
Abundant	A	≥50
Common	C	≥5 and <50
Frequent	F	≥0.5 and <5
Occasional	O	≥0.05 and <0.5
Rare	R	<0.05

Faunistic Studies of Ground Beetles in Alberta Grasslands

In Alberta, grassland carabids are well studied compared with other arthropod taxa or other provinces, but most studies have been in cultivated habitats. Carabid assemblages from the now mostly cultivated grasslands of the Peace River Boreal Plains of Alberta and British Columbia and from the Fescue Grassland and Cypress Upland ecoregions have not been studied. Here, we include an overview of all studies (some unpublished or in progress) by ecoregion and include studies in cultivated sites outside the Prairies Ecozone.

Boreal Transition Ecoregion of the Boreal Plains Ecozone

Cultivated areas of the Boreal Transition Ecoregion of the Boreal Plains Ecozone are included in our treatment because of the similarity of carabid assemblages there and in the Prairies Ecozone. The three most northern studies in Alberta's Boreal Transition Ecoregion are those of Frank (1971*a*) near Calahoo, Griffiths (1985) near Morinville, and Cárcamo (1995) near Neerlandia (Table 5). Frank (1971*a*) documented the assemblage in a field about 32 km northwest of Edmonton (Fig. 6) that was planted to barley in 1967 and oats in 1968. A grid of 100 closely spaced pitfall traps was deployed, and for the most common species, a mark and recapture technique was used to estimate population densities. Frank (1971*a*) reported 63 species (Table 6; number of species reduced through synonymy) and provided notes on the seasonal activity and reproductive patterns for many of the 26 common species. *Amara apricaria* was the only adventive species reported and it was not numerous. *Bembidion quadrimaculatum* was by far the numerically dominant carabid, with an estimated density of 20 individuals/m^2—twice that of all other *Bembidion* species combined. Other common *Bembidion* were *B. obscurellum* (3.9/m^2) and *B. rupicola* (2.6/m^2). Among the large carabids, *Harpalus amputatus* was the most abundant at 4.2/m^2 and seven species of *Amara* were frequently caught. Of the *Agonum* species, *A. cupreum* was most common in 1967 and *A. placidum* in 1968; estimated densities of each species in 1968 were 1.0/m^2 and 1.5/m^2, respectively. Frank inferred from multiple periods of activity, as shown by pitfall catches, that some species have up to three generations per year, but Thiele's (1977) review of studies comparing annual activity patterns with physiological condition concluded that temperate carabids with multiple activity periods have a single generation annually.

Griffiths (1985) used emergence cages and pitfall traps in 1984 to characterize the suite of potential root maggot predators, including Carabidae, near Morinville, about 30 km north of Edmonton (Fig. 6). He reported 18 carabid species from 135 beetles collected from 12 emergence cages between 1 May and 16 July; traps were placed in a fallow field that had been cropped to canola the previous year. He also reported 24 species from 904 adults from pitfall traps ($n = 40$) that operated between 2 June and 13 August in a nearby current canola field. *Bembidion nudipenne* was the only species that was found only in the emergence cages and not in pitfalls. Adults of seven species were caught in pitfall traps but not in emergence cages; four of them were *Bembidion*, and all of them were rare (<1% of the total catch). *Amara farcta* was common in the cages (3.25 individuals/m^2, 29% of catch in cages) but was <1% of the catch in pitfalls. *Agonum placidum* was common in both sample types: 48% of the catch in pitfalls and 18% (2/m^2) in cages. *Bembidion quadrimaculatum* represented 8% and 11% of the pitfall and cage samples, respectively. Its density in the cages was only 1.25/m^2, well below Frank's (1971*a*) estimate of 20/m^2 for Calahoo. Surprisingly, no *Harpalus* species were reported by Griffiths for this site; probably he did not consider them potential predators of root maggots, as it is highly unlikely that this genus would be absent from a cultivated site.

Cárcamo (1995) studied the effect of tillage in two barley fields about 4 km apart from June to August of 1991 near Neerlandia, about 110 km northwest of Edmonton (Fig. 6). Only 29 species were found from 2,299 individuals. The relatively low species richness may be explained by the shorter trapping period and lower sampling effort compared with those in Frank's (1971*a*) study. Dominant species during the growing season varied considerable between the two studies. In Frank's study, *Amara avida*, *Bembidion obscurellum*, and *Harpalus amputatus* ranked third to fifth in frequency, whereas in Cárcamo's study, they accounted for <1% of the catch, or were not reported. *Bembidion quadrimaculatum* was first at Calahoo and ranked second at Neerlandia. *Agonum placidum* was the most common species and accounted for 43% and 67% of the catches in the reduced and conventionally tilled sites in Cárcamo's study, respectively, but was far less common in Frank's study. In general, effects of tillage were inconsistent. Only one specimen of the adventive *Pterostichus melanarius* was found by Cárcamo (1995) and none were reported by Frank (1971*a*).

Aspen Parkland Ecoregion

Several studies have been conducted in the Aspen Parkland Ecoregion in the vicinity of Edmonton. Cárcamo and colleagues (Cárcamo 1992; Cárcamo and Spence 1994; Cárcamo *et al.* 1995) studied the fauna in plots under various cultivation regimes and an adjacent fescue hay meadow near Ellerslie, on the southern outskirts of Edmonton (Table 5, Fig. 6), in 1990 and 1991 and collected 26,212 individuals representing 49 species. In contrast to the assemblage near Neerlandia, the fauna at Ellerslie (Table 6) was dominated by *Pterostichus melanarius*, which accounted for 41% of all catches, but up to 70% of the carabids at the meadow. Other common species were shared with the assemblage at Neerlandia. The studies of Cárcamo *et al.* (1995) and Frank (1971*a*) illustrated the importance of documenting, as fully as possible, the annual activity patterns of carabids. For example, the peak activity of *B. quadrimaculatum* occurred during the first sampling period in April of 1991 at Ellerslie. However, most researchers in agricultural habitats begin their trapping after seeding in May and terminate it before harvest in August, thereby missing most of the activity of early spring and autumn species. Such studies overestimate the relative abundance of summer species such as *P. melanarius*. Fifteen years after the Cárcamo study, the ground beetles at Ellerslie were resampled by Hummel *et al.* (2012), who reported 41 and 33 species from a sample of 6,235 (2005) and 19,574 adults (2006), respectively. Hummel did not sample spring species, and therefore the two assemblages cannot be directly compared; in general, they appear to be similar. *Pterostichus melanarius* accounted for 41% of the catch in 2005 and 86% in 2006.

In 2000, Hartley *et al.* (2007), sampled along a 60 km urban to rural gradient east from Edmonton and compared the carabid faunas of graveyards and nearby less disturbed grassland sites. They reported 24 species from their catch of 3,162 beetles. Abundance and richness were higher at the grassland sites than at the graveyards. Three adventive species, *P. melanarius*, *Carabus granulatus*, and *C. nemoralis*, accounted for 86% of the catch, with *P. melanarius* alone representing 80%. *Agonum cupreum*, the most frequently caught native species, was 4% of the catch. The highly managed graveyards had lower species richness and a lower proportion of brachypterous species than the undisturbed grassland, suggesting that, following disturbance in the graveyard sites, the fauna was replenished by immigration.

In an as-yet unpublished study, S. Kulkarni and L. Dosdall documented carabid assemblages in canola near Leduc (35 km south of Edmonton) and Vegreville (100 km east of Edmonton) from June to August in 2011 (Table 5, Fig. 6). At Leduc, they collected 15,268 beetles and about 25 species (plus 26 unidentified individuals); *P. melanarius* was dominant (59%) with *A. placidum* second (28%). However, *Amara littoralis* was also a common species (7%) in contrast to the findings of previous studies where it accounted for less than 1% of the fauna. At Vegreville, the same sampling effort of 25 traps from June to August yielded only 2,634 adults representing at least 25 species (86 unidentified individuals). The community structure was very different from the assemblage at Ellerslie and from the closest other study by Hartley *et al.* (2007) that had a site 60 km east of Edmonton. The dominant species at Vegreville were *A. littoralis* (48%), *Agonum placidum* (22%), *A. cupreum* (4.3%), *Poecilus lucublandus* (3.6%), *P. melanarius* (3.5%), and *P. adstrictus* (2.5%). This assemblage had a high evenness component of diversity—there were six other species (*Amara* and *Harpalus*) with frequencies of 1–2%. *Bembidion quadrimaculatum* was rare at both sites, and the high evenness can be explained by the late start of the trapping season in this study.

Three additional studies in the Aspen Parkland Ecoregion have been conducted about 125 km south of Edmonton at the Lacombe Research Centre of Agriculture and Agri-Food Canada (Table 5, Fig. 6). Butts *et al.* (2003) in 1995–1996 and Hummel *et al.* (2012) in 2005–2006 studied intercrops of canola with cereals or peas. In Butts' study, 16,500 beetles were collected and 34 carabid species were identified, although not all carabids were identified to species. Native species in the genera *Bembidion* and *Amara* appeared to be as dominant as adventive species. *Agonum placidum*, as in other studies, was a common species, but *A. cupreum* was absent. Hummel *et al.* (2012) found higher diversity than Butts *et al.* (2003), with 54 carabid species from 15,291 individuals; however, Hummel's diversity was similar to that in a nearby study by Broatch (2008), who collected 14,025 carabids representing 59 species (Table 6) from 2003 to 2005 in canola plots. Both the Hummel and Broatch studies showed overwhelming dominance by *P. melanarius*, and two other adventive species, *Carabus granulatus* and *Clivina fossor*, were within the 10 most frequently collected. *Agonum placidum*, and less often, *Amara torrida*, ranked second to *P. melanarius* in one of the years in these studies.

Moist Mixed Grassland Ecoregion

The Moist Mixed Grassland or Mixed Grassland ecoregions of Alberta were the birthplace of entomological research in Alberta: E. H. Strickland started his career in crop entomology at the Lethbridge Dominion Farm in 1913. However, the first carabid faunal study at Lethbridge (about 130 km SSE of Calgary) was that of Butts *et al.* (2003), who pitfall trapped 26,148 beetles in plots of canola/barley and pea/barley intercrops, as well as monocultures, in 1993–1995 (Table 5). They recognized at least 37 distinct carabid "morphospecies" (estimated from their Table 2 by HC). *Pterostichus melanarius* and *A. placidum* were clearly the most numerous species at 66% and 10.5% of the total catch, respectively. The complex of *Amara carinata*/*lacustris* accounted for 5% and *Bembidion* spp. for 6%. Other common species (1–3%) were *Amara quenseli*, *Harpalus fuscipalpis*, and *A. littoralis*.

Four other studies have been conducted on research plots associated with the Lethbridge Research Centre. HC and S. Bourassa (unpublished) collected 3,852 adults, representing 39 species, in pitfall traps operating from June to August 1999–2001 in canola plots used for insecticide studies. The most numerous species were *Amara quenseli* (22%) and *Microlestes lineolaris*, which was only slightly more abundant than *P. melanarius* (14%). The evenness of this assemblage was relatively high: 11 other species had a frequency of 1–7%. Floate *et al.* (2007) reported 39 species (Table 6) from 13,319 adults trapped from 2000 to 2003 in plots planted to corn cultivars varying in expression of the *Bt* trait. *Pterostichus melanarius* was dominant (27% of total catch), and *Amara carinata*, *Poecilus corvus,* and *B. quadrimaculatum* each represented 9–14% of the catch. A later study (2004–2005) at the same site (Bourassa *et al.* 2010) trapped 11,913 carabids, representing 49 species (Table 6). *Bembidion quadrimaculatum* dominated the early season captures in 2004, making up 46% of the 3,485 beetles representing 37 species caught between 3 May and 1 July: Its activity peak was during the last two weeks of June. From 2 July to 30 September, *P. melanarius* accounted for 40% of the 4,521 beetles caught. In both sampling periods, 10 species represented 90% of the beetles caught. In 2005, *Amara farcta* adults were 69% of the total in early season catches from 4 April to 24 May, consisting of 3,907 carabids representing 34 species. In another unpublished study, A. Mauduit, L. Dosdall, and HC used pitfall traps from early April to late July 2012 to document potential predators of diamondback moth, *Plutella xylostella*, in canola plots, adjacent winter wheat, and a saline grassy border. Adult carabid catches from eight traps at each of the latter two habitats were similar: 435 and 445 individuals. Most frequently caught at the border were *Amara* (42%) and these, along with *Harpalus* species and *Bembidion*, accounted for about 65% of the assemblage. At the grass border, *P. melanarius* was the second most frequently caught, with 31% of the total catch, but in winter wheat, less than 100 m away, 94% of the catch was *P. melanarius* and no *Amara* and few other native species were caught. In the same period, traps in the canola plots caught 6,116 carabids, of which *P. melanarius* represented 93%, *Harpalus* and *Amara* species represented only 2–3%, and *Bembidion* were less than 0.05%. In all three habitats, the adventive species *Clivina fossor* made up 1–3% of the total catch.

Mixed Grassland Ecoregion

Carabid communities from the Mixed Grassland Ecoregion have not been studied as much as those in the northern ecoregions of the Prairies Ecozone in Alberta. Nevertheless, this region includes the only sample from a grassland reserve in Alberta: the Suffield Grassland Reserve, about 250 km southeast of Calgary (Fig. 6). Dan Johnson (unpublished data) found 22 species (identified by HC and D. Shpeley) from 490 individuals in pitfall traps collected on 21 June and 17 July 1995 at this site. The four most frequent species were *Pasimachus elongatus* (43%), *Harpalus reversus* (13%), *H. paratus* (13%), and *Amara convexa* (11%). Eleven species had frequencies of ca. 1–4% (in descending order of frequency): *Agonum placidum*, *Agonum cupreum*, *Amara obesa*, *Amara littoralis*, *Harpalus fuscipalpis*, *H. opacipennis*, *Euryderus grossus*, *Bembidion nitidum*, *H. somnulentus*, *Amara coelebs*, and *Amara confusa*. Seven species were each represented by a single specimen: *H. ellipsis*, *H. amputatus*, *Amara carinata*, *Agonum corvus*, *Cymindis interior*, *Calosoma lepidum*, and *Poecilus lucublandus*.

A much larger data set is available from research plots at the Vauxhall Research Farm of Agriculture and Agri-Food Canada, about 70 km west of the Suffield site (Table 5, Fig. 6). Bourassa *et al.* (2008) identified 62 carabid species (Table 6) from a sample of 12,813 adults collected in pitfall traps in wheat, bean, and potato plots in 2000 and in 2003–2005. In nearby canola plots at this site during 2002, HC (unpublished) found 31 species (identified by S. Bourassa) from 1,068 adults. In both studies, *Pterostichus melanarius* was the dominant species, and several of the other frequent or common species were found in both. An exception was *Amara farcta*, which ranked second in Bourassa's study, but was a "singleton" in HC's study. The Vauxhall sampling periods encompassed the sampling period from Johnson's mid-summer study at Suffield, but the assemblages were distinct. *Pasimachus elongatus* and *Amara convexa* were represented by single specimens in the two Vauxhall studies, but ranked first and fourth at Suffield, respectively. The second most frequent species at the grassland reserve, *H. reversus*, was not reported from the Vauxhall site. Other species at Suffield but not at the Vauxhall Farm were *H. opacipennis*, *E. grossus*, *A. coelebs*, *H. ellipsis*, and *C. lepidum*. Additional sampling in grass borders in this ecoregion is needed to determine whether these species are conserved in fragmented grassland around cultivated habitats.

Alberta Studies on Effects of Agronomic Practices

Many of the studies summarized above examined the effects of agronomic practices on carabid assemblages in cultivated former prairie grasslands. These practices included crop selection and rotations, tillage, reduced input (sustainable agriculture), and intercropping. In general, in plots subjected to the same practice over years, carabid activity density increased when pesticide inputs were reduced, but the studies have been confounded by differences in vegetation (Carcamo *et al.* 1995; Bourassa *et al.* 2008). Intercropping did not influence carabid activity or diversity patterns at Ellerslie or Lacombe, according to Carcamo *et al.* (1995) and Hummel *et al.* (2012), despite experimental evidence for *P. melanarius*' preference for an intercrop of pea–barley over monocultures of faba bean, barley, or fescue grass (Carcamo and Spence 1994). Most studies show that crop species can affect carabids, but subspecific differences between crops have less effect. For example, catches of species of *Amara* and *Bembidion* are higher in pea and canola crops than in these intercropped with barley or in monocultures of barley (Butts *et al.* 2003). In addition, Bourassa *et al.* (2010) concluded that incorporating canola in rotation with corn had a greater effect on carabid community structure than did inclusion of an herbicide-tolerant corn cultivar. Similarly, there is a lack of appreciable or consistent effects on carabid catches among plots with genetically modified corn with a *Bt* trait, or an isoline corn line with or without insecticides, but catches of two carabid species differed between these corn treatments and wheat (Floate *et al.* 2007). In the future, it would be of interest to conduct studies in commercial farms and analyze current year patterns in light of the history of the site in terms of crop rotation and pesticide inputs.

Faunistic Studies of Ground Beetles in Grasslands of Saskatchewan

Although Carabidae of Saskatchewan are listed by ecoregion in Hooper and Larson (2012), there have been relatively few formal studies of the diversity of carabids in the Prairies Ecozone in the province. As in Alberta, most of these studies have been in agriculturally modified habitats located in Aspen Parkland, Moist Mixed Grassland, and Mixed Grassland ecoregions. We are unaware of any faunistic studies from the Cypress Upland Ecoregion. The study of Floate (1987) on cultivated sites in the Boreal Transition Ecoregion of the Boreal Plains Ecozone was earlier described in detail (see section on "Carabids of the Boreal Transition: Nipawin, Saskatchewan — K.D. Floate," p. 38).

In the Moist Mixed Grassland Ecoregion, Doane (1981) deployed pitfall traps in a wheat field and in its grassy borders near Clavet, about 25 km southeast of Saskatoon (Table 5, Fig. 6) from April or May until mid-October in 1975 and 1976. The resulting catch numbered 8,741 beetles representing 87 species in 25 genera (Table 6). Thirty percent of the species were recovered only in the field border, 7% only in the field, and 63% in both habitats. Catches in the field border were lower than those in the field, but exhibited overall higher diversity. Sex ratios for most species tended to be 1:1, but significantly more females than males of *Amara carinata* and *Poecilus lucublandus* were caught. Common species in the wheat field included *Bembidion obscurellum*, *B. quadrimaculatum*, *B. nitidum*, *B. timidum*, *Amara lacustris*, *A. carinata*, *A. farcta*, *Harpalus herbivagus*, and *P. lucublandus*. The latter two species, plus *Amara quenseli* and *A. obesa*, were the most frequently caught in the field border.

Melnychuk *et al.* (2003) reported results of a study performed to assess the effect of different cropping systems on carabid diversity in sites that span the Moist Mixed Grassland, Mixed Grassland, and Aspen Parkland ecoregions, as well as the Boreal Plains Ecozone (Table 5, Fig. 6). Pitfall traps were operated for one week in each of June, July, and August from 1994 to 1996 at eight commercial farms that used annual-grain rotation with high inputs, annual-grain rotation with organic inputs, diversified grain-forage rotation with high inputs, or diversified grain-forage rotation with organic inputs. The catch of 2,241 beetles represented 51 species (Table 6), of which *B. quadrimaculatum*, *B. obscurellum*, *Agonum placidum*, *Amara littoralis*, and *B. nitidum* accounted for 57% of the total. There was greater diversity of species in the annual-grain system than in the diversified grain-forage system, but no difference in abundance as estimated by trap catch. High versus low input organic systems did not differ in species diversity or abundance.

As a by-product of a study on the effect of degree of transparency of trap covers and vegetation height on pitfall trap efficiency, Bell *et al.* (2014) amassed a substantial body of data on the carabid assemblage of tame pasture near Elbow, Saskatchewan, in the Moist Mixed Grassland Ecoregion (Table 5, Fig. 6). Pitfall traps, operated from 20 June to 18 August 2012, caught a total of 1,520 carabids representing 28 species (Table 6). Of these, *Agonum cupreum* and *Amara obesa* formed 72% of the total, with a further 13% represented by *Syntomus americanus*.

Habitat fragmentation is one factor that may affect the structure and composition of arthropod assemblages. Pepper (1999) examined this phenomenon by operating pitfall traps on seven remnants of native mixedgrass prairie. These were located in southwestern Saskatchewan in the Mixed Grassland Ecoregion (Table 5, Fig. 6) and comprised pastures varying in size from 7 to 17,800 ha. Traps were operated for five periods of approximately one week each between 22 May and 22 August 1995. All spiders and beetles were identified to species. These included 449 carabids that comprised 37 species (Table 6). Similar to the findings of Bell *et al.* (2014), *A. cupreum* and *A. obesa* were the two most common species.

Combined, they represented 35.6% of the total carabids caught. Other common carabids included *Microlestes curtipennis* (10.2%), *Cicindela nebraskana* (8.5%), and *Amara farcta* (6.7%). *Syntomus americanus* made up 5.8% of the total. The number of species of beetles (all families combined) and of spiders showed a positive correlation with the size of the remnant prairie, but the Shannon-Weiner diversity index did not. The assemblage composition of carabids was influenced by range condition, which was a function of grazing pressure on the pasture.

Faunistic Studies of Ground Beetles in Grasslands of Manitoba

Many of the early studies of carabid beetles in Manitoba were not intended to provide detailed inventories of species, but were collections taken over an unspecified area. Many of these are associated with Aweme, and D. Pollock's treatment earlier in the chapter represents the first faunistic assessment of this material (see p. 39). With the exception of Bird (1930), faunistic studies of Manitoba carabids in the Prairies Ecozone began in the late 1970s and have included both cultivated and natural habitats and two of the three ecoregions within the ecozone. We are not aware of any studies in the Boreal Transition Ecoregion.

Lake Manitoba Plain Ecoregion

This ecoregion includes the only area of tallgrass prairie within the Prairies Ecozone. Much of the tallgrass prairie has been cultivated, and there are few relict areas (Shorthouse 2010*b*). The late Rob Roughley and colleagues conducted studies on carabids of the relict tallgrass prairie fragment at the St. Charles Rifle Range on the western outskirts of Winnipeg (Roughley *et al.* 2006, 2010), and several studies have been conducted in the agroecosystems that have replaced the original vegetation.

Roughley *et al.* (2006) reported on the carabid fauna in tallgrass prairie and in aspen forest at the St. Charles Rifle Range (Table. 5, Fig. 6). Pitfall traps were deployed in each of the two habitats from 1998 to 2000, with trapping beginning early in spring (31 March in 2000) and continuing until November. A total of 639 ground beetles, representing 53 species, were collected. Overall, for the three years, numbers caught per unit effort were lower, and diversity, as measured by log series α, was higher in the prairie than in the forest sites, although other diversity measures did not differ significantly between habitats. There were 19 species unique to each habitat and, from redundancy analysis, the assemblages differed significantly between the two habitats. In the tallgrass habitat, the most numerous species were *Pterostichus femoralis* (18% of catch in the habitat), *Agonum placidum* (11%), *Poecilus lucublandus* (9%), and *Pterostichus melanarius* (9%); in the forest, *Pterostichus caudicalis* (15%), *P. femoralis* (12%), *P. melanarius* (12%), and *Platynus decentis* (10%) were most frequently caught. Roughley *et al.* (2010) reported on the effects of fire, used as a prairie management tool, on carabid species. About 12 times the number of pitfall traps as used in Roughley *et al.* (2006) were deployed in a tallgrass site adjacent to the earlier study sites and were sampled for the same periods in 1998–2000, but were also sampled in 1997. In the four years, 11,364 carabid beetles representing 92 species were collected. A composite list of species from both studies is provided in Roughley *et al.* (2010), but lacks quantitative information on catch.

Pitfall traps, operated from May to October in 1979 and 1980, were also used to assess the effects of vegetation management on carabid beetles at heavy clay agricultural sites at the University of Manitoba's Glenlea Research Farm, 30 km south of Winnipeg (Richardson 1982) (Table 5, Fig. 6). A total of 19,751 adult beetles, representing 18 species, were caught (Table 6); almost all of these were in the tribes Zabrini, Harpalini, and Pterostichini.

Thirty-five percent of the catch was *Amara avida*, followed by *Amara apricaria* (34%), *Poecilus corvus* (6%), and *Anisodactylus sanctaecrucis* (5%). Compared with control plots, vegetation was suppressed for eight weeks by tillage and herbicide treatments applied in late June 1979 and early July 1980. The reduction in vegetation was associated with reduced catches of all common species. The site was flooded by the Red River in spring 1979, and this may have been responsible for striking differences between years for several species, with more than twice as many *A. apricaria* and *A. avida* caught in 1979 as in 1980, and with catches in 1980 at least twice those in 1979 for *P. corvus*, *A. sanctaecrucis*, and *Amara farcta*. Two specimens of *P. melanarius* were caught during the study.

In another site on the Glenlea Research Farm, carabid beetles were sampled with pitfall traps in a long-term rotation study that included different levels of fertilizer and herbicide inputs, and in which weeds were also studied (Humble 2001). Catches from 30 June to crop harvest were recorded for 1995 and 1999, when all plots were in flax, and for a nearby seeded prairie area. A total of 9,216 carabid adults, representing 28 species, were reported. In the flax crop, 39% of catches were *Poecilus corvus*, followed by *Agonum placidum* (16%) and *Harpalus pensylvanicus* (9%). Redundancy analysis showed that crop rotation did not influence carabid assemblage composition as much as inputs: Plots with fertilizer and no herbicide had higher weed densities and higher catches of several Zabrini and Harpalini, as well as *P. corvus* and *Poecilus lucublandus*. In the prairie grasses, catches of *P. corvus* were 18% of the total, followed by *Harpalus pensylvanicus* (13%) and *H. amputatus* (10%). Catches of *Pterostichus melanarius* were 3% of the total for the study, much higher than in the nearby sites of Richardson (1982) some 20 years previously. Some of the differences between Richardson (1982) and Humble (2001) may be due to the more restricted sampling period in the latter study. However, this seems unlikely to be responsible for the much lower relative frequency of *Amara apricaria* (2%) and *A. avida* (2%) in Humble (2001), as these species were frequently caught in July and August by Richardson (1982).

About 25 km south of the Glenlea sites, Songa (1994) conducted a study of the role of carabid beetles in the predation of grasshopper eggs (*Melanoplus bivittatus* (Say) (Orthoptera: Acrididae)). Pitfall traps were deployed in seven roadside egg beds in spring (May–June) and fall (September–October) of 1992 and 1993, when the eggs were present. A total of 11,495 carabids were caught, representing 25 species; 89% of individuals were caught in the spring trapping period. *Poecilus corvus,* mostly caught in the spring, accounted for 74% of the total catch, followed by *Chlaenius sericeus* (8%). *Pterostichus femoralis* (4% of total catch), *Amara obesa* (2%), and *A. carinata* (2%) were caught mostly in the fall when they formed 20%, 12%, and 11%, respectively, of the fall catch. Laboratory studies (Songa and Holliday 1997) indicate that both *P. corvus* and *Pterostichus femoralis* consume grasshopper eggs on the surface and underground. In spring 1992, *P. corvus* catches were positively correlated with egg densities in the egg beds (Songa 1994).

The previous three studies were located close to the Red River in regions with heavy clay soils. Hawkins-Bowman (2006) reported results of a study at the University of Manitoba's Carman Research Station, about 85 km southwest of Winnipeg (Table 5, Fig. 6), on fine sandy loam. The study examined the effect of fall and spring tillage, or zero tillage, on the abundance of cabbage maggot, *Delia radicum,* in subsequent canola plots. Carabids were investigated in these plots as potential predators of maggots. Pitfall traps were in place in the plots from crop emergence to harvest in 1999 and from seeding to harvest in 2000. A total of 6,312 adult and larval carabids were caught over the two years, with 24 species identified. Three species were common: *Agonum placidum* (51% of catch) and the two adventive species *Pterostichus melanarius* (21%) and *Carabus granulatus*

(10%). The next most numerous species was *Bembidion quadrimaculatum* (4%). The potentially herbivorous tribes Zabrini (four species) and Harpalini (five species) together constituted <5% of the total catch.

Uddin (2005) reported on carabids in commercial alfalfa fields east and north of Winnipeg. The fields were managed for seed production or hay production. Some fields were in the Manitoba Plain Ecoregion, but outside the tallgrass area; the more northerly fields were within the Interlake Plain Ecoregion of the Boreal Plains Ecozone (Table 5, Fig. 6). Each year from 1999 to 2001, a hay field, an adjacent seed field, and a more distant seed field were sampled in each of two locations (Table 5, Fig. 6) by using pitfall traps deployed from about May to September. Hay fields were mown twice each year, usually in late June and in August; seed fields received insecticide at about the time of the first mowing. A total of 30,536 carabid adults, representing 101 species in 25 genera, were reported (Table 6). Of these, 65% were *Pterostichus melanarius*, followed by *Agonum cupreum* (13%), *Poecilus corvus* (6%), and *P. lucublandus* (5%). In the sites in the Interlake Plain, many of the rarer carabids were of species associated with the forest or wetland habitats adjacent to the fields. Numbers of individuals, number of species, and the log series α index of diversity did not differ between hay and seed fields and were not significantly influenced by mowing or the spring insecticide application in hay and seed fields, respectively. The spring insecticide application significantly reduced catches of *P. corvus*, *P. lucublandus*, and *A. cupreum*, but had no effect on catches of *P. melanarius*. These differential responses to insecticides are probably responsible for the markedly different percentages of *A. cupreum* (22% of total catch in hay fields, 6% in seed fields) and *P. melanarius* (58% in hay, 71% in seed) under the two management systems.

Aspen Parkland Ecoregion

Among the earliest faunistic studies in Canada was that by Bird, who in 1928, inventoried the flora and vertebrate and invertebrate fauna of communities within the Aspen Parkland Ecoregion at Birtle, Manitoba, about 100 km northwest of Brandon (Bird 1930) (Table 5, Fig. 6). The communities selected were virgin prairie, mature aspen grove, and successional intermediates including a willow-dominated site. The major plants, birds, mammals, and amphibians were assessed during frequent visits by direct observation, trapping, or shooting. The invertebrates were sampled every two weeks by a combination of sweep net and quantitative sampling. In quantitative sampling, a cylinder (0.1 m^2 in cross-sectional area) was forced down over vegetation and filled with ether vapour. The knocked-down contents were identified, as were the inhabitants of the soil beneath to a depth of ≥5 cm. A total of 36 adult and 11 larval carabids were recovered from the quantitative sampling, and the adults represented 23 species, five from the genus *Bembidion*. These totals were augmented by four adults, adding one additional species, from gut dissections of seven leopard frogs (*Rana pipiens* Schreber (Anura: Ranidae)).

Two other studies in this ecoregion are both documented earlier in this chapter: the analysis of a century of data from Aweme, Manitoba (p. 39), and the study of effects on the carabid assemblage of grazing on mixedgrass prairie (p. 61).

Threatened and Endangered Carabid Species

Canadian legislation provides for the protection of species under federal and (or) provincial law. This legislation is discussed at length in Volume 2 of this series (Hall *et al.* 2011) and is only briefly discussed here. At the federal level, species are designated as Extinct, Extirpated, Endangered, Threatened, or Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (http://www.cosewic.gc.ca/). These designations are based on recommendations provided by Species Specialist Subcommittees (SSCs) for which members have the requisite expertise, for example, the Arthropod SSC. The SSCs use existing information to compile SSC Candidate Lists of species at potential risk of national extirpation or extinction. The SSCs rank these species as high, mid, or low priority and then forward the names and justifications for high-priority species to COSEWIC. COSEWIC uses this information to compile and prioritize the COSEWIC Candidate List. Status reports are then commissioned by COSEWIC for the highest priority species. These reports form the basis of discussion and assessment by the SSCs and subsequently by COSEWIC to set species' designations. The federal government considers COSEWIC's designations to identify species for protection under Canada's *Species at Risk Act* (SARA).

Three taxa of tiger beetles have been designated through SARA as Endangered (http://www.sararegistry.gc.ca/species/default_e.cfm), but these do not occur in the Prairies Ecozone. They are *Cicindela marginipennis* Dejean, *C. patruela* Dejean, and *C. parowana wallisi* Calder. COSEWIC designated the tiger beetle subspecies *Cicindela formosa gibsoni* Brown as Threatened in 2012; in Canada, this insect occurs in southwestern Saskatchewan. As of 31 December 2013, there were no Carabidae on COSEWIC's Candidate List. However, the Arthropod SSC Candidate List identified *Bembidion lachnophoroides* as high priority; it occurs mainly on sterile sandy river banks and had been collected primarily in the area of Medicine Hat, Alberta (Lindroth 1961–1969), although more recently it has been found in other localities (Bousquet 1987, 2012). No Carabidae were listed as mid priority. Low-priority species on the list included *Carabus vinctus* Weber; *Ellipsoptera* (*Cicindela*) *cuprascens*; *C. hirticollis athabascensis* Graves, Krejci and Graves; *C. h. couleensis* Graves, Krejci and Graves; *C. h. rhodensis* Calder; *C. h. shelfordi* Graves, Krejci and Graves; *Ellipsoptera lepida*; and *Dicaelus purpuratus* Bonelli. Among these, *C. formosa gibsoni*, *C. h. shelfordi*, and *E. lepida* occur mainly in the Prairies Ecozone, where they have localized distributions associated with active sand dunes (Acorn 2001). This habitat has declined in recent decades because of the stabilization of dunes by vegetation, a trend that is expected to continue.

What We Know Now and What We Need to Do

Among the objectives of the *Arthropods of Canadian Grasslands* series is to raise awareness of the arthropods of grassland habitats; many of these habitats have undergone enormous change in the last two centuries. Conservation of arthropods requires knowledge of their biology, distribution, and habitat requirements, and this chapter is an attempt to assess our level of the required knowledge for the carabid beetles of grasslands. As is evident from Table 5, the majority of our knowledge of prairie carabids comes from research in highly disturbed systems that differ greatly from the perennial-dominated prairie ecosystems of former times. Carabid assemblages in annual crops tend to be simple and dominated by a few species that represent a handful of genera (Luff 2002, Table 6). Notwithstanding this, many of our native carabids now use annual crop ecosystems, and given the extent of such systems, the majority of the population of many native species may now inhabit agricultural fields. It is therefore appropriate that we understand the implications of changing agricultural practices in these habitats, as they may threaten the native species. The studies we have summarized suggest that the factors that most influence carabid assemblages are changes in crop species and use of insecticides. To date, genetically modified crops do not appear to affect carabid assemblages greatly, but the effect of further innovations in this area will need to be assessed. Increasing areas of irrigated crops may threaten carabid species that have made the transition from grasslands to crop systems, but require arid habitats. This is an area worthy of investigation, as is the effect of habitat change driven by climate change. Carabid assemblages in annual crop ecosystems appear to be particularly vulnerable to incursions from adventive species, and continued increases in *Pterostichus melanarius* and other adventive species that are tolerant of agricultural practices could pose a threat to native species that inhabit agricultural habitats. We recommend an assessment of how these immediate threats may be ameliorated and vigorous support of measures to reduce new arrivals of alien invasive species.

Animal agriculture is an important land use on the Prairies. It is common for non-native livestock to graze on relict prairies, where they may be used to manage woody vegetation encroachment and where honouring of former grazing rights is often essential to conservation of the prairie. Livestock are ecosystem engineers that can also be used to manipulate vegetation structure for conservation objectives (Derner *et al.* 2009), including the conservation of arthropods (Moranz *et al.* 2012). However, Stjernberg (2011 and in this chapter) is the first experimental study to examine how livestock influence the carabid fauna of prairie grasslands. Observational studies of carabid responses to previous grazing, such as Pepper (1999), are also rare in the Great Plains. Studies in operational grazing systems are logistically challenging, but are essential for conservation of carabids in these ecosystems.

Our survey of faunistic studies of carabids reveals several neglected areas where future research could be focused. At the ecoregion level within the Prairies Ecozone, we found no faunistic studies on the Cypress Upland, Fescue Grassland, and Manitoba's Boreal Transition ecoregions; we are also unaware of carabid faunistic studies on the grasslands of the Peace River Boreal Plains of Alberta and British Columbia. Within studied ecoregions, several habitat types are under-represented. Table 3 illustrates the association of many carabid species in the Prairies Ecozone with moist or wet habitats; indeed, 53% of these species are described in Larochelle and Larivière (2003) as living near water, with 13% inhabiting shores and 8% living at the water's edge. We know of no faunistic studies in the Prairies Ecozone of carabids near water, despite ongoing depletion of wetland habitats (Wrubleski and Ross 2011 and references therein) and the consequent urgent need for an understanding of the carabid fauna of these habitats. Other habitats within the ecozone that should receive more research attention are woodland habitats, including aspen bluffs and river bottom forests, and the remaining native undisturbed grasslands, particularly those of Saskatchewan and Alberta.

The shortcomings and reasons for continued use of pitfall traps have been discussed. Only a few of the faunistic studies documented in this chapter augmented pitfall sampling with other techniques that can allow calibration of the biases of pitfall trapping for different species. Trap catches of many species vary seasonally between years and between what seem to be similar habitats. Probable causes of such fluctuations are life cycle or physiologically related behavioural changes, intrinsic or environmentally driven changes in population processes, and variation in the subtle cues that carabids use to select habitats (Evans 1983, 1988, 1997). For most prairie carabids, we are completely ignorant of these aspects of their biology. Detailed laboratory and field studies of life cycles of prairie species are restricted to a few Harpalini (Kirk, 1973, 1974, 1975*a*), Pterostichini (Kirk 1971, 1975*b*; Goulet 1974), and Carabini (Burgess and Collins 1917). Without detailed biological studies, interpretation of pitfall catches is problematic, and we are poorly equipped to enhance carabid habitat or conserve carabid beetle populations.

Conservation of any species often requires placing limitations upon use of that species' habitat, a step that requires political will. Public support for conservation is greater when "charismatic megafauna" are involved, but appreciation for arthropods can be changed by experience of them (Bradshaw and Rice 2009). With the possible exception of tiger beetles, carabids are unlikely to be considered charismatic by the naïve public. Carabid beetles are common and seldom troublesome inhabitants of the urban environments where most citizens live. Development of these citizens' appreciation of the carabid beetles on their sidewalks and in their backyards can be achieved by education and extension efforts by entomologists. For carabids and other arthropods in urban and rural environments, such a program to change urban attitudes—particularly those of voters—is important preparation for future conservation efforts requiring public support for environmental and habitat protection.

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References

Acorn, J. 2001. Tiger Beetles of Alberta: Killers on the Clay, Stalkers on the Sand. The University of Alberta Press, Edmonton.

Baars, M.A. 1979. Catches in pitfall traps in relation to mean densities of carabid beetles. Oecologia, **41**: 25–46.

Báldi, A., Batáry, P., and Kleijn, D. 2013. Effects of grazing and biogeographic regions on grassland biodiversity in Hungary—analysing assemblages of 1200 species. Agriculture, Ecosystems and Environment, **166**: 28–34.

Ball, G.E. 1979. Conspectus of carabid classification: history, holomorphology, and higher taxa. *In* Carabid Beetles: Their Evolution, Natural History, and Classification. Proceedings of the First International Symposium of Carabidology, Smithsonian Institution, Washington D.C., 21–25 August 1976. *Edited by* T.L. Erwin, G.E. Ball, D.R. Whitehead, and E.L. Halpern. Dr W. Junk bv Publishers, The Hague, Netherlands. pp. 63–111.

Ball, G.E., and Bousquet, Y. 2000. Carabidae Latreille, 1810. *In* American Beetles, Vol. 1: Archostemata, Myxophaga, Adephaga, Polyphaga: Staphyliniformia. *Edited by* R.H. Arnett, Jr. and M.C. Thomas. CRC Press, Boca Raton, Florida. pp. 32–132.

Basedow, T. 1973. The impact of epigeal predaceous arthropods on the abundance of phytophagous insects in the agrarian landscape. Pedobiologia, **13**: 410–422.

Batáry, P., Báldi, A., Szél1, G., Podlussány, A., Rozner, I., and Erdos, S. 2007. Responses of grassland specialist and generalist beetles to management and landscape complexity. Diversity and Distributions, **13**: 196–202.

Bell, A.J., I.D. Phillips, K.D. Floate, B.M. Hoemsen and C.E. Phillips. 2014. Effects of pitfall lid transparency and habitat structure on the catches of carabid beetles (Coleoptera: Carabidae) in an untamed pasture. Environmental Entomology, **43**: 139–145.

Bird, R.D. 1927. A preliminary ecological survey of the district surrounding the entomological station at Treesbank, Manitoba. Ecology, **8**: 207–220.

Bird, R.D. 1930. Biotic communities of the aspen parkland of central Canada. Ecology, **11**: 356–442.

Bird, R.D. 1961. Ecology of the Aspen Parkland of Western Canada in Relation to Land Use. Research Branch, Canada Department of Agriculture, Ottawa, Ontario. Publication 1066.

Bouchard, P., and Wheeler, T.A. 1997. Arthropods of alvar habitats. Newsletter of the Biological Survey of Canada (Terrestrial Arthropods), **16**(2). Available from http://www.biology.ualberta.ca/bsc/news16_2/alvar.htm [accessed 7 May 2013].
Bourassa, S., Cárcamo, H.A., Larney, F.J., and Spence, J.R. 2008. Carabid assemblages (Coleoptera: Carabidae) in a rotation of three different crops in southern Alberta, Canada: a comparison of sustainable and conventional farming. Environmental Entomology, **37**: 1214–1223.
Bourassa, S., Spence J.R., Cárcamo, H.A., Spence, J.R., Blackshaw, R.E., and Floate, K. 2010. Effects of crop rotation and genetically modified herbicide-tolerant corn on ground beetle diversity, community structure, and activity density. The Canadian Entomologist, **142**: 143–159.
Bourassa, S., Spence, J.R., Hartley, D.J., and Lee, S-I. 2011. Wing-dimorphism and population expansion of *Pterostichus melanarius* (Illiger, 1798) at small and large scales in central Alberta, Canada (Coleoptera, Carabidae, Pterostichini). ZooKeys, **147**: 545–558.
Bousquet, Y. 1987. The carabid fauna of Canada and Alaska: range extensions, additions and descriptions of two new species of *Dyschirius* (Coleoptera: Carabidae). Coleopterists Bulletin, **41**: 111–135.
Bousquet, Y. 2010. Illustrated Identification Guide to Adults and Larvae of Northeastern North American Ground Beetles (Coleoptera: Carabidae). Pensoft, Sofia, Bulgaria.
Bousquet, Y. 2012. Catalogue of Geadephaga (Coleoptera, Adephaga) of America, north of Mexico. ZooKeys, **245**: 1–1722.
Bradshaw, J.D., and Rice, M.E. 2009. Of ants and elephants: measuring student appreciation for insects and charismatic megafauna during an African safari. American Entomologist, **55**: 6–8.
Broatch, J.S. 2008. Root Maggot and Beneficial Insect Dynamics in Response to Weed Populations in Canola. Ph.D. thesis, University of Alberta, Edmonton.
Burgess, A.F., and Collins, C.W. 1917. The Genus *Calosoma*. United States Department of Agriculture Bulletin 417.
Butts, R.A., Floate, K.D., David, M., Blackshaw, R.E., and Burnett, P.A. 2003. Influence of intercropping canola or pea with barley on assemblages of ground beetles (Coleoptera: Carabidae). Environmental Entomology, **32**: 535–541.
Cárcamo, H.A. 1992. The Effects of Agricultural Practice on a Carabid Fauna (Coleoptera: Carabidae) in Central Alberta. M.Sc. thesis, University of Alberta, Edmonton.
Cárcamo H.A. 1995. Effect of tillage on ground beetles (Coleoptera: Carabidae): a farm-scale study in central Alberta. The Canadian Entomologist, **127**: 631–639.
Cárcamo H.A., Niemelä, J.K., and Spence, J.R. 1995. Farming and ground beetles: effects of agronomic practice on populations and community structure. The Canadian Entomologist, **127**: 123–140.
Cárcamo, H.A., and Spence, J.R. 1994. Crop type effects on the activity and distribution of ground beetles (Coleoptera: Carabidae). Environmental Entomology, **23**: 684–692.
Cress, D.C., and Lawson, F.A. 1971. Life history of *Pasimachus elongatus*. Journal of the Kansas Entomological Society, **44**: 304–313.
Criddle, A. 1973. Criddle-de-diddle-ensis. Privately printed, Winnipeg, Manitoba.
Crowson, R.A. 1981. The Biology of the Coleoptera. Academic Press, London, U.K.
Dennis, P., Young, M.R., Howard, C.L., and Gordon, I.J. 1997. The response of epigeal beetles (Col.: Carabidae, Staphylinidae) to varied grazing regimes on upland *Nardus stricta* Grasslands. Journal of Applied Ecology, **34**: 433–443.
Derner, J.D., Lauenroth, W.K., Stapp, P., and Augustine, D.J. 2009. Livestock as ecosystem engineers for grassland bird habitat in the western great plains of North America. Rangeland Ecology and Management, **62**: 111–118.
Digweed, S.C., Currie, C.R., Cárcamo, H.A., and Spence, J.R. 1995. Digging out the “digging-in effect” of pitfall traps: influences of depletion and disturbance on catches of ground beetles (Coleoptera: Carabidae). Pedobiologia, **39**: 561–576.
Doane, J.F. 1981. Seasonal captures and diversity of ground beetles (Coleoptera: Carabidae) in a wheat field and its grassy borders in central Saskatchewan. Quaestiones Entomologicae, **17**: 211–233.
Eisner, T., and Aneshansley, D.J. 1999. Spray aiming in the bombardier beetle: photographic evidence. Proceedings of the National Academy of Sciences of the United States of America, **96**: 9705–9709.
Environment Canada. 2013. Monthly Data Report for 2005 and 2006, Brandon CDA Manitoba [online]. National Climate Data and Information Archive. Available from www.climate.weatheroffice.gc.ca [accessed 6 July 2013].
Epstein, M.E., and Kulman, H.M. 1990. Habitat distribution and seasonal occurrence of carabid beetles in east-central Minnesota. American Midland Naturalist, **123**: 209–225.

Erwin, T.L. 2011. *Pasimachus (Pasimachus) elongatus*. eAgra [online]. Available from http://canopy.lifedesks.org/pages/1284 [accessed 22 July 2013].

Erwin, T.L., and Kavanaugh, D.H. 1981. Systematics and zoogeography of *Bembidion* Latreille: I. The *carlhi* and *erasum* groups of western North America (Coleoptera: Carabidae, Bembidiini). Entomologica Scandinavica (Supplement), **15**: 33–72.

Evans, W.G. 1983. Habitat selection in the Carabidae. Coleopterists Bulletin, **37**: 164–167.

Evans, W.G. 1988. Chemically mediated habitat recognition in shore insects (Coleoptera: Carabidae; Hemiptera: Saldidae). Journal of Chemical Ecology, **14**: 1441–1454.

Evans, W.G. 1997. Humidity-invoked upwind orientation of shore insects (*Bambidion* [sic] *obtusidens*, Coleoptera: Carabidae). Journal of Insect Behaviour, **10**: 355–363.

Finch, S., and Collier, R.H. 2007. Pest insect control by predatory ground beetles—40 years of doubt. IOBC/WPRS Bulletin, **30**: 43–51.

Floate, K.D. 1987. Effect of Carabid (Coleoptera: Carabidae) Predators on Populations of the Orange Wheat Blossom Midge, *Sitodiplosis mosellana* (Géhin), in NE Saskatchewan. M.Sc. thesis, University of Saskatchewan, Saskatoon.

Floate, K.D., Cárcamo, H.A., Blackshaw, R.E., Postman, B., and Bourassa, S. 2007. Response of ground beetle (Coleoptera: Carabidae) field populations to four years of Lepidoptera-specific *Bt* corn production. Environmental Entomology, **36**: 1269–1274.

Floate, K.D., Doane, J.F., and Gillott, C. 1990. Carabid predators of the wheat midge (Diptera: Cecidomyiidae) in Saskatchewan. Environmental Entomology, **19**: 1503–1511.

Floate, K.D., Elliott, R.H., Doane, J.F., and Gillott, C. 1989. Field bioassay to evaluate contact and residual toxicities of insecticides to carabid beetles (Coleoptera: Carabidae). Journal of Economic Entomology, **82**: 1543–1547.

Frank, J.H. 1971*a*. Carabidae (Coleoptera) of an arable field in central Alberta. Quaestiones Entomologicae, **7**: 237–252.

Frank, J. H. 1971*b*. Carabidae (Coleoptera) as predators of the red-backed cutworm (Lepidoptera: Noctuidae) in central Alberta. The Canadian Entomologist, **103**: 1039–1044.

García, R.R., Ocharan, F.J., García, U., Osoro, K., and Celaya, R. 2010. Arthropod fauna on grassland-heathland associations under different grazing managements with domestic ruminants. Comptes Rendus Biologies, **333**: 226–234.

Goulet, H. 1974. Biology and relationships of *Pterostichus adstrictus* Eschscholtz and *Pterostichus pensylvanicus* LeConte. Quaestiones Entomologicae, **10**: 3–33.

Greenslade, P.J.M. 1964. Pitfall trapping as a method for studying populations of Carabidae (Coleoptera). Journal of Animal Ecology, **33**: 301–310.

Greenslade, P., and Greenslade, P.J.M. 1971. The use of baits and preservatives in pitfall traps. Journal of the Australian Entomological Society, **10**: 253–260.

Griffiths, G.C.D. 1985. Field Studies of *Delia radicum* (L.) as a Pest of Canola in Northern Alberta. Technical Report, Farming for the Future 82-0123 and 83-0150. Alberta Agriculture (Government of Alberta), Edmonton.

Hall, P.W., Catling, P.M., and Lafontaine, J.D. 2011. Insects at risk in the prairie region. *In* Arthropods of Canadian Grasslands, Vol. 2: Inhabitants of a Changing Landscape. *Edited by* K.D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 323–349. Available from http://www.biology.ualberta.ca/bsc/english/grasslandbook2/Chapter13_ACGv2.pdf [accessed 20 March 2014].

Hancock, M.H., and Legg, C.J. 2012. Pitfall trapping bias and arthropod body mass. Insect Conservation and Diversity, **5**: 312–318.

Hartley, D.J., Koivula, M.J., Spence, J.R., Pelletier, R., and Ball, G.E. 2007. Effects of urbanization on ground beetle assemblages (Coleoptera, Carabidae) of grassland habitats in western Canada. Ecography, **30**: 673–684.

Hawkins-Bowman, A.K. 2006. The Effect of Tillage and Seeding Rate on Infestations of Cabbage Root Maggots, *Delia radicum* (L.) (Diptera: Anthomyiidae) in Canola, *Brassica napus* (L.), in Manitoba. M.Sc. thesis, University of Manitoba, Winnipeg.

Hieke, F. 2007. Aktueller Katalog der Gattung Amara Bonelli, 1810. Available from http://download.naturkundemuseum-berlin.de/fritz.hieke/Amkatal.doc [online] [accessed 9 July 2013].

Hilchie, G.J. 1985. The tiger beetles of Alberta (Coleoptera: Carabidae, Cicindelini). Quaestiones Entomologicae, **21**: 319–347.

Holliday, N.J. 1984. Carabid beetles (Coleoptera: Carabidae) from a burned spruce forest (*Picea* spp.). The Canadian Entomologist, **116**: 919–922.

Holliday, N.J. 2005. Norman Criddle: pioneer entomologist of the Prairies. Bulletin of the Entomological Society of Canada, **37**: 10–19.
Holliday, N.J., and Hagley, E.A.C. 1979. Distribution and density of carabid beetles (Coleoptera) in a pest management apple orchard. The Canadian Entomologist, **111**: 759–770.
Hooper, R.R., and Larson, D.J. 2012. Checklist of Beetles (Coleoptera: Insecta) of Saskatchewan [online]. Available from http://www.entsocsask.ca/insect_lists.html [accessed 8 March 2013].
Humble, S.M. 2001. Weeds and Ground Beetles (Coeloptera: Carabidae) as Influenced by Crop Rotation Type and Crop Input Management. M.Sc. thesis, University of Manitoba, Winnipeg.
Hummel, J.D., Dosdall, L.M., Clayton, G.W., Harker, K.N., and O'Donovan, J.T. 2012. Ground beetle (Coleoptera: Carabidae) diversity, activity density, and community structure in a diversified agroecosystem. Environmental Entomology, **41**: 72–80.
Johnson, N.E., and Cameron, R.S. 1969. Phytophagous ground beetles. Annals of the Entomological Society of America, **62**: 909–914.
Kavanaugh, D.H. 1979. Studies on the Nebriini (Coleoptera: Carabidae), III. New Nearctic *Nebria* species and subspecies, nomenclatural notes, and lectotype designations. Proceedings of the California Academy of Sciences, **42**: 87–133.
Kavanaugh, D.H. 1981. Studies on the Nebriini (Coleoptera: Carabidae), IV. Four new *Nebria* taxa from western North America. Proceedings of the California Academy of Sciences, **42**: 435–442.
Kavanaugh, D.H. 1984. Studies on Nebriini (Coleoptera: Carabidae), V. New Nearctic *Nebria* taxa and changes in nomenclature. Proceedings of the California Academy of Sciences, **43**: 159–177.
Kirk, V.M. 1971. Biological studies of a ground beetle, *Pterostichus lucublandus*. Annals of the Entomological Society of America, **64**: 540–544.
Kirk, V.M. 1972*a*. Identification of ground beetle larvae found in cropland in South Dakota. Annals of the Entomological Society of America, **65**: 1349–1356.
Kirk, V.M. 1972*b*. Seed-caching by larvae of two ground beetles, *Harpalus pensylvanicus* and *H. erraticus*. Annals of the Entomological Society of America, **65**: 1426–1428.
Kirk, V.M. 1973. The biology of a ground beetle, *Harpalus pensylvanicus*. Annals of the Entomological Society of America, **66**: 513–518.
Kirk, V.M. 1974. The biology of a ground beetle, *Harpalus erraticus*. Annals of the Entomological Society of America, **67**: 24–28.
Kirk, V.M. 1975*a*. Biology of *Stenolophus* (=*Agonoderus*) *comma*, a ground beetle of cropland. Annals of the Entomological Society of America, **68**: 135–138.
Kirk, V.M. 1975*b*. Biology of *Pterostichus chalcites*, a ground beetle of cropland. Annals of the Entomological Society of America, **68**: 855–858.
Klimaszewski, J., Langor, D., Batista, R., Duval, J.-A., Majka, C.G., Scudder, G.G.E., and Bousquet, Y. 2012. Synopsis of Adventive Species of Coleoptera (Insecta) Recorded from Canada. Part 1: Carabidae. Pensoft Series Faunistica No. 103. Pensoft Publishers, Sofia, Bulgaria.
Knapp, A.K., Blair, J.M., Briggs, J.M., Collins, S.L., Hartnett, D.C., Johnson, L.C., and Towne, E.G. 1999. The keystone role of bison in North American tallgrass prairie. BioScience, **49**: 39–50.
Landry, J.-F. 1994. Resource partitioning in a guild of marsh-dwelling *Agonum* (Coleoptera: Carabidae) in central Alberta. The Canadian Entomologist, **126**: 709–728.
Larochelle, A., and Larivière, M.-C. 2003. A Natural History of the Ground-Beetles (Coleoptera: Carabidae) of America North of Mexico. Pensoft Publishers, Sofia, Bulgaria.
Lenoir, L., and Lennartsson, T. 2010. Effects of timing of grazing on arthropod communities in semi-natural grasslands. Journal of Insect Science, **10**: 1–20.
Liebherr, J.K. 1994. Identification of New World *Agonum*, review of the Mexican fauna, and description of *Incagonum*, new genus from South America (Coleoptera: Carabidae: Platynini). Journal of the New York Entomological Society, **102**: 1–55.
Lindroth, C.H. 1957. The Faunal Connections between Europe and North America. Almqvist and Wiksell, Stockholm, Sweden.
Lindroth, C.H. 1961–1969. The ground-beetles (Carabidae, excl. Cicindelinae) of Canada and Alaska. Parts 1 (1969), 2 (1961), 3 (1963), 4 (1966), 5 (1968), 6 (1969). Opuscula Entomologica Supplementum, 35, 20, 24, 29, 33, 34.
Luff, M.L. 1975. Some features influencing the efficiency of pitfall traps. Oecologia, **19**: 345–357.
Luff, M.L. 2002. Carabid assemblage organization and species composition. *In* The Agroecology of Carabid Beetles. *Edited by* J.M. Holland. Intercept, Andover, U.K. pp. 41–79.
Maddison, D.R. 2000. Coleoptera. Beetles. Version 11 September 2000 [under construction]. Available from http://tolweb.org/Coleoptera/8221/2000.09.11 [accessed 11 July 2013].

Maddison, D.R. 2012. Phylogeny of *Bembidion* and related ground beetles (Coleoptera: Carabidae: Trechinae: Bembidiini: Bembidiina). Molecular Phylogenetics and Evolution, **63**: 533–576.

Majka, C.G., Bousquet, Y., and Westby, S. 2007. The ground beetles (Coleoptera: Carabidae) of the Maritime Provinces of Canada: review of collecting, new records, and observations on composition, zoogeography, and historical origins. Zootaxa, **1590**: 1–36.

Mauduit, L.A. 2012. First Assessment of Predation by the Arthropod Natural Enemy Complex on the Insect Pests of Canola-Cropping Systems in Southern Alberta in Canada: Example of the Diamondback Moth (*Plutella xylostella*). Master thesis, Institut Polytechnique LaSalle-Beauvais, Beauvais, France.

Melnychuk, N.A., Olfert, O., Youngs, B., and Gillott, C. 2003. Abundance and diversity of Carabidae (Coleoptera) in different farming systems. Agriculture, Ecosystems and Environment, **95**: 69–72.

Moran, J., Gormally, M., and Skeffington, M.S. 2012. Turlough ground beetle communities: the influence of hydrology and grazing in a complex ecological matrix. Journal of Insect Conservation, **16**: 51–69.

Moranz, R.A., Debinski, D.M., McGranahan, D.A., Engle, D.M., and Miller, J.R. 2012. Untangling the effects of fire, grazing, and land-use legacies on grassland butterfly communities. Biodiversity and Conservation, **21**: 2719–2746.

Morris, M.G. 2000. The effects of structure and its dynamics on the ecology and conservation of arthropods in British grasslands. Biological Conservation, **95**: 129–142.

Niemelä, J., Spence, J.R., and Cárcamo, H. 1997. Establishment and interactions of carabid populations: an experiment with native and introduced species. Ecography, **20**: 643–652.

Niemelä, J., and Spence, J.R. 1999. Dynamics of local expansion by an introduced species: *Pterostichus melanarius* Ill. (Coleoptera, Carabidae) in Alberta, Canada. Diversity and Distributions, **5**: 121–127.

Noonan, G.R. 1985. Classification and Names of the Selenophori Group (Coleoptera: Carabidae: Harpalini) and of Nine Genera and Subgenera Placed in Incertae Sedis within Harpalina. Milwaukee Public Museum Contributions in Biology and Geology No. 64.

Noonan, G.R. 1991. Classification, Cladistics, and Natural History of Native North American *Harpalus* Latreille (Insecta: Coleoptera: Carabidae: Harpalini), Excluding Subgenera *Glanodes* and *Pseudophonus*. Thomas Say Foundation Monographs No. 13.

Noonan, G.R. 1996. Classification, Cladistics, and Natural History of Species of the Subgenus *Anisodactylus* Dejean (Insecta: Coleoptera: Carabidae: Harpalini: *Anisodactylus*). Milwaukee Public Museum Contributions in Biology and Geology No. 89.

Noonan, G.R. 2001. Systematics and cladistics of the North American subgenus *Anadaptus* Casey (genus *Anisodactylus* Dejean) and a geographic information system analysis of the biogeography of included species. Annals of the Entomological Society of America, **94**: 301–332.

Pearson, D.L., Knisley, C.B., and Kazilek, C.J. 2006. A Field Guide to the Tiger Beetles of the United States and Canada: Identification, Natural History, and Distribution of the Cicindelidae. Oxford University Press, New York.

Pepper, J.L. 1999. Diversity and Community Assemblages of Ground-Dwelling Beetles and Spiders on Fragmented Grasslands of Southern Saskatchewan. MSc. thesis, University of Regina, Regina.

Prasad, R.P., and Snyder, W.E. 2004. Predator interference limits fly egg biological control by a guild of ground-active beetles. Biological Control, **31**: 428–437.

Prasad, R.P., and Snyder, W.E. 2006. Polyphagy complicates conservation biological control that targets generalist predators. Journal of Applied Ecology, **43**: 343–352.

Richardson, R.J. 1982. The Effects of Habitat Disturbance on the Occurrence of Carabid Beetles. M.Sc. thesis, University of Manitoba, Winnipeg.

Rivard, I. 1964. Observations on the breeding periods of some ground beetles (Coleoptera: Carabidae) in eastern Ontario. Canadian Journal of Zoology, **42**: 1081–1084.

Rook, A.J., and Tallowin, J.R.B. 2003. Grazing and pasture management for biodiversity benefit. Animal Research, **52**: 181–189.

Roughley, R.E., Pollock, D.A., and Wade, D.J. 2006. Biodiversity of ground beetles (Coleoptera: Carabidae) and spiders (Araneae) across a tallgrass prairie-aspen forest ecotone in southern Manitoba. The Canadian Entomologist, **138**: 545–567.

Roughley, R.E., Pollock, D.A., and Wade, D.J. 2010. Tallgrass prairie, ground beetles (Coleoptera: Carabidae) and the use of fi re as a biodiversity and conservation management tool. *In* Arthropods of Canadian Grasslands, Vol. 1: Ecology and Interactions in Grassland Habitats. *Edited by* J.D. Shorthouse and K.D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 227–235. Available from http://www.biology.ualberta.ca/bsc/english/grasslandsbook/Chapter10_ACG.pdf [accessed 20 March 2014].

Salt, G. 1928. Notes on the life history of *Pelecium sulcatum* Guérin. Psyche, **35**: 131–134.

Saska, P., and Honek, A. 2004. Development of the beetle parasitoids, *Brachinus explodens* and *B. crepitans* (Coleoptera: Carabidae). Journal of Zoology, **262**: 29–36.

Shay, C.T. 1984. The history of Manitoba's vegetation. *In* Natural Heritage of Manitoba: Legacy of the Ice Age. *Edited by* J.T. Teller. Manitoba Museum of Man and Nature, Winnipeg. pp. 93–125.

Shorthouse, J.D. 2010*a*. Canada's grasslands as a habitat for arthropods. *In* Arthropods of Canadian Grasslands, Vol. 1: Ecology and Interactions in Grassland Habitats. *Edited by* J.D. Shorthouse and K.D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 27–51. Available from http://www.biology.ualberta.ca/bsc/english/grasslandsbook/Chapter2_ACG.pdf [accessed 20 March 2014].

Shorthouse, J.D. 2010*b*. Ecoregions of Canada's prairie grasslands. *In* Arthropods of Canadian Grasslands, Vol. 1: Ecology and Interactions in Grassland Habitats. *Edited by* J.D. Shorthouse and K.D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 53–81. Available from http://www.biology.ualberta.ca/bsc/english/grasslandsbook/Chapter3_ACG.pdf [accessed 20 March 2014].

Songa, J.M. 1994. Biological Control of Grasshoppers (Orthoptera: Acrididae) in Manitoba with Emphasis on Predators and Parasitoids of the Eggs. M.Sc. thesis, University of Manitoba, Winnipeg.

Songa, J.M., and Holliday, N.J. 1997. Laboratory studies of predation of grasshopper eggs, *Melanoplus bivittatus* (Say), by adults of two species of *Pterostichus* Bonelli (Coleoptera: Carabidae). The Canadian Entomologist, **129**: 1151–1159.

Spence, J.R., and Niemelä, J.K. 1994. Sampling carabid assemblages with pitfall traps: the madness and the method. The Canadian Entomologist, **126**: 881–894.

Spence, J.R., and Spence, D.H. 1988. Of ground-beetles and men: introduced species and the synanthropic fauna of western Canada. Memoirs of the Entomological Society of Canada, **144**: 151–168.

Stjernberg, A. 2011. The Effect of Twice-Over Rotational Cattle Grazing on the Ground Beetles (Coleoptera: Carabidae) and Spiders (Araneae) on the Yellow Quill Mixed Grass Prairie Preserve. M.Sc. thesis, University of Manitoba, Winnipeg.

Taylor, L.R., Kempton, R.A., and Woiwod, I.P. 1976. Diversity statistics and the log series model. Journal of Animal Ecology, **45**: 255–271.

ter Braak, C.J.F. 1990. Interpreting canonical correlation analysis through biplots of structure correlations and weights. Psychometrika, **55**: 519–531.

ter Braak, C.J.F., and Looman, C.W.N. 1994. Biplots in reduced-rank regression. Biometrical Journal, **36**: 983–1003.

Thiele, H.-U. 1977. Carabid Beetles in Their Environments: A Study on Habitat Selection by Adaptations in Physiology and Behaviour. Springer-Verlag, Berlin, Germany.

Uddin, M.J. 2005. Insects of Alfalfa in Manitoba with Particular Reference to *Lygus* spp., *Adelphocoris lineolatus* (Hemiptera: Miridae) and *Acyrthosiphon pisum* (Homoptera: Aphididae) and Their Natural Enemies. Ph.D. thesis, University of Manitoba, Winnipeg.

van Emden, F.I. 1942. A key to the genera of larval Carabidae (Col.). Transactions of the Royal Entomological Society of London, **92**: 1–99.

Vankosky, M.A., Cárcamo, H.A., and Dosdall, L.M. 2011. Identification of potential natural enemies of the pea leaf weevil, *Sitona lineatus* L. in western Canada. Journal of Applied Entomology, **135:** 293–301.

Wallis, J.B. 1961. The Cicindelidae of Canada. University of Toronto Press, Toronto, Ontario.

Weber, D.C., Rowley, D.L., Greenstone, M.H., and Athanas, M.M. 2006. Prey preference and host suitability of the predatory and parasitoid carabid beetle, *Lebia grandis*, for several species of *Leptinotarsa* beetles [online]. Journal of Insect Science, 6:09. Available from http://www.insectscience.org/6.09 [accessed 22 August 2013].

Weber, D.C., Saska, P., and Chaboo, C.S. 2008. Carabid beetles as parasitoids. *In* Encyclopedia of Entomology, 2nd edition, Vol. 2. *Edited by* J.L. Capinera. Kluwer, Dordrecht, Netherlands. pp. 35–37.

Wrubleski, D.A., and Ross, L.C.M. 2011. Aquatic invertebrates of prairie wetlands: community composition, ecological roles, and impacts of agriculture. *In* Arthropods of Canadian Grasslands, Vol. 2: Inhabitants of a Changing Landscape. *Edited by* K. D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 91–116. Available from http://www.biology.ualberta.ca/bsc/english/grasslandbook2/Chapter5_ACGv2.pdf [accessed 20 March 2014].

Zahn, A., Juen, A., Traugott, M., and Lang, A. 2007. Low density cattle grazing enhances arthropod diversity of abandoned wetland. Applied Ecology and Environmental Research, **5**: 73–86.

Chapter 2
Click Beetles and Wireworms (Coleoptera: Elateridae) of Alberta, Saskatchewan, and Manitoba

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Abstract. This chapter describes the Elateridae of Alberta (144 species), Saskatchewan (108 species), and Manitoba (109 species). It provides current names for species, as well as synonymized names that persist in the literature. Also discussed are the species that have been left out during recent changes to elaterid renaming and classification, although no new name combinations are given. The chapter outlines species distributions, biogeography where known, and the life histories of five common species: *Aeolus mellillus* (Say), *Agriotes mancus* (Say), *Hypnoidus bicolor* (Eschscholtz), *Limonius californicus* (Mannerheim), and *Selatosomus aeripennis destructor* (Brown). An examination of the seasonal movements and activity of larvae in response to soil temperature and moisture and moulting cycles is followed by an overview of past research on Prairie Province species. The chapter concludes with a discussion of current research needs and management issues.

Résumé. Le présent chapitre décrit les Elateridae de l'Alberta (138 espèces), de la Saskatchewan (76 espèces) et du Manitoba (104 espèces). Il fournit les noms actuels de ces espèces, ainsi que les synonymes qui persistent dans la documentation spécialisée. Il se penche également sur les espèces qui ont été laissées de côté lors des récents changements apportés à la nomenclature et à la classification des élatéridés, sans toutefois s'attarder aux nouvelles combinaisons de noms. Le chapitre décrit la répartition des espèces, leur caractéristiques biogéographiques — lorsqu'elles sont connues — ainsi que le cycle de vie de cinq espèces communes : *Aeolus mellillus* (Say), *Agriotes mancus* (Say), *Hypnoidus bicolor* (Eschscholtz), *Limonius californicus* (Mannerheim), et *Selatosomus aeripennis destructor* (Brown). Il examine les déplacements saisonniers et l'activité des larves sous l'effet des variations de la température et de l'humidité du sol ainsi qu'au fil des cycles de la mue, et présente un aperçu des recherches effectuées par le passé sur les espèces des provinces des Prairies. Nous nous penchons en guise de conclusion sur les besoins actuels et les enjeux de la gestion de la recherche.

Introduction

The Elateridae are the largest family of the series Elateriformia and superfamily Elateroidea and the ninth most diverse family of beetles overall, with nearly 10,000 described species worldwide and nearly 1,000 described species in the Nearctic region (Johnson 2002). The family is well represented in Canada. Bousquet *et al.* (2013) lists 133 elaterid species for Alberta, 102 for Saskatchewan, and 100 for Manitoba (numbers adjusted in this chapter). The main feature distinguishing this family from other Coleoptera is the flexible union of the prothorax and mesothorax, a result of a prosternal intercoxal process fitting into a groove on the mesosternum, which the beetles can flex and snap to right themselves and possibly also to startle and evade predators. This snapping action propels the beetles into the air and produces an audible click, giving the family its common names click beetles

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and skipjacks and the reason for the Greek root of the family's name, ελατηρ: to drive, hurl, or set in motion. Beetle families generally placed close taxonomically include the Cerophytidae (rare click beetles), Eucnemidae (false click beetles), and Throscidae, all of which have some members that share the clicking mechanism (Calder *et al*. 1993), though molecular data suggest that Lycidae, Lampyridae, and Cantharidae may be more closely related to the Elateridae (Kundrata and Bocak 2010). In recent years, the Lissomidae, Cebrionidae, and some tribes of the Eucnemidae and Cerophytidae have been included as new subfamilies in the Elateridae (Johnson 2002), and most Drilidae have been included in the elaterid subfamily Agrypninae (Kundrata and Bocak 2010).

Research into the biodiversity, distribution, and ecology of elaterids in Canada has decreased in the last few decades relative to most of the 1900s. For example, Thomas (1940) reviewed >450 papers on wireworm biology and management that had been published since his similar-sized review a decade previous (Thomas 1930). Subklew (1938) reviewed >1,000 papers, Gaedike (1969) >1,500, and Keaster *et al.* (1988) ~2,500. This attention was driven primarily by economics. Although adult elaterids are rarely of economic importance, wireworms (the name given to the long-lived (1–5 year) larval form) cause damage to cereal and vegetable crops worldwide. Their economic importance resulted in copious and excellent research, particularly in the United Kingdom, Germany, Japan, and North America. In Canada, research was done on pest elaterids from the 1930s to the 1970s in British Columbia (Wilkinson 1963; Wilkinson *et al*. 1964, 1976), Ontario (Begg 1957, 1962), Quebec (Lafrance 1963, 1967, 1968; Lafrance and Cartier 1964), and Atlantic Canada (Morris 1951; Eidt 1953, 1954, 1958, 1959; Fox 1961), but especially in the Prairie Provinces (Strickland 1927, 1935, 1939, 1942; King 1928; Arnason 1931; King *et al*. 1933; Glen *et al*. 1943; Glen 1950; Davis 1957, 1958*a,* 1958*b*, 1958*c*, 1959*a,* 1959*b*, 1959*c*, 1959*d*, 1961; Zacharuk 1958*a*, 1958*b*, 1962*a*, 1962*b*, 1962*c*, 1970*a*, 1970*b*, 1971, 1972, 1973*a*, 1973*b*, 1974; Doane 1961, 1963, 1966, 1967, 1977*a*, 1977*b*, 1981; Burrage 1963, 1964; Doane *et al*. 1975). The basic research done during this time, although unfortunately often overlooked in recent publications on wireworm biology and management, remains invaluable. In Canada, for example, the work by Wilkinson (1963) and Glen *et al.* (1943) led to identification keys for larvae of pest species in British Columbia and Canada, respectively, that are still in use for identifying larvae collected both within and well outside their intended regions (Vernon and van Herk 2012), and Doane *et al*.'s (1975) work on wireworm movement in soil is the basis for our own observational work (van Herk and Vernon 2007; van Herk *et al*. 2008*b*). Nearly all the elaterid research in Canada during this time focused on the biology and management of wireworms, and comparatively little attention was given to adults—notable exceptions being Brooks' (1960) treatment of adult elaterids for Alberta, Saskatchewan, and Manitoba; Becker's revisions of Neartic *Athous* Eschscholtz (Becker 1974, 1979*b*) and *Agriotes* Eschscholtz (Becker 1956); and Brown's descriptions of Canadian elaterids, which amounted to a sizeable part of *The Canadian Entomologist* in the 1930s (Brown 1930, 1933*a*, 1933*b*, 1934*a*, 1934*b*, 1934*c*, 1934*d*, 1935*a*, 1935*b*, 1935*c*, 1936*a*, 1936*b*, 1936*c*, 1936*d*, 1936*e*, 1939).

Interest in elaterid research waned after the 1960s, when organophosphate and organochlorine insecticides effectively controlled wireworms. In British Columbia, for example, aldrin and heptachlor killed wireworms (*Agriotes obscurus* L.) for 13 years after a single application to soil (Wilkinson *et al*. 1964, 1976). The elimination of these chemicals (which also persisted in potato tubers harvested for human consumption; Begg *et al*. 1960) from registration, and their replacement with compounds that are generally ineffective in reducing populations (Vernon *et al*. 2009, 2013; Vernon and van Herk 2012), has caused a recent resurgence of wireworm populations in the Canadian Prairie Provinces, and with it a resurgence of interest in wireworms (for producers and insecticide companies) (Vernon and van Herk 2012). This increase in wireworm presence and grower concern across the Canadian Prairie Provinces has allowed us to identify larvae collected from hundreds of fields in Alberta, Saskatchewan, and Manitoba where crop damage has occurred. These data, collected over the last decade, have allowed us to compare historical and current distributions of pest species, assess the degree of genetic variability among and within species, and correlate this variability with geographical distance. Virtually all that is known about elaterid biology and distributions in the Prairie Provinces resulted from past and present pest management work. For this reason, and because wireworms are re-emerging as one of the most important agricultural pests in Canada and elsewhere (Vernon and van Herk 2012), this chapter includes a discussion of the biology, behaviour, and distribution of select elaterid species of economic importance.

Species and Distribution

Names of Species Listed

In this chapter, we list all species found in Alberta, Saskatchewan, and Manitoba, rather than only those known to occur in the grassland areas of these provinces. We have chosen this approach because little is known about the distribution of most species within these provinces (and the rest of Canada; Fuller 1992), and listing all species gives us an opportunity to provide their current names. We compile all species listed for Alberta, Saskatchewan, and Manitoba by Glen *et al*. (1943), Glen (1950), Brooks (1960), Campbell *et al*. (1989), Bousquet (1991), Fuller (1992, 2002, 2008), Douglas (2011*b*), and Bousquet *et al.* (2013). There are currently 182 species known for the Prairie Provinces, of which 144 are known for Alberta, 108 for Saskatchewan, and 109 for Manitoba (Table 1). The names given in Table 1 generally follow Bousquet *et al.* (2013). Our checklist (Table 1) includes many names now in synonymy because these occur in the standard literature on larval and adult identification (i.e., Glen *et al*. 1943; Glen 1950; Brooks 1960) and on pest species (i.e., Campbell *et al*. 1989) for the Prairie Provinces, as well as in the first edition of Bousquet's popular checklist (Bousquet 1991).

Three genera have recently been divided into multiple genera. Many Canadian species of *Negastrius* Thomson were transferred to the genera *Fleutiauxellus* Mequignon, *Paradonus* Stibick, *Microhypnus* Kishii, *Migiwa* Kishii, *Neohypdonus* Stibick, and *Paradonus* Stibick (Stibick 1990). Species once listed in *Cryptohypnus* Eschscholtz and *Hypolithus* Eschscholtz are now included in *Ascoliocerus* Mequignon, *Hypnoidus* Dillwyn, *Ligmargus* Stibick, and *Margaiostus* Stibick (Stibick 1978). Species once placed in *Ctenicera* Latreille (and before that in *Ludius* Eschscholtz and/or *Prosternon* Latreille) are now included in *Actenicerus* Kiesenwetter, *Ctenicera*, *Corymbitodes* Buysson, *Hypoganus* Kiesenwetter, *Liotrichus* Kiesenwetter, *Nitidolimonius* Johnson, *Paraphotistus* Kishii, *Prosternon*, *Pseudanostirus* Dolin, *Selatosomus* Stephens, *Setasomus* Gurjeva, and *Sylvanelater* Johnson (Tarnawski 1995, 1996, 2001; Johnson 2002; Majka and Johnson 2008). There is currently only one Prairie Province species left in the genus, *Ctenicera kendalli* (Kirby).

The revision of *Ctenicera* has complicated finding current names for some species, since recent revisions have not covered all species that were once included in the genus (Table 2). For these species, the most current name is reported in Table 1. In other cases, certain species are referred to inconsistently by different authors, or are now considered invalid.

Table 1. Elaterid species found in Alberta (AB), Saskatchewan (SK), and Manitoba (MB). Species marked with an * are known to occur on grassland habitats. Species marked with an † are not listed for these provinces in Bousquet *et al.* (2013). *Species checklist available at* http://dx.doi.org/10.5886/5drq7v8p

Current Name[1]	Distribution			Synonyms[2]
Family Elateridae Leach				
Subfamily Agrypninae Candèze				
Tribe Agrypnini Candèze				
Danosoma brevicorne (LeConte)	AB	SK	MB	*Lacon brevicornis, Lepidotes (Danosoma) brevicornis*
Danosoma obtectum (Say)	AB	SK	MB	*Danosoma obtecta, Lepidotes (Danosoma) obtectus, Lacon obtectus*
Lacon auroratus (Say)	AB		MB	*Lepidotes (Lepidotes) auroratus*
Tribe Oophorini Gistel				
Aeolus mellillus mellillus (Say) †	AB	SK	MB	*Drasterius mellillus*
Aeolus mellillus comis (LeConte)*	AB			
Aeolus mellillus marginicollis (Horn)		SK	MB	
Conoderus auritus (Herbst)*	AB	SK	MB	
Tribe Hemirhipini Candèze				
Alaus myops (Fabricius)			MB	
Subfamily Lissominae Laporte				
Oestodes puncticollis Horn*	AB	SK	MB	
Oestodes tenuicollis (Randall) †			MB	
Subfamily Pityobiinae Hyslop				
Pityobius anguinus LeConte	AB	SK	MB	
Subfamily Dendrometrinae Gistel				
Tribe Dendrometrini Gistel				
Athous aterrimus Fall	AB			
Athous nigropilis Motschulsky*	AB			
Athous productus (Randall)	AB	SK	MB	*Denticollis productus*
Athous rufifrons (Randall)			MB	
Athous rufiventris rufiventris (Eschscholtz)	AB			*Athous rufiventris*
Denticollis denticornis (Kirby)	AB	SK	MB	*Lepturoides denticornis*
Harminius triundulatus (Mannerheim)[3]	AB	SK		
Hemicrepidius brevicollis (Candèze)*		SK	MB	
Hemicrepidius carbonatus (LeConte)*	AB	SK	MB	
Hemicrepidius nemnonius (Herbst)*	AB	SK	MB	*Hemicrepidius memnonius*
Hemicrepidius simplex (LeConte)	AB			
Limonius aeger LeConte*	AB	SK	MB	
Limonius aurifer LeConte			MB	
Limonius californicus (Mannerheim)*	AB	SK	MB	*Limonius occidentalis* Candeze
Limonius canus LeConte*	AB	SK		
Limonius consimilis Walker	AB	SK		*Limonius lecontei* Lane[4], *L. nitidicollis* LeConte

Current Name[1]	Distribution			Synonyms[2]
Limonius ectypus (Say)	AB	SK	MB	*Limonius infuscatus* Motschulsky, *L. pilosulus* Candèze
Limonius lanei Van Dyke*	AB	SK	MB	
Limonius nitidulus Horn†	AB			
Limonius pectoralis LeConte*	AB	SK	MB	
Limonius rufihumeralis Lane	AB			
Limonius subauratus LeConte*		SK	MB	*Limonius anceps* LeConte
Limonius ursinus Van Dyke*	AB	SK	MB	
Tribe Hypnoidini Schwarz				
Ascoliocerus sanborni (Horn)	AB		MB	*Cryptohypnus sanborni*
Hypnoidus abbreviatus (Say)*	AB	SK	MB	*Cryptohypnus abbreviatus, Hypolithus abbreviatus*
Hypnoidus bicolor (Eschscholtz)*	AB	SK	MB	*Cryptohypnus nocturnus bicolor, C. nocturnus* (Eschscholtz)*, Hypnoidus nocturnus*[5]*, Hypolithus bicolor*
Hypnoidus impressicollis (Mannerheim)	AB	SK	MB	*Hypolithus impressicollis*
Hypnoidus leei Stibick	AB			
Hypnoidus rivularius (Gyllenhal)	AB	SK	MB	*Hypnoidus rivularis*
Hypnoidus squalidus (LeConte)	AB			*Hypolithus squalidus*
Ligmargus funebris (Candèze)*	AB			*Hypolithus funebris, Cryptohypnus funebris*
Margaiostus glacialis (Van Dyke)	AB			*Hypolithus glacialis*
Tribe Prosternini Gistel				
Actenicerus cuprascens (LeConte) †		SK	MB	*Ctenicera cuprascens*
Anostirus bipunctatus (Brown) †	AB			*Ctenicera bipunctata*
Corymbitodes dorothyae (Knull)		SK		
*Corymbitodes pygmaeus (Van Dyke)**	AB	SK	MB	*Ctenicera lobata pygmaea, C. pygmaea*
Corymbitodes tarsalis (Melsheimer)		SK		
Ctenicera consors (Brown)[6,7] †	AB	SK	MB	
Ctenicera kendalli Kirby	AB	SK	MB	*Ludius kendalli, Ludius virens* (Schrank)
Ctenicera silvatica Van Dyke[6]	AB			
Eanus albertanus Brown	AB			
Eanus decoratus (Mannerheim)	AB	SK	MB	
Eanus estriatus (LeConte)	AB	SK	MB	
Hadromorphus callidus (Brown)	AB			*Ctenicera callida, Selatosomus callidus*
Hadromorphus glaucus (Germar)*	AB	SK		*Ludius glaucus, Ctenicera glauca, Selatosomus glaucus*
Hypoganus sulcicollis (Say)*		SK	MB	*Ctenicera sulcicollis, Ludius sulcicollis*
Liotrichus crestonensis (Brown)[8]	AB			*Ctenicera crestonensis*
Liotrichus spinosus (LeConte)			MB	*Ctenicera spinosa*
Liotrichus stricklandi (Brown)*	AB	SK	MB	*Ctenicera stricklandi*
Liotrichus umbricolus (Eschscholtz)	AB			*Ctenicera umbricola, Liotrichus umbricola*

Current Name[1]	Distribution			Synonyms[2]
Liotrichus umbripennis (LeConte) [8]	AB			*Ctenicera umbripennis*
Metanomus insidiosus (LeConte)	AB	SK		*Ctenicera lutescens* (Fall)
Nitidolimonius resplendens (Eschscholtz) [9]	AB	SK	MB	*Ctenicera resplendens resplendens*
Nitidolimonius resplendens aeraria (Randall)*[9] †	AB	SK	MB	*Ludius resplendens aerarius, Ctenicera resplendens aeraria*
Oxygonus obesus (Say)*	AB	SK	MB	
Prosternon bombycinum (Germar)	AB			*Ludius bombycinus, Ctenicera bombycina*
Prosternon medianum (Germar)	AB	SK	MB	*Ludius medianus, Ctenicera mediana*
Prosternon viduum (Brown)	AB			*Ludius viduus, Ctenicera vidua*
Pseudanostirus hieroglyphicus (Say)*			MB	*Ludius hieroglyphicus, Ctenicera hieroglyphica*
Pseudanostirus hoppingi (Van Dyke)[8] †		SK	MB	*Ctenicera hoppingi*
Pseudanostirus laricis (Brown) [8] †	AB			*Ctenicera laricis*
Pseudanostirus nebraskensis (Bland)	AB			*Ludius nebraskensis, Ctenicera nebraskensis*
Pseudanostirus nigricollis (Bland)	AB	SK	MB	*Ctenicera nigricollis*
Pseudanostirus ochreipennis (LeConte)	AB	SK	MB	*Ctenicera ochreipennis*
Pseudanostirus propolus columbianus (Brown)	AB			*Ctenicera columbiana* (Brown), *C.propola columbiana*
Pseudanostirus propolus propolus (LeConte)	AB	SK	MB	*Ludius propola propola, Ctenicera propola propola, C. propola*
Pseudanostirus pudicus (Brown)*	AB			*Ludius pudicus, Ctenicera pudica*
Pseudanostirus triundulatus (Randall)	AB	SK	MB	*Ludius triundulatus, Ctenicera triundulata*
Pseudanostirus watsoni (Randall)	AB	SK	MB	
Selatosomus aeripennis aeripennis (Kirby)[10]	AB	SK		*Ludius aeripennis aeripennis, Ctenicera aeripennis aeripennis, C.aeripennis*
Selatosomus aeripennis destructor (Brown)* [10]	AB	SK	MB	*Ludius aeripennis tinctus* LeConte, *L. aeripennis destructor, Ctenicera destructor, C. aeripennis destructor*
Selatosomus appropinquans (Randall)		SK	MB	*Ludius appropinquans, Ctenicera appropinquans*
Selatosomus festivus (LeConte)*	AB	SK	MB	*Ludius cruciatus festivus, Ctenicera pulchra* (LeConte), *C. cruciata* L., *C. festiva, Selatosomus pulcher*[5]
Selatosomus montanus (Brown)	AB			*Ctenicera montana*
Selatosomus morulus (LeConte)	AB	SK	MB	*Ctenicera morula*
Selatosomus semimetallicus (Walker)	AB			*Ctenicera semimetallica*
Selatosomus sexualis (Brown)*	AB	SK		*Ludius sexualis, Ctenicera sexualis*
Selatosomus splendens (Ziegler)	AB	SK	MB	*Ctenicera splendens*
Setasomus aratus (LeConte)	AB	SK	MB	*Ctenicera arata*

Current Name[1]	Distribution			Synonyms[2]
Setasomus nitidulus (LeConte)	AB	SK	MB	*Ludius nitidulus, Ctenicera nitidula, Paraphotistus nitidulus*
Setasomus rufopleuralis (Fall)			MB	*Ludius rufopleuralis, Ctenicera rufopleuralis, Paraphotistus rufopleuralis*
Sylvanelater limoniiformis (Horn)*		SK	MB	*Ludius limoniiformis, Ctenicera limoniiformis*
Sylvanelater mendax (LeConte)	AB	SK		*Ctenicera mendax*
Subfamily Negastriinae Nakane & Kishii				
Fleutiauxellus manki (Fall)	AB			*Negastrius manki*
Microhypnus striatulus (LeConte)*	AB	SK		*Negastrius striatulus*
Migiwa dubius (Horn)*	AB	SK	MB	*Negastrius dubius, Hypnoidus dubius*
Negastrius arnetti Stibick	AB		MB	
Negastrius choris (Say)* †			MB	
Negastrius colon (Horn)	AB			
Neohypdonus gentilis (LeConte)*	AB	SK		*Negastrius gentilis*
Neohypdonus tumescens LeConte*	AB	SK	MB	*Negastrius tumescens*
Oedostethus femoralis LeConte*	AB	SK	MB	
Paradonus obliquatulus (Melsheimer) †	AB			*Negastrius obliquatulus*
Paradonus pectoralis (Say)*	AB	SK	MB	*Negastrius pectoralis*
Subfamily Elaterinae Leach				
Tribe Agriotini Gistel				
Agriotes criddlei Van Dyke*	AB	SK	MB	
Agriotes ferrugineipennis (LeConte)*	AB			
Agriotes fucosus (LeConte)*	AB	SK	MB	
Agriotes limosus (LeConte)	AB	SK	MB	
Agriotes mancus (Say)	AB	SK	MB	
Agriotes opaculus (LeConte)	AB			
Agriotes pubescens Melsheimer		SK	MB	
Agriotes quebecensis Brown			MB	
Agriotes stabilis (LeConte)*		SK	MB	
Agriotes tardus Brown	AB			
Dalopius asellus Brown*	AB	SK		
Dalopius fucatus Brown*	AB			
Dalopius gartrelli Brown	AB			
Dalopius gentilis Brown		SK		
Dalopius inordinatus Brown	AB	SK		
Dalopius insolens Brown	AB			
Dalopius mirabilis Brown*	AB	SK	MB	
Dalopius pallidus Brown*	AB	SK	MB	
Dalopius parvulus Brown*		SK	MB	
Dalopius vagus Brown*		SK	MB	
Dalopius vernus Brown*		SK	MB	

Current Name[1]	Distribution			Synonyms[2]
Tribe Ampedini Gistel				
Ampedus apicatus (Say)* [11]	AB	SK	MB	
Ampedus brevis (Van Dyke)	AB			
Ampedus collaris (Say)			MB	
Ampedus deletus (LeConte)	AB	SK	MB	
Ampedus evansi Brown		SK	MB	
Ampedus fusculus (LeConte)	AB	SK	MB	
Ampedus hoppingi (Van Dyke) †	AB			
Ampedus laurentinus Brown	AB	SK	MB	
Ampedus luctuosus (LeConte)*	AB	SK	MB	
Ampedus melsheimeri (Leng)		SK	MB	
Ampedus miniipennis (LeConte)	AB	SK		
Ampedus mixtus (Herbst)	AB	SK	MB	
Ampedus moerens (LeConte)	AB			
Ampedus molestus (LeConte)			MB	
Ampedus nigricans Germar	AB	SK	MB	
Ampedus nigrinus (Herbst)	AB	SK	MB	
Ampedus oblessus (Say) [12]	AB			
Ampedus occidentalis Lane	AB			
Ampedus pedalis Germar	AB	SK	MB	
Ampedus phelpsi (Horn)	AB			
Ampedus pullus Germar	AB	SK	MB	
Ampedus quebecensis Brown	AB	SK	MB	
Ampedus rubricus (Say)			MB	
Ampedus sanguinipennis (Say) †	AB	SK	MB	
Ampedus sellatus (Leng)* [12]	AB	SK	MB	*Ampedus sellatus* Germar
Ampedus subtilis (LeConte)* †		SK	MB	
Ampedus uteanus (Van Dyke)	AB	SK		
Ampedus varipilis (Van Dyke)	AB			
Tribe Elaterini Leach				
Elater abruptus Say			MB	
Parallelostethus attenuatus (Say) †			MB	
Sericus incongruus (LeConte)	AB	SK	MB	
Tribe Megapenthini Gurjeva				
Megapenthes solitarius Fall	AB			
Megapenthes stigmosus (LeConte)*	AB	SK	MB	
Tribe Melanotini Candèze				
Melanotus castanipes (Paykull)*			MB	
Melanotus leonardi (LeConte)			MB	
Melanotus similis (Kirby)*		SK	MB	*Melanotus fissilis* (Say)
Tribe Physorhinina Candèze				
Anchastus cinereipennis (Eschscholtz)*	AB	SK		

Current Name[1]	Distribution			Synonyms[2]
Tribe Pomachiliini Candèze				
Idolus bigeminata (Randall)[13]		SK	MB	*Agriotella bigeminatus*
Idolus debilis LeConte	AB	SK	MB	*Drasterius debilis; Agriotella debilis*
Idolus occidentalis Brown*	AB			*Agriotella occidentalis*
Subfamily Cardiophorinae Candèze				
Cardiophorus acutus Lanchester	AB			
Cardiophorus brunnipennis Lanchester †	AB			
Cardiophorus cardisce (Say)	AB	SK	MB	
Cardiophorus fenestratus LeConte	AB	SK		
Cardiophorus gagates Erichson			MB	
Cardiophorus kooskooskiensis Lanchester	AB			
Cardiophorus montanus Bland*	AB			
Cardiophorus parvulus LeConte* †	AB			
Cardiophorus pratensus Lanchester	AB			
Cardiophorus propinquus Lanchester[14]	AB	SK	MB	
Cardiophorus pubescens Blanchard* [15]	AB	SK	MB	
Cardiophorus silvanus Lanchester	AB			
Cardiophorus sodalis Lanchester	AB			
Cardiophorus tenebrosus LeConte*	AB	SK	MB	
Cardiophorus tumidicollis LeConte*	AB			
Cardiophorus tutus Lanchester	AB			

1 As they appear in Al Dhafer (2009), Becker (1952, 1979*a*, 1979*b*), Bousquet *et al.* (2013), Brooks (1960), Campbell *et al*. (1989), Douglas (2003), Fuller (2002, 2008), Johnson (2001, 2002), Lane and Lanchester (1971), Majka and Johnson (2008), Quate and Thompson (1967), Stibick (1971, 1975, 1978, 1990), Tarnawski (1996, 2001), Wells (1996), Westcott *et al*. (2006), and Zack (1996).

2 As they appear in Arnett (1952), Bousquet (1991), Bousquet *et al.* (2013), Brooks (1960), Campbell *et al*. (1989), Fuller (2002), Glen *et al*. (1943), Glen (1950), Jewett (1940), King (1928), and Strickland (1935). The scientific authority is given only if it differs from that listed in the first column.

3 Genus does not appear in Johnson (2002).

4 *Limonius lecontei* is not mentioned in Al Dhafer's (2009) revision of North American *Limonius,* but he lists *L. nitidicollis* LeConte as a synonym of *L. consimilis* Walker.

5 Listed as a separate species in Bousquet *et al.* (2013).

6 Species that await renaming (see Table 2).

7 Now considered a *nomen nudum* (see Table 2).

8 Name given in Bousquet *et al.* (2013).

9 *Ctenicera resplendens* was renamed *Nitidolimonius resplendens* in Majka and Johnson (2008), but subspecies are not mentioned in that paper (see Table 2).

10 Zacharuk (1962*a*) and Brooks (1960) considered *Ctenicera (Ludius) aeripennis* and *destructor* as separate species, but Brown (1935*b*), Glen (1950), and Tarnawski (2001) considered them subspecies. The two do not interbreed (Zacharuk 1962*a*).

11 A revision of *Ampedus* is anticipated in the near future.

12 Bousquet *et al*. (2013) list *Ampedus sellatus* Leng as a synonym of *A. oblessus* Say.

13 Until recently in *Agriotella*, but Cate (2007) considers *Idolus* an older synonym for this genus.

14 This species was misidentified as *C. cardisce* by Brooks (1960).

15 Species is not mentioned in Douglas' (2003) revision, but is listed in Brooks (1960).

Confusion may also exist regarding some species of *Limonius* Eschscholtz. Bousquet (1991) listed *L. infuscatus* Motschulsky and *L. ectypus* (Say) as separate species, with *L. infuscatus* occurring only in Alberta, and *L. ectypus* only in Saskatchewan and Manitoba, but Al Dhafer (2009) has recently shown them to be the same species, and they are listed as such in Bousquet et al. (2013).

Table 2. Confusion in taxonomic names resulting from recent revision to *Ctenicera.*

Former Species Name(s)[1]	Reference	New/Alternative Name[1]	Reference	Name Listed in Table 1
C. arata[2]	Brooks (1960)	*Setasomus aratus*	Majka and Johnson (2008)	*Setasomus aratus* (LeConte)
C. bipunctata[2]	Brooks (1960)	*Anostirus bipunctatus*	Majka and Johnson (2008)	*Anostirus bipunctatus* (Brown)
C. callida[3]	Bousquet (1991)	*Hadromorphus callidus, Selatosomus callidus*	Johnson (2002)	*Hadromorphus callidus* (Brown)
C. consors[2,4]	Bousquet (1991)			*Ctenicera consors* (Brown)
C. crestonensis[2,5]	Bousquet (1991)			*Liotrichus crestonensis* (Brown)[6]
C. cruciata L., *C. festiva*, *C. pulcher* (LeConte), *C. pulchra* (LeConte)[7]	Brooks (1960) Bousquet (1991)	*Ludius cruciatus festivus, Selatosomus pulcher*	Glen (1950), Bousquet *et al.* (2013)	*Selatosomus festivus* (LeConte)
C. glauca[3]	Bousquet (1991)	*Hadromorphus glaucus, Selatosomus glaucus*	Johnson (2002)	*Hadromorphus glaucus* (Germar)
C. hoppingi[2,8]	Bousquet (1991)			*Pseudanostirus hoppingi* (Van Dyke)[6]
C. laricis[2]	Bousquet (1991)			*Pseudanostirus laricis* (Brown)[6]
C. montana[9]	Bousquet (1991)	*Ludius montanus*	Brown (1935*b*)	*Selatosomus montanus* (Brown)
C. nigricollis[2]	Brooks (1960)	*Pseudanostirus nigricollis*	Westcott *et al.* (2006)	*Pseudanostirus nigricollis* (Bland)
C. nitidula[10]	Bousquet (1991)	*Setasomus nitidulus, Mosotalesus nitidulus, Paraphotistus nitidulus*	Johnson (2002), Tarnawski (1996, 2001)	*Setasomus nitidulus* (LeConte)
C. resplendens[2,11]	Brooks (1960)	*Nitidolimonius resplendens*	Majka and Johnson (2008)	*Nitidolimonius resplendens* (Eschscholtz)
C. resplendens aeraria[2,11]	Brooks (1960)			*Nitidolimonius resplendens aeraria* (Randall)
C. rufopleuralis[10]	Bousquet (1991)	*Setasomus rufopleuralis, Mosotalesus rufopleuralis, Paraphotistus rufopleuralis,*	Johnson (2002), Tarnawski (1996, 2001)	*Setasomus rufopleuralis* (Fall)

Former Species Name(s)[1]	Reference	New/Alternative Name[1]	Reference	Name Listed in Table 1
C. silvatica[2]	Bousquet (1991)			*Ctenicera silvatica* (Van Dyke)
C. umbripennis[2]	Bousquet (1991)			*Liotrichus umbripennis* (LeConte)[6]
C. sjaelandica and *C. viridis* (Say)[12]	Bousquet (1991)	*Ludius sjaelandicus*	Glen (1950)	*Actenicerus sjaelandicus* (Müller)

[1] Scientific authority is given only if it differs from that listed in the last column.

[2] Not found in Tarnawski's revisions (1995, 1996, 2001).

[3] Tarnawski (1996, 2001) placed this species in *Selatosomus (Hadromorphus)*.

[4] *C. consors* is not found in either Glen (1950) or Brooks (1960) and is considered a *nomen nudum* (invalid) by Fuller (2002).

[5] *C. crestonensis* occurs in Brown's *"volitans"* group (Brown 1935*c*), which Johnson moved to *Liotrichus*.

[6] Name given in Bousquet *et al.* (2013).

[7] Brown (1935*a*) and Brooks (1960) list *pulcher, festiva,* and *cruciata* as three subspecies of *Ludius (Ctenicera) cruciata* (for eastern Canada, western Canada, and Europe, respectively). Tarnawski (2001) lists these three as separate species. The species is listed as *Selatosomus festivus* in Tarnawski (1996). Bousquet *et al.* (2013) list both *S. festivus* and *S. pulcher* for the Prairie Provinces.

[8] *C. hoppingi* belongs to Brown's "*propola"* group of *Ctenicera* (Brown 1936*d*), which Johnson (2002) placed in *Pseudanostirus*.

[9] Should not be confused with some other species in the same subfamily, e.g., *Actenicerus montanus* (Kishii), *Oxygonus montanus* Schaeffer, or *Ctenicera montanus* Vats & Chauhan 1992.

[10] This species was placed in *Mosotalesus (Setasomus)* by Tarnawski (1996) and in *Paraphotistus (Setasomus)* by Tarnawski (2001).

[11] Subspecies not covered in Majka and Johnson (2008).

[12] The correct name for this species remains uncertain. It was thought by Brooks (1960) to be the same as *C. cuprascens* LeConte—which is not listed in Bousquet (1991) and which is now known as *Actenicerus cuprascens*. Cate (2007) also considers *A. cuprascens* a synonym for *A. sjaelandicus.* Tarnawski (1996) considered both *Corymbites (Elater) micans* (Germar) and *Co. cuprascens* (LeConte) as synonyms of *A. sjaelandicus*. Majka and Johnson (2008) consider *A. micans* and *A. cuprascens* the only names available to North American species, and it remains to be determined which of these names will end up being ascribed to this Prairie Province species.

Elaterid Classification

The family Elateridae is infamous "for its unstable and even chaotic subfamilial and tribal classifications" (Calder *et al*. 1993: 1349), something that has frustrated elaterid specialists (e.g., Arnett 1952; Becker 1979*a*), as it leads to repeated (sometimes reversible, e.g., Arnett 1952 vs. 1953) name changes (see Tables 1 and 2 for examples with Nearctic *Ctenicera* and *Hypnoidus* species; other examples occur in *Pheletes* Kiesenwetter (*Limonius*), *Crypohypnus* (*Hypolithus, Hypnoidus, Negastrius*), *Ludius* (*Ctenicera*), *Asaphes* Kirby (*Hemicrepidius* Germar), *Lepturoides* Herbst (*Denticollis* Piller and Mitterpacher), and others). Older names often persist in the literature, and multiple names are sometimes used for the same species. As name changes sometimes occur in studies of regional fauna and/or are introduced without comment, they are easy to miss. It would be useful for authors to mention older synonyms of recently renamed species discussed in their publications.

Elaterid classification is challenged by the family's species richness and high incidence of homoplasy, and, particularly in the past, by the characters and life stage that formed the basis of the classification system (Calder *et al.* 1993). Classifications have been based on adult characters only (e.g., those of ECA Candèze, EA Schwarz) (Gur'yeva 1969) or on larval characters (e.g., Hyslop 1917; Böving and Craighead 1931; Ôhira 1962; Becker 1991), but separate use of larval and adult characters produced contradictions (Gur'yeva 1969). Therefore, elaterid systematists began to consider both larval and adult characteristics (Crowson 1960; Stibick 1979). However, Stibick's system appears to have found limited acceptance, and recent classifications and phylogenies based on morphological characters appear to focus almost exclusively on adult characters (e.g., Douglas 2011*a*).

The classification we follow in Table 1 is that of Bouchard *et al*. (2011), as this is the most recent classification and was used for other lists of elaterids in Canada (see Webster *et al*. 2012; Bousquet *et al.* 2013). Bouchard *et al*. (2011) differ from Johnson (2002) and Majka and Johnson (2008) in that Johnson's subfamily Prosterninae becomes Dendrometrinae; Johnson's tribes Athoini (Athouini) and Pityobiini become tribe Dendrometrini and subfamily Pityobiinae; and (in Elaterinae) Johnson's subtribes Pomachiliina, Melanotina, and Physorhinina become tribes Pomachiliini, Melanotini, and Physorhinini, respectively. All genera listed in Table 1 are found in Johnson (2002) and Majka and Johnson (2008), with the exception of *Harminius* Fairmaire, which we included because *H. triundulatus* (Mannerheim) was recognized by Becker (1979*a*).

Distribution of Economic Species

The distribution of elaterids in the Prairie Provinces is based on reports of pest species because these account for virtually all that is known about elaterid species distributions and because some species tend to be pests wherever they are found. Our list of current and past pest species follows reports from King (1928), Strickland (1935), Glen *et al*. (1943), Brooks (1960), Zacharuk (1962*a*), Burrage (1964), Doane (1977*a*), and Campbell *et al*. (1989). The reports by Brooks (1960) and Campbell *et al*. (1989) are themselves largely based on those of Glen *et al*. (1943).

The species of economic importance in the Prairie Provinces can be divided into two categories—species that are widespread and frequently pests, and species that are incidental pests and/or pests in a small geographical region (Table 3). In addition, a number of species are reported in the literature as pests that are probably rarely, if ever, pests today (Table 3). We determined pest status by comparing historical reports (Strickland 1927, 1935; King 1928; Arnason 1931; Glen *et al*. 1943) with more recent reports (Brooks 1960; Zacharuk 1962*a*; Burrage 1964; Doane 1977*a*, 1977*b*; Campbell *et al.* 1989) and our own recent surveys (see the section "Surveys" below).

The most important pest species in Alberta and Saskatchewan remains *Selatosomus aeripennis destructor* (Brown), the main wireworm pest in western Canada from the 1920s to the 1970s (Campbell *et al*. 1989). This species is abundant across the Prairie Provinces and injurious to many crops (Table 3) on well-drained light and medium soils of open grasslands and occasionally on irrigated sandy soil. The second important pest species is the much smaller *Hypnoidus bicolor* (Eschscholtz) (Fig. 1), which generally co-occurs with *S. a. destructor* and *S. a. aeripennis* (Kirby) (which is morphologically similar to *S. a. destructor*). *Hypnoidus bicolor* can also be a serious pest of cereals (Campbell *et al*. 1989), and it is likely that the importance of this species is often underappreciated because of its small size (King 1928) and resemblance to early instars of *S. a. destructor* (Fig. 1). The relative importance of this pest likely depends on the crops affected, as it may affect some crops more than expected from its abundance. For example, Burrage (1963) found approximately 60 times as many *S. a. destructor* as *H. bicolor* in studies of weekly wireworm activity in potato tubers during the summers of 1959–1961 in Saskatoon, despite

Table 3. Elaterid species reported as pests in Alberta (AB), Saskatchewan (SK), and Manitoba (MB).

Species	Crops Affected	Area Where Reported as Pests	Comment
Predominant Pest Species			
Hypnoidus bicolor (Eschscholtz)	Cereals, potato, most field and garden crops	AB, SK, MB	Co-occurs with both *Selatosomus aeripennis destructor* and *S. a. aeripennis*
Selatosomus aeripennis destructor (Brown)	Cereals, corn, potato, sugar beet, field-grown vegetables, ornamental plants	AB, SK, MB	
Species of Lesser or More Regional Importance			
Aeolus mellillus (Say)	Cereals	Southern AB, SK, MB	Also found on irrigated land, with *S. a. destructor* and *H. bicolor*
Agriotes criddlei Van Dyke	Cereals	Southern AB, southwestern SK	Also found on irrigated land
Agriotes mancus (Say)	Cereals, corn, potato, strawberry, field-grown vegetables	Southeastern SK, MB	
Hypnoidus abbreviatus (Say)	Field-grown vegetables	SK, MB	
Limonius californicus (Mannerheim)	Cereals, corn, potato, sugar beet, field-grown vegetables	Southern AB, SK, MB	Probably Glen *et al.*'s (1943) *Limonius 'near ectypus'* Found on irrigated land
Limonius canus LeConte	Cereals, potato, sugar beet, field-grown vegetables	Southern AB	
Limonius pectoralis LeConte	Cereals		Only in black soils, occasionally a serious pest
Selatosomus aeripennis aeripennis (Kirby)	Cereals, corn, sugar beet, field-grown vegetables, ornamental plants	AB, SK, MB	
Hadromorphus glaucus (Germar)	Cereals	Southern AB	
Species That Are Rarely or Not Likely Pests			
Agriotes ferrugineipennis (LeConte)			Occasional pest in British Columbia; not a pest in the Praire Provinces
Agriotes limosus (LeConte)		Northern SK	
Ctenicera kendalli Kirby		Northern SK	On previously uncultivated land
Dalopius pallidus Brown		AB	
Dalopius parvulus Brown	Cereals	SK, MB	On previously uncultivated land
Dalopius mirabilis Brown	Cereals	SK, MB	
Hemicrepidius nemnonius (Herbst)	Field-grown vegetables	AB, SK, MB	
Limonius aeger LeConte			Occasional pest in Quebec; not a pest in the Praire Provinces
Migiwa dubius (Horn)		AB, SK, MB	
Oestodes puncticollis Horn	Cereals	AB, SK	
Selatosomus morulus (LeConte)			Often found with *S. a. aeripennis*
Selatosomus sexualis (Brown)		AB, SK	In areas with native grasses
Sylvanelater limoniiformis (Horn)		SK	

the two species occurring in a 3:1 ratio, respectively. Similarly, Stewart (1949) collected only larvae of *S. a. destructor* from potato plants and tubers in a field containing both species, suggesting that larvae of *H. bicolor* are not strongly attracted to potatoes. The feeding preferences and behaviours of the two species are known to differ (Doane 1981), but while both are serious pests of wheat, larvae of *S. a. destructor* can destroy 3–10 times as many seeds as larvae of *H. bicolor* (Arnason 1931; Zacharuk 1962*b*). In addition, early instar *S. a. destructor* larvae (which are the same size as late instar *H. bicolor*) were found to be as destructive to wheat seeds as late instars because of their mode of attack (King *et al*. 1933).

Species that are of lesser or more regional importance (Table 3) include *Aeolus mellillus* (Say), *Agriotes criddlei* (Van Dyke), *A. mancus* (Say), *Hadromorphus glaucus* (Germar), *Hypnoidus abbreviatus* (Say), *Limonius californicus* (Mannerheim), *L. canus* LeConte, *L. pectoralis* LeConte, and *S. a. aeripennis*. Species that are reported as pests and are found on agricultural land, but are rarely, if ever, pests today (Table 3) include *Agriotes limosus* (LeConte), *Ctenicera kendalli* Kirby, *Dalopius pallidus* Brown, *Dalopius parvulus* Brown, *Dalopius mirabilis* Brown, *Hemicrepidius nemnonius* (Herbst), *Migiwa dubius* (Horn), *Oestodes puncticollis* Horn, *Selatosomus morulus* (LeConte), *S. sexualis* (Brown), and *Sylvanelater limoniiformis* (Horn). Some species are likely not pests in Alberta, Saskatchewan, and Manitoba, though they are apparently pests elsewhere, including *Limonius aeger* LeConte and *Agriotes ferrugineipennis* (LeConte) (Table 3).

Surveys

The largest surveys of elaterids in the Prairie Provinces since Glen *et al*. (1943) were done by Zacharuk (1962*a*), Burrage (1964), and WvH and RSV (unpublished data). Zacharuk compiled all the distribution records of *Selatosomus aeripennis aeripennis* and *S. a. destructor* (i.e., those of A.R. Brooks, W.J. Brown, and R. Glen), which he considered to be separate species. Zacharuk reported both subspecies for Alberta, Saskatchewan, and Manitoba, and noted that *S. a. destructor* also occurs in North and South Dakota and Minnesota and that *S. a. aeripennis* occurs in British Columbia, the Northwest Territories, Alaska, Washington, Oregon, and Wyoming (Zacharuk 1962*a*). There appears to be little overlap of the two subspecies, except in the Peace River area.

Fig. 1. Late instar larvae of *Selatosomus aeripennis destructor* (top) and *Hypnoidus bicolor*, the two most important pest species of the Canadian Prairie Provinces.

Burrage (1964) surveyed wireworm damage in grain crops in Saskatchewan by monitoring 200–500 fields per year from 1954 to 1961. Damage was largely contained in the western two-thirds of the province in the brown and black soil zones, confirming 1922–1927 surveys by King (1928). Burrage (1964) attributed the damage he observed to *S. a. destructor* and noted more damage (i.e., stand reduction) in wheat than in barley and oats. He noted this trend regardless of soil type.

We have also been surveying wireworm species causing crop damage across Canada since 2003 on the basis of samples and relevant soil and cropping data collected by provincial entomologists, agronomists, and field scouts of Syngenta Crop Protection and Bayer CropScience in fields where damage occurred. In 2010 alone, this survey returned 176 samples (>1600 larvae) from 96 sites across Alberta, Saskatchewan, and Manitoba (Fig. 2A). The most prevalent species associated with crop damage were *H. bicolor* (70% of larvae), *S. a. destructor* (13%), and *Limonius californicus* (6%) (Fig. 2B and C). Few larvae of *Aeolus mellillus* (0.2%) and *Dalopius* spp. (1.7%) were collected. These data, and those from other years (not shown), suggest that the identity and distribution of the species of greatest importance, *H. bicolor* and *S. a. destructor,* have changed little (except, perhaps, in relative proportions) since earlier reports (e.g., Strickland 1935; Glen *et al*. 1943; Zacharuk 1962*a*). Past reports suggest *S. a. destructor* was more predominant than *H. bicolor* (e.g., 50.3 and 46.7%, respectively: Clavet, Saskatchewan, wheat field; 65.5 and 29.9%, respectively: sod field borders; Doane 1977*b*; 58 and 34%, respectively: Saskatoon grassland; Stewart 1949; 62 and 30%, respectively: Swift Current, Saskatchewan, potato field; Willard 1973). In all three reports the other larvae found were *Aeolus mellillus* and *L. californicus*.

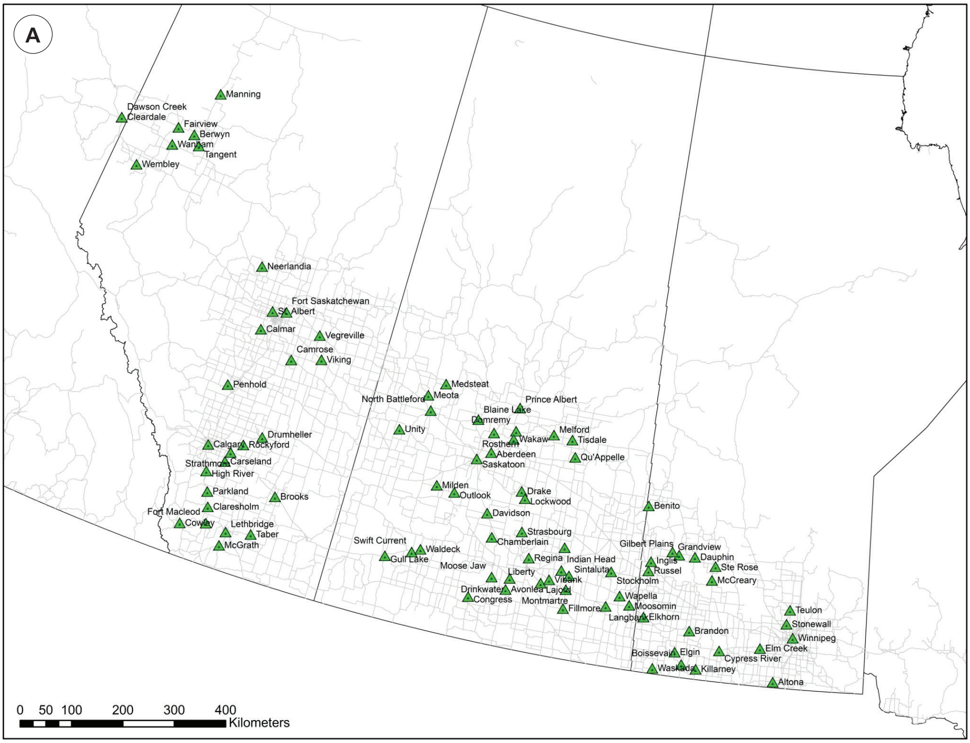
Grassland Species

The most complete treatment of species distribution in grassland remains that of Brooks (1960), who summarized all information available at the time. He divided southern Alberta, Saskatchewan, and Manitoba into nine bio-ecological regions and associated species with a specific region if they were present exclusively in that region, or if they were generally and widely distributed in a region and only occasionally appeared elsewhere. Brooks' division of the prairie grasslands into four regions, and their associated elaterid species, are listed in Table 4, along with records published since 1960.

Biogeographical Aspects

The distribution of wireworm species across Alberta, Saskatchewan, and Manitoba is affected by soil moisture and type. *Aeolus mellillus* appears to prefer drier soils, but is also found in irrigated fields (Glen *et al*. 1943). In Alberta and Saskatchewan, *Limonius californicus* is commonly found on irrigated land, but generally not on dry land (WvH and RSV, unpublished data). Similarly, the distribution of *Agriotes mancus* and *Melanotus* spp. appears to be governed by moisture (Glen *et al*. 1943); large numbers of *A. mancus* have been collected in Manitoba from fields with very different soil types, and *Melanotus* spp. are found in the Prairie Provinces only in the heavy clay soils of the Red River Valley and along Manitoba river bottoms (Glen *et al*. 1943). Soil type appears to determine the distribution of *Limonius pectoralis,* which is found only in the black soil regions (Glen *et al*. 1943), and of *Hypnoidus bicolor*, which is most abundant in areas with heavy soil, in grassy areas, and in fields removed from sod (Glen *et al*. 1943).

The effect of soil type on species distribution is most striking in its separation of the two subspecies of *S. aeripennis*. *Selatosomus aeripennis destructor* is found in the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Neerlandia
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Penhold
Drumheller
Rockyford
Carseland
High River
Parkland
Claresholm
Brooks
Fort Macleod
Lethbridge
Taber
McGrath
Medsteat
North Battleford
Meota
Prince Albert
Blaine Lake
Unity
Melford
Tisdale
Aberdeen
Saskatoon
Qu'Appelle
Milden
Outlook
Drake
Lockwood
Davidson
Strasbourg
Chamberlain
Swift Current
Waldeck
Gull Lake
Moose Jaw
Regina
Indian Head
Liberty
Drinkwater
Congress
Montmartre
Fillmore
Stockholm
Wapella
Moosomin
Elkhorn
Benito
Gilbert Plains
Grandview
Dauphin
Inglis
Russel
Ste Rose
McCreary
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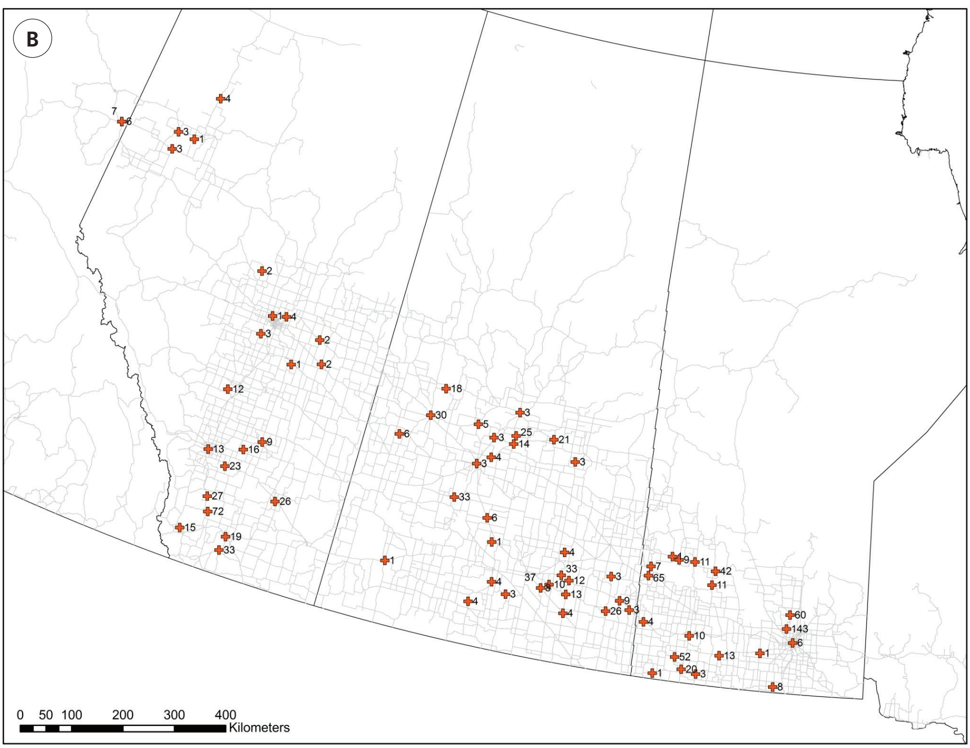
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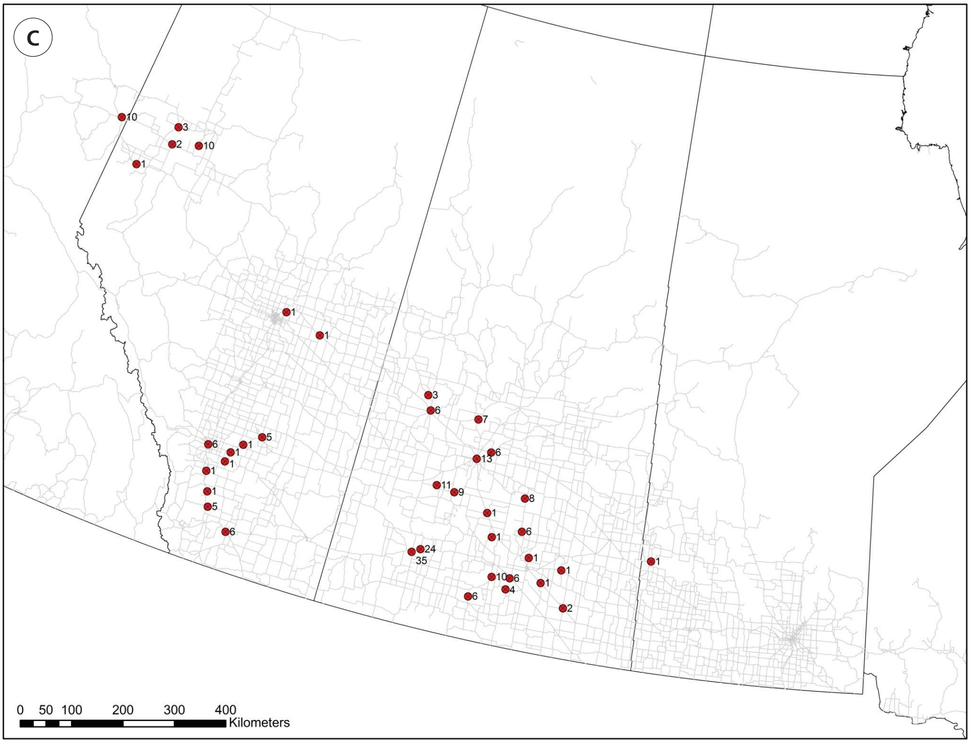

Fig. 2. Location of wireworm samples collected in 2010 to identify species of economic importance in Alberta, Saskatchewan, and Manitoba, and distribution of the two predominant species, *Selatosomus aeripennis destructor* and *Hypnoidus bicolor*. A, Locations from which wireworms were collected. B, Locations from which larvae of *Hypnoidus bicolor* were collected. Numbers beside markers indicate number of specimens collected. C, Locations from which larvae of *Selatosomus aeripennis destructor* were collected. Numbers beside markers indicate number of specimens collected.

Brown, Dark Brown, and Black Chernozemic soils of the Mixed Grassland Ecoregion, Moist Mixed Grassland Ecoregion, and grassland parts of Aspen Parkland Ecoregion, whereas *S.a. aeripennis* is found in the Dark Gray Chernozems of the more woody areas of the Aspen Parkland Ecoregion and in the soils of the Boreal Plains Ecozone (Zacharuk 1962*a*; Shorthouse 2010). The two subspecies apparently do not mix even in the transition zone between the soil types (Zacharuk 1962*a*). Highest densities of *S. a. destructor* larvae were found in friable, poorly leached clay and silty loam soil sites, whereas larvae of *S. a. aeripennis* were taken from loose light loam and sand/clay soils. These soil preference differences may be one mechanism that separated the two subspecies, particularly because larvae of *S. a. aeripennis* apparently do not survive in prairie soil (Brooks 1960).

Intraspecies Diversity

The large geographical distribution of some species has, not surprisingly, led to considerable within-species genetic variability. Analysis of the mitochondrial 16S rRNA of wireworms collected in our 2010 survey revealed genetic variability related to geographical location for *L. californicus* and *H. bicolor*, within-species variability at a particular location for some species (e.g., *Aeolus mellillus*) but not others (e.g., *Agriotes criddlei*, *A. stabilis* (LeConte)), and cryptic species within *H. bicolor*. This analysis also confirmed that *S. a. aeripennis* and *S. a. destructor* were genetically similar, as expected by their subspecies designations (Benefer *et al*. 2013). As some elaterid species with a large geographical distribution have pheromone variants (Yatsynin *et al*. 1996; Vernon and van Herk 2012), it would be useful to determine if the different haplotypes of the predominant Prairie Province species (e.g., *H. bicolor*) respond differently to pheromone extracts and how this might affect attempts to manage pest species.

Table 4. Elaterid species associated with grassland regions of the Canadian Prairie Provinces, as summarized by Brooks (1960) and with additions from Fuller (1992).

Region(s)[1]	Description	Species
True Prairie, Eastern Parkland (Lake Manitoba Plain, Tallgrass Prairie, parts of Aspen Parkland)	South and west of Manitoba's forested region, and a few kilometres into eastern Saskatchewan, following the Souris, Qu'Appelle, and Assiniboine river valleys	*Pseudanostirus hieroglyphicus* (Say), *Hypoganus sulcicollis* (Say), *Limonius subauratus* LeConte, *Hemicrepidius brevicollis* (Candèze), *Melanotus castanipes* (Paykull), *Melanotus similis* (Kirby), *Agriotes mancus* (Say), *Agriotes stabilis* (LeConte), *Dalopius vernus* Brown, *Dalopius vagus* Brown, *Oxygonus obesus* (Say)
Mixed Prairie (Mixed Grassland, Moist Mixed Grassland)	The brown and dark-brown soil zones of southern Alberta and Saskatchewan, extending into southwestern Manitoba along the Souris, Qu'Appelle, and Assiniboine river valleys	*Selatosomus aeripennis destructor* (Brown), *Selatosomus sexualis* (Brown), *Hadromorphus glaucus* (Germar), *Hypnoidus bicolor* (Eschscholtz), *Limonius californicus* (Mannerheim), *Limonius lanei* Van Dyke, *Hemicrepidius nemnonius* (Herbst), *Hemicrepidius carbonatus* (LeConte), *Anchastus cinereipennis* (Eschscholtz), *Conoderus auritus* (Herbst), *Aeolus mellillus mellillus* (Say), *Paradonus pectoralis* (Say), *Negastrius choris* (Say), *Migiwa dubius* (Horn), *Oestodes puncticollis* Horn, *Dalopius pallidus* Brown, *Agriotes criddlei* Van Dyke, *Cardiophorus tenebrosus* LeConte
Submontane Parkland (Fescue Grassland, Cypress Upland)	Southwestern Alberta adjacent to the montane and southern subalpine forest regions, mostly localized in river valleys. Also extending eastward along the South Saskatchewan river valley, and in the Cypress Hills and Wood Mountains areas of southern Saskatchewan	*Pseudanostirus pudicus* (Brown), *Ligmargus funebris* (Candèze), *Limonius ursinus* Van Dyke, *Limonius canus* LeConte, *Athous nigropilis* Motschulsky, *Neohypdonus gentilis* (LeConte), *Microhypnus striatulus* (LeConte), *Dalopius fucatus* Brown, *Dalopius insolens* Brown, *Agriotes ferrugineipennis* (LeConte), *Idolus occidentalis* Brown, *Cardiophorus pubescens* Blanchard, *Cardiophorus tumidicollis* LeConte, *Cardiophorus montanus* Bland
Northern Parkland (Aspen Parkland)	A broad belt adjacent to the western boreal forest. Also in isolated islands within the Mixed Prairie and Submontane Parkland regions (i.e., in the Cypress Hills, Wood and Moose mountains, Great Sand Hills, and Elbow Forest Reserve areas) and within forested regions (i.e., in the Peace River and Wood Buffalo National Park areas)	*Corymbitodes pygmaeus* (Van Dyke), *Liotrichus stricklandi* (Brown), *Selatosomus festivus* (LeConte), *Nitidolimonius aeraria* (Randall), *Sylvanelater limoniiformis* (Horn), *Hypnoidus abbreviatus* (Say), *Limonius aeger* LeConte, *Limonius pectoralis* LeConte, *Oedostethus femoralis* LeConte, *Neohypdonus tumescens* LeConte, *Dalopius asellus* Brown, *Dalopius mirabilis* Brown, *Dalopius parvulus* Brown, *Agriotes fucosus* (LeConte), *Megapenthes stigmosus* (LeConte), *Ampedus sellatus* (Leng), *Ampedus apicatus* (Say), *Ampedus luctuosus* (LeConte), *Ampedus subtilis* (LeConte), *Pityobius anguinus* LeConte, *Harminius triundulatus* (Mannerheim)

[1] Names in parentheses are the closest corresponding grassland ecoregions from Shorthouse (2010: 55).

Life Histories and Seasonal Activity

Despite the volume of literature published on wireworms and click beetles, the life history of all but a few species remains poorly understood. Previous research indicates that life histories vary considerably and that there exists no "typical" life history of elaterids (Vernon and van Herk 2012). Instead we discuss the life histories of five economically important and morphologically distinct species found in the Prairie Provinces. Attention is also given to the seasonal activity of some species, as this has been the subject of extensive research and has profound implications for wireworm sampling and management.

Life Histories

Aeolus mellillus

The life history of this species is highly flexible (Jewett 1942), with one generation per year in Canada (Stirrett 1936) and two generations farther south (i.e., Kentucky; Jewett 1942), where the species overwintered in both adult and larval form and the entire life cycle could be completed in 53 days under favourable circumstances (Jewett 1942). Overwintering adults oviposited from mid-May to mid-September (in Kentucky), overwintered larvae pupated in spring, and new adults began ovipositing shortly thereafter. Eggs laid in spring may develop into larvae that pupate in July and produce eggs in August and September, but no oviposition was recorded when pupation occurred in August or later (Jewett 1942). Only a parthenogenetic form of *A. mellillus* is known in Canada (Glen *et al*. 1943). Parthenogenicity was first suspected by Stirrett (1936), who collected only female beetles, and confirmed by Jewett (1940). Jewett observed that parthenogenic beetles laid 18 eggs on average over 14 days, the eggs hatching in 7–18 days (Jewett 1940, 1942). If these data are representative of the fecundity of *A. mellillus* in Canada, it partially explains why the species occurs in low numbers alongside other species that occupy the same dry grassland habitats (*S. a. destructor* and *H. bicolor*).

Aeolus mellillus adults became active in late May in Canada, reached peak activity between mid-June and mid-July, and declined in activity by late August (Doane 1977*b*). Activity levels were measured primarily by walking behaviour, but Doane (1977*b*) noted that dispersion of females by flight increased toward the end of the summer. Doane's (1977*b*) observation that females flew farther to lay eggs as the season progressed is similar to those of Begg (1957, 1962) on *Limonius agonus* (Say). It is noteworthy that *A. mellillus* larva are notoriously predaceous and their activity noticeably greater than that of most wireworms (Glen *et al*. 1943), a tendency that may help the species reduce populations of the other pest species (Doane 1977*b*). It is also of interest that *A. mellillus* apparently attacks cereals differently than other species, attacking plants at the soil surface and cutting stems off completely rather than boring into and shredding wheat stems (Glen *et al*. 1943). Finally, two subspecies of *A. mellillus* are reported for the grasslands area (Table 1), but it is unknown whether these life history observations apply equally.

Agriotes mancus

The life history of this species is known from the work of Comstock and Slingerland (1891), Hawkins (1936), Rawlins (1940) (in New York and Maine), and Lafrance (1967) (Quebec). The similarity between these reports suggests that the life history they describe for *A. mancus* is likely representative of its life history in Manitoba and also similar to that of *A. obscurus* and *A. lineatus* L. (the introduced species that are important pests in parts of British Columbia and eastern Canada; Vernon and van Herk 2012). Lafrance (1967) reared *A. mancus* in outdoor cages from 1961 to 1965 at Ste. Clotilde, Quebec, and determined that the species had a four-year life cycle. After spending three years as larvae, the species pupated in late summer and overwintered in their pupal cells as adults (2.5–17 cm deep in southwestern Quebec). Beetles emerged in early May when soil temperatures reached 2–10 °C (Lafrance 1967). Adults of both sexes are relatively inactive compared with other elaterids and are not active fliers, but flight attempts have been observed on very warm days (Rawlins 1940; Lafrance 1967).

Beetles mated soon after emergence, provided the air temperature was between 14 and 27 °C, and oviposition began mid-June, peaked in late June, and lasted for up to 44 days (Lafrance 1967). Up to 194 eggs were laid in the top few centimetres of soil (Lafrance 1967). In New York, the average fecundity of *A. mancus* was 105 eggs, with some beetles laying up to 176; eggs were laid either singly or in groups (Rawlins 1940). Eggs hatched after three to four weeks and neonate larvae grew to only 6 mm long in their first year. Neonate larvae remained in the top 15 cm of soil, moved deeper when the soil dried out in mid-summer, migrated back to the soil surface in September to feed, and again moved down when the soil began to freeze (Rawlins 1940; Lafrance 1967). In their second year, during which most growth occurred, larvae moulted in May–June and again in August–September. First-year larvae were susceptible to starvation, but those in their second and third years could remain alive without living plants for at least two years, during which time little change in larval size occurred (Rawlins 1940). Most larvae pupated in mid-July (in Quebec) in their third year, when larvae were 15–22 mm long, but many required one or two additional years (Rawlins 1940; Lafrance 1967).

Hypnoidus bicolor

This species has both parthenogenetic and sexual forms in Canada, the former occurring in the northern and western (Aspen Parkland) parts of Saskatchewan with *S. a. aeripennis*, and the latter found with *S. a. destructor* (Zacharuk 1958*a*). Equal numbers of male and female beetles were collected at various places in the Mixed Grassland Ecoregion in Saskatchewan, and they mated readily with each other, though it was not determined if mating was required for oviposition. Higher numbers of females than males were found in areas where the two forms overlapped (e.g., Lethbridge, Alberta) (Zacharuk 1958*a*). Adults reared from larvae of the parthenogenetic form were all female and laid viable eggs.

In southern Saskatchewan, adults of *H. bicolor* generally became active later in the season than those of *S. a. destructor*, laid fewer eggs per batch and in total, and lived longer (Doane 1977*a*). Adult males were found on the soil surface from late April to early August in Saskatchewan (Doane 1961), and in spring were often found crowding together in tight groups of up to 15 under stones, lumps of dirt, and pads of dried cow manure, or without any cover at all (Doane 1963). Mark-release-recapture studies indicated that female beetles disperse as quickly by walking as males, and unlike *S. a. destructor*, fly readily (Doane 1963, 1977*a*). The flight activity of females is not thought to be related to the amount of eggs carried (as with *Aeolus mellillus*), for flight begins soon (one to five weeks) after emergence (Doane 1963).

The larval period of *H. bicolor* is thought to be two to three years, but longer under adverse conditions (King *et al*. 1933). *Hynoidus bicolor* larvae were more active (King *et al*. 1933) and more aggregated in the field (Doane 1977*a*) than larvae of *S. a. destructor*.

Limonius californicus

This species, described as a pest new to Alberta in the 1950s (MacNay 1954), occurs normally in low numbers alongside *S. a. destructor* and *H. bicolor* in fields in Alberta and Saskatchewan, particularly along sod borders (Doane 1977*b*). Nearly all we know about the life history of this species comes from studies done in California (Stone 1941), and it is likely that emergence and seasonal activity data will be somewhat different for the Prairie Provinces.

In California, larvae of *L. californicus* passed through 10–13 instars and completed their development in two (72%) or three (19%) years (Stone 1941). Pupation occurred from June to October, 25 cm deep in the soil, and lasted approximately 21 days. Adults left pupal cells one to two months before emergence in spring to begin moving to the surface. Males and females emerged in similar numbers, males appearing several days before females. Females mated as soon as they emerged, and males sometimes mated repeatedly with the same female. Mating was seldom observed on cool, cloudy, rainy, and/or windy days. Oviposition began approximately eight days after mating (range 3–20) and lasted for an average of 31 days (range 7–75). Most eggs were laid in the first week of ovipositing, but the oviposition rate was highly influenced by temperature. Females produced an average of 268 eggs (range 51–704), but some died before completing oviposition. After mating, males lived approximately 30 days (range 2–91) and females 46 days (range 21–81). As with other species, the adult life duration can be extended under cold conditions (Stone 1941; van Herk *et al.* 2008*a*). Stone (1941) took adults that emerged in March, stored them at 4.5 °C until early September, and observed them to mate and lay viable eggs when they were returned to room temperature.

Selatosomus aeripennis destructor

Larvae of *S. a. destructor* pupated in late July and August, after 9–11 larval instars, and (in Saskatoon) overwintered less than 10 cm deep in the soil as adults (Zacharuk 1962*a*; Doane 1977*a*). The pupal cell is created in firm, moist soil by the pre-pupa's continuous rotation (Strickland 1939; Zacharuk 1962*a*), which is similar to that observed for *A. obscurus* and *L. canus* (WvH, pers. obs.). Males apparently pass through fewer larval instars than females, and their instar duration may be longer (Zacharuk 1962*a*). Males also need a longer post-eclosion time to become sexually mature (Zacharuk 1958*b*, 1962*a*). Adults emerged in late April and May, when the soil temperature reached 10 °C (Strickland 1935, 1939; Zacharuk 1962*a*). After emergence, adults immediately located a mate, apparently following chemical cues produced only by unmated females, and copulated for 10–25 minutes; neither sex mated more than once, and matings of less than 15 minutes did not produce viable eggs (Zacharuk 1958*b*, 1962*a*). Males were active as soon as they emerged, but died one to three weeks after mating (Zacharuk 1962*a*; Doane 1977*a*). Females remained hidden in soil cracks until they began to oviposit 7–16 days after mating, generally in mid-May to mid-June (Zacharuk 1962*a*; Doane 1977*a*). Oviposition continued for 1–22 days (Zacharuk 1962*a*), and female activity increased after most of their eggs were laid (Doane 1961) and persisted until late July (Doane 1977*a*). The sexes differed in their walking speed on the soil surface; males walked 110 m or more in one day, a distance that females needed nine days to reach (Doane 1963). Neither Doane (1963) nor Zacharuk (1962*a*) observed either sex in flight, though Zacharuk (1962*a*) and Strickland (1935) did report flight for female *S. a. aeripennis*. Strickland (1935) observed a male (but no female) *S. a. destructor* in flight in Alberta, and from his observations concluded that females oviposit near their site of emergence.

Reports vary with respect to oviposition, from an average of 180 eggs (up to 480) (Zacharuk 1962*a*) to 350 eggs (up to 407) (Strickland 1927), with Doane (1963) reporting averages of 160–950 eggs (up to 1,400) in various other studies. All three authors report that oviposition typically followed an interrupted pattern of several days of laying, followed by several days of not laying, repeated several times. Eggs were laid in batches of a few to several hundred, usually under soil lumps or other places where there was sufficient soil moisture, sometimes up to 15 cm deep (Doane 1967, 1977*a*). Many females die before laying all their eggs (Strickland 1939). Eggs hatch after three to four weeks, and soil moisture is important for survival, as eggs absorb water from the soil a few days after oviposition (Doane 1966, 1977*a*).

Larvae are thought to moult twice in their first year (Strickland 1939). Early instar larvae feed on root hairs and fungal mycelia, whereas later instars attack seeds (Zacharuk 1962*a*). Growth of individual larvae can vary: Strickland (1927) found some larvae that were twice the size of others of the same age by the end of the second year of development. The larval period lasted an average of three years (Campbell *et al*. 1989), but late instar larvae could delay pupation by a year or more (King *et al*. 1933). Strickland (1942) reported that the larval stage varied from three to four (considered normal) to 11 or more years and that larvae could decline in size despite availability of food, moulting up to 24 times (Strickland 1939). Zacharuk (1962*a*) observed similar regressive moulting in the laboratory, with repeated moulting over several weeks and reduction in size with each moult until death, though certain body parts such as mouthparts did not change. Doane (1977*a*) observed that there are no reliable characters that can be used to separate the larval stadia (e.g., head capsule width or body length) and that the overlapping generations present in a field at any time are indistinguishable except for relative size.

Seasonal Movements of Larvae

Wireworm seasonal movement in soil appears to be largely the result of three factors: wireworm feeding and moulting cycles, soil moisture, and soil temperature (though soil texture and cultivation practices likely affect the ability of wireworms to move as well). Some factors affect early instars more than later instars. King *et al*. (1933) reported that, provided the soil was not too dry, late instar larvae of *S. a. destructor* stayed near the soil surface regardless of temperature (they do not freeze), but that prior to winter, earlier instars moved down to slightly below the depth to which the soil had been tilled. Feeding activity in *S. a. destructor* increased with soil temperature and moisture (Strickland 1935, 1939; Burrage 1963), but only until June (Doane 1981). Strickland (1939) reported that the feeding activity of this species was highest at 25 °C, and Zacharuk (1962*b*) reported a direct relationship between feeding activity and soil temperature (between 10 and 30 °C) and soil moisture (5–22% by weight—it decreased after 22%) in loam soil in a laboratory setting. The feeding preferences of field-collected larvae were also affected by prior temperature and moisture conditions in the field (Zacharuk 1962*b*). Similarly, wireworm appetence was affected by previous exposure to food (Burrage 1963). This suggests that appetence and other state variables need to be considered when using field-collected wireworms for laboratory studies (van Herk and Vernon 2013).

Wireworms stop feeding to moult, but resume feeding soon afterward. How long they feed may depend on their size. Zacharuk (1962b) observed that early instars of laboratory-raised *S. a. destructor* commonly stopped feeding 1-7 days before ecdysis and resumed feeding within a week thereafter. Late instars began feeding shortly after moulting, and continued to do so, voraciously, for several weeks, but then remained generally inactive until the next moult. This difference in the feeding habits of small and large larvae of *S. a. destructor* has also been observed in the field (Burrage 1963; Doane 1981) and may help to explain the peaks of wireworm activity there. Doane (1981) and Burrage (1963) both reported that *S. a. destructor* had at least two peaks of feeding activity in Saskatchewan, the largest peak in early to mid-June, followed by a second peak in early August and possibly a third peak in early September. The June peak was likely due to the activity of large- and medium-sized larvae, which declined sharply in activity thereafter, smaller larvae staying active until the end of the season (Doane 1981). Doane (1981) found activity patterns for *H. bicolor* that were similar to those of *S. a. destructor*, with the largest peak of activity (mostly due to large wireworms) in June and a smaller peak (mostly due to small wireworms) in August.

Wireworm seasonal activity patterns vary among species, each having their own temperature and moisture preferences. Larvae of *H. bicolor* are more sensitive to heat and drought and therefore move down earlier in the summer than larvae of *S. a. destructor* (King *et al*. 1933), and *S. a. destructor* larvae prefer higher temperatures than larvae of *S. a. aeripennis* (Zacharuk 1962*b*). Food availability is another factor confounding larval activity: *S. a. destructor* will tolerate higher than optimal temperatures in the presence of food (Zacharuk 1962*b*), and larvae of *S. a. destructor* and *L. californicus* will avoid dry soils (<10% moisture by weight) more at high than at low temperatures, but only in the absence of food (Zacharuk 1962*b*). On the other hand, although most (about 80%) *H. bicolor* larvae return to the soil surface in autumn to feed, they will not do so if the soil is too dry (Burrage 1963; Doane 1977*a*).

Because wireworm seasonal movements and the period(s) of peak activities depend on soil variables, wireworm populations are difficult to predict by sampling. We recently discussed sampling approaches and wireworm management elsewhere (Vernon and van Herk 2012), but if bait trapping is used to determine the presence of wireworms, it should be done when peak larval activity is expected, which for both *S. a. destructor* and *H. bicolor* typically begins around 1 June or 1 August. Doane (1981) recommended two consecutive trapping periods, each of two weeks' duration.

Additional Relevant Prairie Provinces Wireworm Research

We frequently consult the extensive previous research done on Prairie Province wireworm species, and two obvious conclusions are that the level of interest and research activity was highest from the 1930s to the 1970s and that this body of work is largely overlooked today. Some of the excellent research during this period was listed earlier, but the following examples are valuable for understanding this important family of pest insects and therefore worth mentioning here.

Methods for rearing *S. a. destructor* aseptically in test tubes were developed by Davis (1959*a*, 1961), who also conducted numerous studies on the differing dietary preferences of both *S. a. aeripennis* and *S. a. destructor* (Davis 1957, 1958*a*, 1958*b*, 1958*c*, 1959*a*, 1959*b*, 1959*c*, 1959*d*). Interestingly, he discovered that *S. a. destructor* larvae could survive without feeding for 60 weeks or more, during which time they still moulted, though the head capsule size—the standard way of determining larval stadia (McDougall 1934)—did not always increase (Davis 1959*b*). The latter finding was later confirmed by Zacharuk (1962*a*) and Doane (1977*a*). During this same time, Eidt (1958) researched *S. a. destructor* anatomy and histology, and described their extra-oral mode of feeding and highly efficient oral filter (Eidt 1959). Eidt's histological work was continued by Zacharuk, who, among many other things, studied the sense organs (Zacharuk 1962*c*) and cuticle structure of *S. a. destructor*, *H. bicolor*, and *L. californicus* and how the cuticle changed during moulting (Zacharuk 1972). He also published information on histological changes within wireworms caused by infection with *Metarhizium anisopliae* (Hypocreales: Clavicipitaceae) (Zacharuk 1970*a*, 1970*b*, 1971, 1973*a*) and how common bacterial pathogens such as *Pseudomonas aeruginosa* and *Enterobacter (Aerobacter) aerogenes* enter the wireworm midgut through the ecdysial space between the old and new cuticles during moulting and invade the hemocoel thereafter (Zacharuk 1973*b*). In addition, he found that bacterial pathogens could likely not enter wireworms by ingestion because of their extra-oral mode of feeding and (large) bacteria-excluding oral filter (Zacharuk 1972, 1973*b*, 1974). Working at the same time and place as Zacharuk, Doane determined that wireworms orient to potential food sources in the soil by following increasing gradients of CO_2 and are capable of detecting concentration changes as low as 0.002% per cm (Doane et al. 1975). Doane's work on wireworm orientation to potential food sources appears to apply to most pest elaterids and is of crucial importance when designing sampling programs and management strategies (Vernon and van Herk 2012). Doane also discovered that wireworm sensitivity to CO_2 is facilitated by specialized sensilla on the maxillary and labial palps (Doane and Klinger 1978). All of these researchers contributed extensively to our understanding of wireworms, and most of their work remains relevant, or has laid the foundations for wireworm research today.

Research Challenges and Needs, Concluding Comments

Strickland began his article "The Biology of Prairie-Inhabiting Wireworms" with the caveat that most of it would be devoted to a discussion of how little was known about wireworms despite the "voluminous literature" about them and "how seriously this [lack] has retarded the development of effective control measures" (Strickland 1935: 520). Despite the amount of research published in the 80 years since, Strickland's comments remain somewhat true today, and much more research remains to be done, both for pest management and for a general understanding of elaterid diversity, biology and behaviour, and distribution.

Knowledge gaps in wireworm biology include information on most of the basic life history details for nearly all species. We currently have an incomplete picture of the fecundity of nearly all Prairie Province species, the survivorship of eggs and different larval stages, and the feeding habits and preferences and other plant associations of both larvae and adults. For all but two species, *S. a. destructor* and *H. bicolor*, virtually nothing is known about these aspects of their biology. The larval stage of most (approximately 90% of those listed in Table 1) elaterids remains unknown and/or undescribed. To date, the pheromones of few of these species have been identified, notable exceptions being those of *L. californicus* and *L. canus*—these incidentally representing some of the first semiochemicals to be isolated from any Coleoptera (Lilly 1959; Jacobson *et al*. 1968; Butler *et al*. 1975). With the exception of the most important pest species (*S. a. destructor* and *H. bicolor*), virtually nothing is known about Prairie Province elaterid habitat preferences, ability to disperse as adults and larva, potential to invade other areas or risk of extinction, whether they are pests or beneficial insects, or their relative susceptibilities and behavioural responses to modern-day insecticides. For even the most studied species, the seasonal vertical movements in the soil remain difficult to predict. Little is known about their actual distribution or genetic variability within and among species, or the stability of species complexes over long periods of time. Doane (1977*b*) found the relative proportions of *S. a. destructor*, *H. bicolor,* and *A. mellillus* both inside and around wheat fields to remain stable over an eight-year period, but our surveys since 2005 suggest *H. bicolor* may have become more prevalent than *S. a. destructor* across the Prairie Provinces, perhaps because their shorter life cycle allows populations to increase more rapidly, and/or possibly because of the deregistration of highly persistent (e.g., aldrin, heptachlor) and moderately persistent (e.g., lindane) organochlorine insecticide from use in Canada. Other factors may be responsible: King *et al*. (1933) noted that under certain conditions—he did not name them—populations of *H. bicolor* increase while those of *S. a. destructor* decrease and that such species differences complicate wireworm management. Finally, little is known about the natural enemies of Prairie Province elaterids. Mermithid nematodes, commonly found in late instar *Agriotes obscurus* in Agassiz, British Columbia (WvH, pers. obs.), have been recovered from *A. mancus* larvae (Hawkins 1936), but in general morphological barriers (e.g., heavily sclerotized integument, oral filter, biforate spiracles) appear to make wireworms resistant to infection by entomopathogenic nematodes (Eidt and Thurston 1995). Entomopathogenic fungi have been studied since the work of Zacharuk and Tinline (1960, 1968), but only certain strains of *Metarhizium anisopliae* produced significant mortality under controlled conditions (Ansari *et al.* 2009). Other natural enemies include hymenopteran and dipteran parasites (occasionally retrieved from both larvae and adults), birds, and carabid and therevid larvae (Thomas 1940; Kabaluk *et al.* 2005; WvH and RSV, unpublished data). Phoretic mites (Acaridae) are frequently found on late instar larvae, but are non-parasitic (WvH, pers. obs.).

The limited interest in conducting research on wireworms and click beetles, either for pest management or other purposes, is understandable; elaterids are often challenging and frustrating insects to work with. Larvae are often not there when you look for them, even in severely infested fields (King *et al*. 1933), because of their seasonal vertical movement in the soil (discussed earlier). Multiple species are often present in the field at once, each with a different life history and (likely) each with overlapping generations. King *et al*. (1933) pointed out that the latter stabilizes the population and therefore tends strongly toward the permanence of an infestation in the field. Another factor complicating management is that different wireworm species often do not respond in the same way (in terms of toxicity and behaviour) to contemporary insecticides (van Herk *et al*. 2007; Vernon and van Herk 2012). Hence, the failure to determine the species present in the field and the failure to use rigorous and often laborious experimental methods during management and insecticide efficacy studies (e.g., careful and often labour-intensive plot preparation to eliminate competing sources of food or CO_2 production) often result in the apparent lack of efficacy in insecticides, or in contradictory results among different years or among research teams (discussed in Vernon *et al*. 2009, 2013; Vernon and van Herk 2012). Strickland (1935), having reviewed the (already!) extensive literature on wireworms available at the time, was impressed with how few researchers had studied the biology of the wireworms they were working with, or even named the species. He wondered if their recommended management approaches had any value at all and if the treatments used had anything to do with the reported efficacy of the approach. Much excellent research, however, has been published on elaterid biology in the years since Strickland made these comments (as noted), but more remains to be done for us to understand and effectively manage click beetles and wireworms in the future. In particular, we need to better understand species distribution; life histories; food, soil, and moisture preferences; and, for management, tools for quick and accurate detection and identification of the larvae, as well as crop- and region-specific integrated management approaches (Vernon and van Herk 2012).

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References

Al Dhafer, H.M. 2009. Revision of the North American species of *Limonius* (Coleoptera: Elateridae). Transactions of the American Entomological Society, **135**: 209–352.

Ansari, M.A., Evans, M., and Butt, T.M. 2009. Identification of pathogenic strains of entomopathogenic nematodes and fungi for wireworm control. Crop Protection, **28**: 269–272.

Arnason, A.P. 1931. A Morphological Study of the Immature States of *Cryptohypnus nocturnus* Eschscholtz and a Study of Some Ecological Factors Concerning Wireworms. M.Sc. thesis, University of Saskatchewan, Saskatoon.

Arnett, R.H. 1952. A review of the nearctic Adelocerina (Coleoptera: Elateridae, Pyrophorinae, Pyrophorini). Wasman Journal of Biology, **10**: 103–126.

Arnett, R.H. 1953. Notes on the genus *Lacon* (Elateridae). The Coleopterists Bulletin, **7**: 5–7.

Becker, E.C. 1952. The nearctic species of *Denticollis* (Coleoptera: Elateridae). Proceedings of the Entomological Society of Washington, **54**: 105–114.

Becker, E.C. 1956. Revision of the nearctic species of *Agriotes* (Coleoptera: Elateridae). The Canadian Entomologist, **88**(Suppl. 1).

Becker, E.C. 1974. Revision of the nearctic species of *Athous* (Coleoptera: Elateridae) east of the Rocky Mountains. The Canadian Entomologist, **106**: 711–758.

Becker, E.C. 1979*a*. Notes on some New World and Palearctic species formerly in *Athous* Eschscholtz and *Harminius* Fairmaire with new synonymies (Coleoptera: Elateridae). The Canadian Entomologist, **111**: 401–415.

Becker, E.C. 1979*b*. Review of the western nearctic species of *Athous* (Coleoptera: Elateridae), with a key to the species north of Panama. The Canadian Entomologist, **111**: 569–614.

Becker, E.C. 1991. Elateridae (Elateroidea). *In* Immature Insects, Vol. 2. *Edited by* F.W. Stehr. Kendall/Hunt, Dubuque, Iowa. pp. 409–418.

Begg, J.A. 1957. Observations on the life-history of the eastern field wireworm, *Limonius agonus* (Say), under laboratory conditions. Report of the Entomological Society of Ontario, **87**: 7–11.

Begg, J.A. 1962. The eastern field wireworm, *Limonius agonus* (Say) (Coleoptera: Elateridae), in southwestern Ontario. Proceedings of the Entomological Society of Ontario, **92**: 38–45.

Begg, J.A., Plummer, P.J.G., and Konst, H. 1960. Insecticide residues in potatoes after soil treatments for control of wireworms. Canadian Journal of Plant Science, **40**: 680–689.

Benefer, C.M., van Herk, W.G., Ellis, J.S., Blackshaw, R.P., Vernon, R.S., and Knight, M.E. 2013. The molecular identification and genetic diversity of economically important wireworm species (Coleoptera: Elateridae) in Canada. Journal of Pest Science, **86**: 19–27.

Bouchard, P., Bousquet, Y., Davies, A.E., Alonso-Zarazaga, M.A., Lawrence, J.F., Lyal, C.H.C., Newton, A.F., Reid, C.A.M., Schmitt, M., Ślipiński, S.A., and Smith, A.B.T. 2011. Family-group names in Coleoptera (Insecta). ZooKeys, **88**: 1–972.

Bousquet, Y. 1991. Elateridae. *In* Checklist of Beetles of Canada and Alaska. *Edited by* Y. Bousquet. Research Branch, Agriculture Canada Publication 1861/E, Ottawa, Ontario. pp. 175–185. Online updated version available from http://www.canacoll.org/Coleo/Checklist/PDF%20files/ELATERIDAE.pdf [accessed 17 January 2013].

Bousquet, Y., Bouchard, P., Davies, A.E., and Sikes, D.S. 2013. Checklist of Beetles (Coleoptera) of Canada and Alaska. 2nd edition. Pensoft, Sofia, Bulgaria.

Böving, A.G., and Craighead, F.C. 1931. An Illustrated Synopsis of the Principal Larval Forms of the order Coleoptera. Brooklyn Entomological Society, Brooklyn, New York.

Brooks, A.R. 1960. Adult Elateridae of southern Alberta, Saskatchewan and Manitoba (Coleoptera). The Canadian Entomologist, **92**(Suppl. 20).

Brown, W.J. 1930. A revision of the North American species of *Eanus*. The Canadian Entomologist, **62**: 161–166.

Brown, W.J. 1933*a*. Studies in the Elateridae I (Coleop.). The Canadian Entomologist, **65**: 133–141.

Brown, W.J. 1933*b*. Studies in the Elateridae II. The Canadian Entomologist, **65**: 173–182.

Brown, W.J. 1934*a*. The American species of *Dalopius*. The Canadian Entomologist, **66**: 30–39.
Brown, W.J. 1934*b*. The American species of *Dalopius*. The Canadian Entomologist, **66**: 66–72.
Brown, W.J. 1934*c*. The American species of *Dalopius*. The Canadian Entomologist, **66**: 87–96.
Brown, W.J. 1934*d*. The American species of *Dalopius*. The Canadian Entomologist, **66**: 102–110.
Brown, W.J. 1935*a*. American species of *Ludius*; the *cruciatus* and *edwardsi* groups. The Canadian Entomologist, **67**: 1–8.
Brown, W.J. 1935*b*. American species of *Ludius*; the *aeripennis* group. The Canadian Entomologist, **67**: 125–135.
Brown, W.J. 1935*c*. American species of *Ludius*; the *cribrosus* and *volitans* groups. The Canadian Entomologist, **67**: 213–221.
Brown, W.J. 1936*a*. American species of *Ludius*; the *semivittatus* and *nitidulus* groups. The Canadian Entomologist, **68**: 11–20.
Brown, W.J. 1936*b*. American species of *Ludius*; the *fallax* and *triundulatus* groups. The Canadian Entomologist, **68**: 99–107.
Brown, W.J. 1936*c*. American species of *Ludius*; the *inflatus* group. The Canadian Entomologist, **68**: 133–136.
Brown, W.J. 1936*d*. American species of *Ludius*; the *propola* group. The Canadian Entomologist, **68**: 177–187.
Brown, W.J. 1936*e*. Notes on some species of Elateridae. The Canadian Entomologist, **68**: 246–252.
Brown, W.J. 1939. Some American species of *Ludius* (Coleoptera). The Canadian Entomologist, **71**: 44–49.
Burrage, R.H. 1963. Seasonal feeding of larvae of *Ctenicera destructor* and *Hypolithus bicolor* (Coleoptera: Elateridae) on potatoes placed in the field at weekly intervals. Annals of the Entomological Society of America, **56**: 306–313.
Burrage, R.H. 1964. Trends in damage by wireworms (Coleoptera: Elateridae) in grain crops in Saskatchewan, 1954–1961. Canadian Journal of Plant Science, **44**, 515–519.
Butler, L.I., McDonough, L.M., Onsager, J.A., and Landis, B.J. 1975. Sex pheromones of the Pacific Coast wireworm, *Limonius canus*. Environmental Entomology, **4**: 229–230.
Calder, A.A., Lawrence, J.F., and Trueman, J.W.H. 1993. *Austrelater*, gen. nov. (Coleoptera: Elateridae), with a description of the larva and comments on elaterid relationships. Invertebrate Taxonomy, **7**: 1349–1394.
Campbell, J. M., Sarazin, M. J., and Lyons, D. B. 1989. Canadian Beetles (Coleoptera) Injurious to Crops, Ornamentals, Stored Products, and Buildings. Research Branch, Agriculture Canada Publication 1826, Ottawa, Ontario.
Cate, P.G. 2007. Family Elateridae. *In* Catalogue of Palaearctic Coleoptera, Vol. 4: Elateroidea, Derodontoidea, Bostrichoidea, Lymexyloidea, Cleroidea, Cucujoidea, *Edited by* I. Löbl, and A. Smetana. Apollo Books, Stenstrup, Denmark. pp. 89–209.
Comstock, J.H., and Slingerland, M.V. 1891. Wireworms. Cornell University Agricultural Experimental Station Bulletin 33, Ithaca, NY.
Crowson, R.A. 1960. On some new characters of classificatory importance in adults of Elateridae (Coleoptera). Entomologists Monthly Magazine, **96**: 158–161.
Davis, G.R.F. 1957. Growth and feeding behavior of larvae of *Ctenicera aeripennis destructor* (Brown) (Coleoptera: Elateridae) I. Effects of carrot slices and seeds of wheat, flax, barley, rye, and alfalfa. Annals of the Entomological Society of America, **50**: 578–584.
Davis, G.R.F. 1958*a*. Note on survival and feeding of newly hatched larvae *Ctenicera aeripennis destructor* (Brown) (Coleoptera: Elateridae). Annals of the Entomological Society of America, **51**: 51–52.
Davis, G.R.F. 1958*b*. Growth and feeding behavior of larvae of *Ctenicera aeripennis destructor* (Brown) (Coleoptera: Elateridae) II. Effects of sterilized flax seed and sterilized soil. Annals of the Entomological Society of America, **51**: 164–167.
Davis, G.R.F. 1958*c*. Growth and feeding behavior of larvae of *Ctenicera aeripennis destructor* (Brown) (Coleoptera: Elateridae) III. Effects of seeds of crested wheatgrass, bromegrass, and rape. Annals of the Entomological Society of America, **51**: 248–250.
Davis, G.R.F. 1959*a*. A method for rearing larvae of *Ctenicera aeripennis destructor* (Brown) (Coleoptera: Elateridae) aseptically in test tubes. Annals of the Entomological Society of America, **52**: 173–175.
Davis, G.R.F. 1959*b*. Growth and feeding behavior of larvae of the Puget Sound wireworm, *Ctenicera aeripennis aeripennis* (Kby.) (Coleoptera: Elateridae) on carrot slices and seeds of wheat, flax, barley, rye, and alfalfa. Annals of the Entomological Society of America, **52**: 540–543.
Davis, G.R.F. 1959*c*. Effects of sterilized soil and of starvation on growth and survival of larvae of *Ctenicera aeripennis aeripennis* (Kby.) (Coleoptera: Elateridae). Annals of the Entomological Society of America, **52**: 537–539.
Davis, G.R.F. 1959*d*. Feeding behaviour and growth of larvae of the prairie grain wireworm, *Ctenicera aeripennis destructor* (Brown) (Coleoptera: Elateridae). Entomologia Experimentalis et Applicata, **2**: 300–303.

Davis, G.R.F. 1961. The biting response of larvae of the Prairie grain wireworm, *Ctenicera aeripennis destructor* (Brown) (Coleoptera: Elateridae), to various extracts of germinating rye seed. Canadian Journal of Zoology, **39**: 299–303.

Doane, J.F. 1961. Movement on the soil surface, of adult *Ctenicera aeripennis destructor* (Brown) and *Hypolithus bicolor* Esch. (Coleoptera: Elateridae), as indicated by funnel pitfall traps, with notes on captures of other arthropods. The Canadian Entomologist, **93**: 636–644.

Doane, J.F. 1963. Studies on oviposition and fecundity of *Ctenicera destructor* (Brown) (Coleoptera: Elateridae). The Canadian Entomologist, **95**: 1145–1153.

Doane, J.F. 1966. Absorption and content of water in eggs of *Ctenicera destructor* (Brown), *Ctenicera aeripennis* (Kirby) and *Hypolithus bicolor* Eschscholtz (Coleoptera: Elateridae). The Canadian Entomologist, **98**: 482–486.

Doane, J.F. 1967. The influence of soil moisture and some soil physical factors on the ovipositional behavior of the prairie grain wireworm, *Ctenicera destructor*. Entomologia Experimentalis et Applicata, **10**: 275–286.

Doane, J.F. 1977*a*. Spatial pattern and density of *Ctenicera destructor* and *Hypolithus bicolor* (Coleoptera: Elateridae) in soil in spring wheat. The Canadian Entomologist, **109**: 807–822.

Doane, J.F. 1977*b*. The flat wireworm, *Aeolus mellillus*: studies on seasonal occurrence of adults and incidence of the larvae in the wireworm complex attacking wheat in Saskatchewan. Environmental Entomology, **6**: 818–822.

Doane, J.F. 1981. Evaluation of a larval trap and baits for monitoring the seasonal activity of wireworms in Saskatchewan. Environmental Entomology, **10**: 335–342.

Doane, J.F., and Klinger, J. 1978. Location of carbon dioxide receptive sensilla on larvae of the wireworms *Agriotes lineatus-obscurus* and *Limonius californicus*. Annals of the Entomological Society of America, **71**: 357–363.

Doane, J.F., Lee, Y.W., Klinger, J., and Westcott, N.D. 1975. The orientation response of *Ctenicera destructor* and other wireworms (Coleoptera: Elateridae) to germinating grain and carbon dioxide. The Canadian Entomologist, **107**: 1233–1252.

Douglas, H. 2003. Revision of the *Cardiophorus* (Coleoptera: Elateridae) species of eastern Canada and United States of America. The Canadian Entomologist, **135**: 493–548.

Douglas, H. 2011*a*. Phylogenetic relationships of Elateridae inferred from adult morphology, with special reference to the position of Cardiophorinae. Zootaxa, **2900**: 1–45.

Douglas, H. 2011*b*. New records of European wireworm pests and other click beetles (Coleoptera: Elateridae) in Canada and USA. Journal of the Entomological Society of Ontario, **142**: 11–17.

Eidt, D.C. 1953. European wireworms in Canada with particular reference to Nova Scotian infestations. The Canadian Entomologist, **85**: 408–414.

Eidt, D.C. 1954. A description of the larva of *Agriotes mancus* (Say), with a key separating the larvae of *A. lineatus* (L.), *A. mancus, A. obscurus* (L.), and *A. sputator* (L.) from Nova Scotia. The Canadian Entomologist, **86**: 481–494.

Eidt, D.C. 1958. The anatomy and histology of the full-grown larva of *Ctenicera aeripennis destructor* (Brown) (Coleoptera: Elateridae). The Canadian Journal of Zoology, **36**: 317–361.

Eidt, D.C. 1959. Mode of feeding of the larvae of *Ctenicera aeripennis destructor* (Brown) (Coleoptera: Elateridae). The Canadian Entomologist, **91**: 97–101.

Eidt, D.C., and Thurston, G.S. 1995. Physical deterrents to infection by entomopathogenic nematodes in wireworms (Coleoptera: Elateridae) and other soil insects. The Canadian Entomologist, **127**: 423–429.

Fox, C.J.S. 1961. The distribution and abundance of wireworms in the Annapolis Valley of Nova Scotia. The Canadian Entomologist, **93**: 276–279.

Fuller, E.R. 1992. New records of Elateridae from Alberta and Saskatchewan (Coleoptera). Coleopterists Bulletin, **46**: 413–419.

Fuller, E.R. 2002. Checklist of the Alberta Elateridae (Click Beetles). University of Alberta, Department of Biological Sciences, E.H. Strickland Entomological Museum. Available from http://www.biology.ualberta.ca/facilities/strickland/elateridlist.htm [accessed 23 August 2012].

Fuller, E.R. 2008. New records of *Megapenthes solitarius* Fall from Alberta, Canada (Coleoptera: Elateridae). Coleopterists Bulletin, **62**: 535–536.

Gaedike, R. 1969. Bibliographie der Elateridenlarven-literatur der Welt. Beiträge zur Entomologie, **19**: 159–266.

Glen, R. 1950. Larvae of the elaterid beetles of the tribe Lepturoidini (Coleoptera: Elateridae). Smithsonian Miscellaneous Collections, **111**: 1–246.

Glen, R., King, K.M., and Arnason, A.P. 1943. The identification of wireworms of economic importance in Canada. Canadian Journal of Research, **21**: 358–387.

Gur'yeva, Y.L. 1969. Some trends in the evolution of click beetles (Coleoptera, Elateridae). Entomological Review, **48**: 154–159.

Hawkins, J.H. 1936. The Bionomics and Control of Wireworms in Maine. Maine Agricultural Experimental Station Bulletin No. 381.

Hyslop, J.A. 1917. The phylogeny of the Elateridae based on larval characters. Annals of the Entomological Society of America, **10**: 241–263.

Jacobson, M., Lilly, C.E., and Harding, C. 1968. Sex attractant of sugar beet wireworm: identification and biological activity. Science, **159**: 208–210.

Jewett, H.H. 1940. Observations on the life history of *Aeolus mellillus* (Say). Journal of Economic Entomology, **33**: 816.

Jewett, H.H. 1942. Life History of the Wireworm *Aeolus mellillus* (Say). Kentucky Agricultural Experimental Station, University of Kentucky, Bulletin No. 425.

Johnson, P.J. 2001. Two generic transfers and a synonymy for some North American Elateridae (Coleoptera). Insecta Mundi, **15**: 58.

Johnson, P.J. 2002. 58. Family Elateridae, Leach 1815. *In* American Beetles, Vol. 2: Polyphaga: Scarabaeoidea through Curculionoidea. *Edited by* R.H. Arnett, Jr., M.C. Thomas, P.E. Skelley, and J.H. Frank. CRC Press, Boca Raton, Florida. pp. 160–173.

Kabaluk, J.T., Goettel, M.S., Erlandson, M., Ericsson, J.D., Duke, G., and Vernon, R. 2005. *Metarhizium anisopliae* as a biological control for wireworms and a report of some other naturally-occurring parasites. IOBC WPRS Bulletin, **28**: 109–115.

Keaster, A.J., Jackson, M.A., Ward, S.S., and Krause, G.F. 1988. A Worldwide Bibliography of Elateridae. Missouri Agricultural Experiment Station, University of Missouri-Columbia, Columbia.

King, K.M. 1928. Economic importance of wireworms and false wireworms in Saskatchewan. Scientific Agriculture, **8**: 693–706.

King, K.M., Arnason, P., and Glen, R. 1933. The Wireworm Problem in Field Crops of Western Canada. Leaflet No. 35. Canadian Department of Agriculture, Entomology Branch, Saskatoon, Saskatchewan.

Kundrata, R., and Bocak, L. 2010. The phylogeny and limits of Elateridae (Insecta, Coleoptera): is there a common tendency of click beetles to soft-bodiedness and neotony? Zoologica Scripta, **40**: 364–378.

Lafrance, J. 1963. Emergence and flight of click beetles (Coleoptera: Elateridae) in organic soils of southwestern Quebec. The Canadian Entomologist, **95**: 873–878.

Lafrance, J. 1967. The life history of *Agriotes mancus* (Say) (Coleoptera: Elateridae) in the organic soils in southwestern Quebec. Phytoprotection, **48**: 53–57.

Lafrance, J. 1968. The seasonal movement of wireworms (Coleoptera: Elateridae) in relation to soil moisture and temperature in the organic soils of southwestern Quebec. The Canadian Entomologist, **100**: 801–807.

Lafrance, J., and Cartier, J.J. 1964. Distribution of wireworm population (Coleoptera: Elateridae) in unfrozen and frozen organic soils of southwestern Quebec. Phytoprotection, **45**: 83–87.

Lane, M.C., and Lanchester, H.P. 1971. Elateridae. *In* Beetles of the Pacific Northwest, Part V: Rhipiceroidea, Sternoxi, Phytophaga, Rhynchophora and Lamellicornia. *Edited by* M.W. Hatch. University of Washington Press, Seattle. pp. 6–48.

Lilly, C E. 1959. Response of males of *Limonius californicus* (Mann.) (Coleoptera: Elateridae) to a sex attractant separable by paper chromatography. The Canadian Entomologist, **101**: 145–146.

MacNay, C.G. 1954. New records of insects in Canada in 1952: a review. The Canadian Entomologist, **86**: 55–60.

Majka, C.G., and Johnson, P.L. 2008. The Elateridae (Coleoptera) of the Maritime provinces of Canada: faunal composition, new records, and taxonomic changes. Zootaxa, **1811**: 1–33.

McDougall, W.A. 1934. The determination of larval instars and stadia of some wireworms (Elateridae). Queensland Agricultural Journal, **42**: 43–70.

Morris, R.G. 1951. The larval Elateridae of Eastern spruce forests and their role in the natural control of *Gilpinia hercyniae* (Htg.) (Hymenoptera: Diprionidae). The Canadian Entomologist, **83**: 133–147.

Ôhira, H. 1962. Morphological and Taxonomic Study on the Larvae of Elateridae in Japan (Coleoptera). Entomological Laboratory, Aichi Gakugei University, Okazaki, Japan.

Quate, L.W., and Thompson, S.E. 1967. Revision of click beetles of genus *Melanotus* in America north of Mexico (Coleoptera: Elateridae). Proceedings of the United States National Museum, **121(3568)**: 1–83.

Rawlins, W.A. 1940. Biology and Control of the Wheat Wireworm, *Agriotes mancus* Say. Cornell University Agricultural Experimental Station Bulletin No. 783, Ithaca, NY.

Shorthouse, J.D. 2010. Ecoregions of Canada's prairie grasslands. *In* Arthropods of Canadian Grasslands, Vol. 1: Ecology and Interactions in Grassland Habitats. *Edited by* J. D. Shorthouse and K. D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 53–81.

Stewart, W.W.A. 1949. Investigations on the Control of Wireworms in Potato Fields and Gardens in the Prairie Provinces: Horizontal and Vertical Distribution of Wireworms in a Potato Field. Technical Report of the Canadian Department of Agriculture, Saskatoon, Saskatchewan.

Stibick, J.N.L. 1971. The generic classification of the Negastriinae (Coleoptera: Elateridae). Pacific Insects, **13**: 371–390.

Stibick, J.N.L. 1975. A revision of the Hypnoidinae of the world (Coleoptera Elateridae). Part I: Introduction, phylogeny, biogeography. The Hypnoidinae of North and South America. The genera *Berninelsonius* and *Ligmargus*. Eos, **51**: 143–223.

Stibick, J.N.L. 1978. A revision of the Hypnoidinae of the world (Col. Elateridae). Part II. The Hypnoidinae of North and South America. The genera *Ascoliocerus, Desolakerrus, Margaiostus, Hypolithus*, and *Hypnoidus*. Eos, **52**: 309–386.

Stibick, J.N.L. 1979. Classification of the Elateridae (Coleoptera): relationships and classification of the subfamilies and tribes. Pacific Insects, **20**: 145–186.

Stibick, J.N.L. 1990. North American Negastriinae (Coleoptera, Elateridae): the Negastriinae of the eastern United States and adjacent Canada. Insecta Mundi, **4**: 99–131.

Stirrett, G.M. 1936. Notes of the “flat wireworm,” *Aeolus mellillus* Say. The Canadian Entomologist, **68**: 117–118.

Stone, M.W. 1941. Life History of the Sugarbeet Wireworm in Southern California. USDA Technical Bulletin No. 744.

Strickland, E.H. 1927. Wireworms of Alberta, a Preliminary Report. University of Alberta, Bulletin 2, Edmonton, Alberta.

Strickland, E.H. 1935. The biology of prairie-inhabiting wireworms. Proceedings of the World Grain Exhibition Conference, 1933, **2**: 520–529.

Strickland, E.H. 1939. Life cycle and food requirements of the Northern grain wireworm, *Ludius aeripennis destructor* (Brown). Journal of Economic Entomology, **32**: 322–329.

Strickland, E.H. 1942. Variations in the length of the lifecycle of wireworms. Journal of Economic Entomology, **35**: 109–110.

Subklew, W. 1938. Die bekämpfung der Elateriden. Eine uebersicht über die literatur. Zeitschrift fur Angewandte Entomologie, **24**: 511–581.

Tarnawski, D. 1995. A revision of the genus *Selatosomus* Stephens, 1830 (Coleoptera: Elateridae: Athoinae: Ctenicerini). Genus, **6**(Suppl. 4).

Tarnawski, D. 1996. A world catalogue of Ctenicerini Fleutiaux, 1936 (Coleoptera: Elateridae: Athoinae). Genus, **7**: 587–663.

Tarnawski, D. 2001. A world catalogue of Ctenicerini Fleutiaux, 1936. Part II. (Coleoptera: Elateridae: Athoinae). Genus, **12:** 277–323.

Thomas, C.A. 1930. A Review of Research on the Control of Wireworms. Pennsylvania State College Experimental Station Bulletin No. 259.

Thomas, C.A. 1940. The Biology and Control of Wireworms: A Review of the Literature. Pennsylvania State College Experimental Station Bulletin No. 392.

van Herk, W.G., Kabaluk, J.T., Lam, V.W.M., and Vernon, R.S. 2008*a*. Survival of male click beetles, *Agriotes obscurus* L. (Coleoptera: Elateridae) during and after storage at different temperatures. Journal of the Entomological Society of British Columbia, **105:** 113–114.

van Herk, W.G., and Vernon, R.S. 2007. Soil bioassay for studying behavioral responses of wireworms (Coleoptera: Elateridae) to insecticide-treated wheat seed. Environmental Entomology*,* **36**: 1441–1449.

van Herk, W.G., and Vernon, R.S. 2013. Wireworm damage to wheat seedlings: effect of temperature and wireworm state. Journal of Pest Science, **86**, 63–75.

van Herk, W.G., Vernon, R.S., Clodius, M., Harding, C., and Tolman, J.H. 2007. Mortality of five wireworm species (Coleoptera: Elateridae), following topical application of clothianidin and chlorpyrifos. Journal of the Entomological Society of British Columbia, **104**: 55–63.

van Herk, W.G., Vernon, R.S., Moffat, C., and Harding, C. 2008*b*. Response of the Pacific Coast wireworm, *Limonius canus*, and the dusky wireworm, *Agriotes obscurus* (Coleoptera: Elateridae), to insecticide-treated wheat seeds in a soil bioassay. Phytoprotection, **89**: 7–19.

Vernon, R.S., and van Herk, W.G. 2012. Wireworms as pests of potato. *In* Insect Pests of Potato: Global Perspectives on Biology and Management. *Edited by* P. Giordanengo, C. Vincent, and A. Alyokhin. Academic Press, Elsevier, Amsterdam, Netherlands. pp. 103–164.

Vernon, R.S., van Herk, W.G., Clodius, M., and Harding, C. 2009. Wireworm management I: stand protection versus wireworm mortality with wheat seed treatments. Journal of Economic Entomology, **102**: 2126–2136.

Vernon, R.S., van Herk, W.G., Clodius, M., and Harding, C. 2013. Further studies on wireworm management in Canada: damage protection versus wireworm mortality in potatoes. Journal of Economic Entomology, **106**: 786-799.

Webster, R.P., Sweeney, J.D., and DeMerchant, I. 2012. New Coleoptera records from New Brunswick, Canada: Elateridae. ZooKeys, **179**: 93–113.

Wells, S.A. 1996. Studies on Nearctic *Negastrius* (Coleoptera: Elateridae). Great Basin Naturalist, **56**: 308–318.

Westcott, R.L., Labonte, J.R., Parsons, G.L., and Johnson, P.J. 2006. New records and other notes for Oregon Coleoptera. Zootaxa, **1142**: 1–33.

Wilkinson, A.T.S. 1963. Wireworms of cultivated land in British Columbia. Proceedings of the Entomological Society of British Columbia, **60**: 3–17.

Wilkinson, A.T.S., Finlayson, D.G., and Campbell, C.J. 1976. Controlling the European wireworm, *Agriotes obscurus* L., in corn in British Columbia. Journal of the Entomological Society of British Columbia, **73**: 3–5.

Wilkinson, A.T.S., Finlayson, D.G., and Morley, H.V. 1964. Toxic residues in soil 9 years after treatment with aldrin and heptachlor. Science, **143**: 681–683.

Willard, J.R. 1973. Soil Invertebrates: II. Elateridae, Population and Biomass. CCIBP Matador Project, Technical Report No. 8, University of Saskatchewan, Saskatoon.

Yatsynin, V.G., Rubanova, E.V., and Okhrimenko, N.V. 1996. Identification of female-produced sex pheromones and their geographical differences in pheromone gland extract composition from click beetles (Col., Elateridae). Journal of Applied Entomology, **120**: 463–466.

Zacharuk, R.Y. 1958*a*. Note on two forms of *Hypolithus bicolor* Esch. (Coleoptera: Elateridae). The Canadian Entomologist, **90**: 567–568.

Zacharuk, R.Y. 1958*b*. Structures and functions of the reproductive systems of the Prairie grain wireworm, *Ctenicera aeripennis destructor* (Brown) (Coleoptera: Elateridae). Canadian Journal of Zoology, **36**: 725–751.

Zacharuk, R.Y. 1962*a*. Distribution, habits, and development of *Ctenicera destructor* (Brown) in western Canada, with notes on the related species *C. aeripennis* (Kby.) (Coleoptera: Elateridae). Canadian Journal of Zoology, **40**: 539–552.

Zacharuk, R.Y. 1962*b*. Seasonal behaviour of larvae of *Ctenicera* spp. and other wireworms (Coleoptera: Elateridae), in relation to temperature, moisture, food, and gravity. Canadian Journal of Zoology, **40**: 697–718.

Zacharuk, R.Y. 1962*c*. Sense organs of the head of larvae of some Elateridae (Coleoptera): their distribution, structure, and innervation. Journal of Morphology, **111**: 1–34.

Zacharuk, R.Y. 1970*a*. Fine structure of the fungus *Metarhizium anisopliae* infecting three species of larval Elateridae (Coleoptera), Part I. Dormant and germinating conidia. Journal of Invertebrate Pathology, **15**: 63–80.

Zacharuk, R.Y. 1970*b*. Fine structure of the fungus *Metarhizium anisopliae* infecting three species of larval Elateridae (Coleoptera), Part III. Penetration of the host integument. Journal of Invertebrate Pathology, **15**: 372–396.

Zacharuk, R.Y. 1971. Ultrastructural changes in tissues of larval Elateridae (Coleoptera) infected with the fungus *Metarrhizium anisopliae.* Canadian Journal of Microbiology, **17**: 281–290.

Zacharuk, R.Y. 1972. Fine structure of the cuticle, epidermis, and fat body of larval Elateridae (Coleoptera) and changes associated with molting. Canadian Journal of Zoology, **50**: 1463–1487.

Zacharuk, R.Y. 1973*a*. Penetration of the cuticular layers of Elaterid larvae (Coleoptera) by the fungus *Metarhizium anisopliae*, and notes on a bacterial invasion Journal of Invertebrate Pathology, **21**: 101–106.

Zacharuk, R.Y. 1973*b*. Ultrastructural changes in the midgut epithelium of an elaterid larva (Coleoptera) infected enterically with *Pseudomonas aeruginosa.* Canadian Journal of Microbiology, **19**: 811–821.

Zacharuk, R.Y. 1974. Ultrastructural pathology of the epidermis of molting Elaterid larvae (Coleoptera) with a fungus and a bacterium in the ecdysial space. Journal of Invertebrate Pathology, **23**: 13–21.

Zacharuk, R.Y., and Tinline, R.D. 1960. Pathogenicity of *Metarhizium anisopliae* (Metch.) Sor. and *Beauveria bassiana* (Bals.) Vuill. to two species of Elateridae. Nature, **187**: 794–795.

Zacharuk, R.Y., and Tinline, R.D. 1968. Pathogenicity of *Metarhizium anisopliae*, and other fungi, for five Elaterids (Coleoptera) in Saskatchewan. Journal of Invertebrate Pathology, **12**: 294–309.

Zack, R.S. 1996. Paratypes of *Cardiophorus* Eschscholtz (Coleoptera: Elateridae), described by H. P. Lanchester, in the M. T. James Entomological Collection, Washington State University. The Coleopterists Bulletin, **50**: 61–71.

Chapter 3
Darkling Beetles (Coleoptera: Tenebrionidae) of Canadian Grasslands

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Abstract. Darkling beetles occur in most terrestrial ecosystems, but they are especially conspicuous in warmer and drier habitats. This chapter documents the diversity, distribution, and biology (where known) of 31 species of darkling beetles that are abundant in Canadian grasslands. Included are habitus drawings of characteristic species from most genera (and subgenera within the genus *Eleodes*), as well as distribution maps for some species largely restricted to Canadian grasslands.

Résumé. On trouve des ténébrions dans la plupart des écosystèmes terrestres, mais ils sont particulièrement présents dans les habitats plutôt chauds et secs. Le présent chapitre se penche sur la diversité, la répartition et la biologie (lorsqu'elle est connue) de 31 espèces de ténébrions abondantes dans les prairies canadiennes. Le chapitre comprend des illustrations d'espèces caractéristiques de la plupart des genres (et des sous-genres dans le cas du genre *Eleodes*), ainsi que des cartes de la répartition de certaines espèces limitées pour l'essentiel aux prairies canadiennes.

Introduction

The family Tenebrionidae is one of the most speciose groups of Coleoptera, with approximately 20,000 described species worldwide (Bouchard *et al*. 2009; Matthews *et al*. 2010). It includes groups formally treated as separate families, such as the Lagriidae and Alleculidae, now recognized as subfamilies within Tenebrionidae (e.g., Aalbu *et al*. 2002*a*, 2002*b*; Bouchard *et al*. 2005, 2011). This is the sixth most diverse family of beetles in North America (north of Mexico), with approximately 1,200 species described in 190 genera (Marske and Ivie 2003). The Canadian fauna includes 141 species (Bousquet et al. 2013); British Columbia, Ontario, and Quebec support the highest diversity. The darkling beetle fauna of Canadian grasslands is quite distinctive and comprises 31 species (Tables 1 and 2).

Darkling beetles occur in most terrestrial habitats, from high latitudes in Canada and Alaska to the hottest deserts (Matthews and Bouchard 2008; Matthews *et al*. 2010; Acorn 2011). Larvae mostly feed on dead plant matter and can be found in two main types of microhabitats: dead or decaying wood, or soil and sand (Aalbu 2002*b*; Matthews *et al*. 2010). Larvae of several species occurring in soil or sand are known to feed on live plant material (these are called false wireworms; see Table 3) and can cause considerable damage to crops in Canada and elsewhere (Allsopp 1980). Because of their relatively

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Table 1. Overall diversity of darkling beetles in Canada and in the Canadian grasslands.

Subfamily	No. Genera in Canada	No. Genera in Canadian Grasslands	No. Species in Canada	No. Species in Canadian Grasslands	Defensive Glands	Biological Notes
Lagriinae Latreille, 1825	4	0	6	0	Present	Forest dwellers; larvae feed on dead plant matter
Phrenapatinae Solier, 1834	2	0	2	0	Absent	Forest dwellers; larvae feed in rotten wood
Pimeliinae Latreille, 1802	7	6	8	7	Absent	Ground-dwelling scavengers; larvae feed in soil
Tenebrioninae Latreille, 1802	25	5	59	23	Present	Diverse feeding habits, including in stored products, on seedlings, and in rotten wood
Alleculinae Laporte, 1840	8	0	29	0	Present	Forest dwellers; larvae feed in dead wood or in soil
Diaperinae Latreille, 1802	10	1	25	1	Present	Diverse feeding habits, including in fungi and in stored products
Stenochiinae Kirby, 1837	8	0	12	0	Present	Forest dwellers; larvae feed in rotten wood
	64	**12**	**141**	**31**		

large size and abundance, darkling beetles represent an important source of nutrition for vertebrates such as birds, reptiles, and mammals in semi-arid and arid ecosystems (e.g., Doyen 1974; Seely 1985; Floate *et al*. 2008). Predation by rodents can be an important factor in limiting darkling beetle populations in some arid ecosystems (Parmenter and MacMahon 1988).

Approach

For the purpose of this chapter, we focus on grasslands in British Columbia, Alberta, Saskatchewan, and Manitoba (see highlighted areas in Fig. 1 in Shorthouse and Larson 2010). Tenebrionidae specimens in all major insect collections in western Canada were examined by the authors in preparation for an upcoming taxonomic treatment of the fauna for Canada and Alaska.

For each native species occurring in Canadian grasslands, we summarize below their distribution in North America and within Canadian grasslands (locality names are listed in alphabetical order within each province), and we include notes on their biology when available. Dorsal habitus drawings are included for most genera and subgenera (Figs. 1–7). Most species illustrated are blackish or dark gray, although they may appear pale from the illustrations. Examples of characteristic distributional patterns for Canadian grassland species are included in Figs. 8 and 9. Note that the coastal species *Coelus ciliatus* Eschscholtz, 1829, is excluded from this treatment.

Acronyms used in the text are defined as follows: CNC, Canadian National Collection of Insects, Arachnids and Nematodes (Ottawa, Canada); USNM, National Museum of Natural History, Smithsonian Institution (Washington D.C., USA).

Annotated List of Native Darkling Beetles of Canadian Grasslands

Subfamily Pimeliinae Latreille, 1802

1. *Anepsius montanus* Casey, 1891 (Fig. 1)

Distribution in North America. This species ranges from Alberta to southeastern New Mexico (Doyen 1987).

Canadian grasslands records. ALBERTA: Medicine Hat; Onefour.

Biological information. Based on the shape of their enlarged foretibiae and their unequal protibial spurs, this species is likely associated with aeolian sand (Doyen 1987) although extensive collecting on sand dunes elsewhere in Alberta and Saskatchewan did not yield any specimens (J.H. Acorn, pers. comm.). Biological data for this species, as well as for all other species in the tribe Anepsiini, are essentially unknown (Doyen 1987).

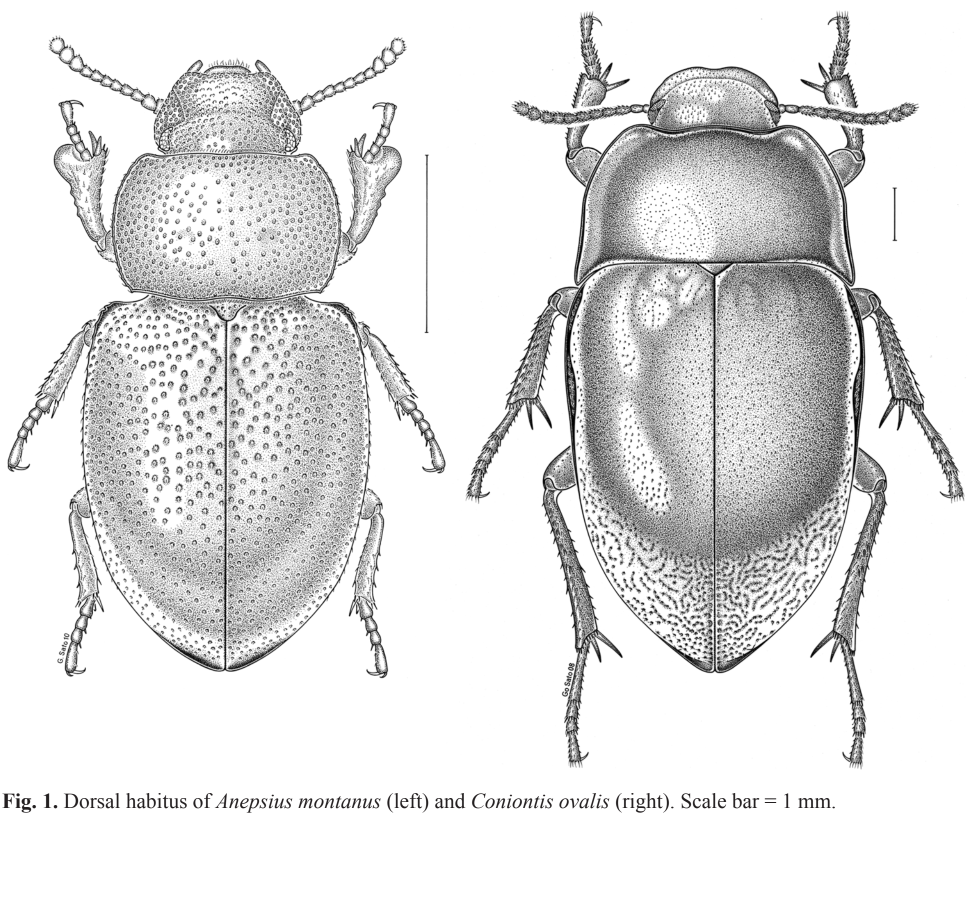

Fig. 1. Dorsal habitus of *Anepsius montanus* (left) and *Coniontis ovalis* (right). Scale bar = 1 mm.

Table 2. Distribution of darkling beetles occurring in Canadian grasslands. Abbreviations: AB = Alberta; AK = Alaska; BC = British Columbia; LB = Labrador; MB = Manitoba; NB = New Brunswick; NF = insular Newfoundland; NS = Nova Scotia; NT = Northwest Territories; NU = Nunavut; ON = Ontario; PE = Prince Edward Island; QC = Quebec; SK = Saskatchewan; YT = Yukon Territory.

Species	AK	YT	NT	NU	BC	AB	SK	MB	ON	QC	NB	NS	PE	LB	NF
Subfamily PIMELIINAE Latreille, 1802															
ANEPSIUS LeConte, 1862															
A. montanus Casey, 1891	–	–	–	–	–	AB	–	–	–	–	–	–	–	–	–
ASIDOPSIS Casey, 1912															
A. opaca (Say, 1824)	–	–	–	–	–	AB	SK	–	–	–	–	–	–	–	–
A. polita (Say, 1824)	–	–	–	–	–	AB	SK	–	–	–	–	–	–	–	–
CONIONTIS Eschscholtz, 1829															
C. ovalis LeConte, 1851	AK	–	–	–	BC	–	–	–	–	–	–	–	–	–	–
GLYPTASIDA Casey, 1912															
G. sordida (LeConte, 1853)	–	–	–	–	–	AB	SK	–	–	–	–	–	–	–	–
MELANASTUS Casey, 1907															
M. acutus (Horn, 1870)	–	–	–	–	–	AB	SK	–	–	–	–	–	–	–	–
PHILOLITHUS Lacordaire, 1859															
P. densicollis (Horn, 1894)	–	–	–	–	BC	–	–	–	–	–	–	–	–	–	–
Subfamily TENEBRIONINAE Latreille, 1802															
BLAPSTINUS Dejean, 1821															
B. discolor Horn, 1870	–	–	–	–	BC	–	–	–	–	–	–	–	–	–	–
B. intermixtus Casey, 1890	–	–	–	–	BC	–	–	–	–	–	–	–	–	–	–
B. metallicus (Fabricius, 1801)	–	–	–	–	–	AB	SK	MB	ON	QC	NB	NS	PE	–	–
B. pratensis LeConte, 1859	–	–	–	–	–	AB	–	–	–	–	–	–	–	–	–
B. substriatus Champion, 1885	–	YT	–	–	BC	AB	SK	MB	–	–	–	–	–	–	–
ELEODES Eschscholtz, 1829															
(Subgenus *Blapylis* Horn, 1870)															
E. constrictus LeConte, 1858	–	–	–	–	BC	–	–	–	–	–	–	–	–	–	–
E. novoverruculus Boddy, 1957	–	–	–	–	BC	AB	–	–	–	–	–	–	–	–	–

E. pimelioides Mannerheim, 1843	–	–	–	–	BC	–	–	–	–	–	–	–	–	–	–
E. tenebrosus Horn, 1870	–	–	–	–	BC	–	–	–	–	–	–	–	–	–	–
(Subgenus *Eleodes* Eschscholtz, 1829)															
E. hispilabris connexus LeConte, 1857	–	–	–	–	BC	–	–	–	–	–	–	–	–	–	–
E. hispilabris hispilabris (Say, 1824)	–	–	–	–	–	AB	SK	MB	–	–	–	–	–	–	–
E. obscurus sulcipennis Mannerheim, 1843	–	–	–	–	BC	–	–	–	–	–	–	–	–	–	–
(Subgenus *Litheleodes* Blaisdell, 1909)															
E. extricatus convexinotus Thomas, 2005	–	–	–	–	–	AB	SK	–	–	–	–	–	–	–	–
E. extricatus extricatus (Say, 1824)	–	–	–	–	–	AB	SK	–	–	–	–	–	–	–	–
E. vandykei modificatus Blaisdell, 1921	–	–	–	–	BC	–	–	–	–	–	–	–	–	–	–
(Subgenus *Melaneleodes* Blaisdell, 1909)															
E. humeralis LeConte, 1857	–	–	–	–	BC	–	–	–	–	–	–	–	–	–	–
E. obsoletus obsoletus (Say, 1824)	–	–	–	–	–	AB	SK	MB	–	–	–	–	–	–	–
E. tricostatus (Say, 1824)	–	–	–	–	–	AB	SK	MB	–	–	–	–	–	–	–
(Subgenus *Metablapylis* Blaisdell, 1909)															
E. nigrinus LeConte, 1858	–	–	–	–	BC	–	–	–	–	–	–	–	–	–	–
(Subgenus *Promus* LeConte, 1862)															
E. opacus (Say, 1824)	–	–	–	–	–	AB	SK	MB	–	–	–	–	–	–	–
EMBAPHION Say, 1824															
E. muricatum (Say, 1824)	–	–	–	–	–	AB	SK	–	–	–	–	–	–	–	–
HELOPS Fabricius, 1775															
H. convexulus LeConte, 1861	–	–	–	–	BC	AB	–	–	–	–	–	–	–	–	–
MECYSMUS Horn, 1870															
M. laticollis Casey, 1890	–	–	–	–	–	AB	–	–	–	–	–	–	–	–	–
Subfamily DIAPERINAE Latreille, 1802															
PLATYDEMA Laporte & Brullé, 1831															
P. americanum Laporte & Brullé, 1831	–	–	–	–	BC	AB	SK	MB	ON	QC	NB	NS	–	–	–
Total	**1**	**1**	**0**	**0**	**16**	**19**	**14**	**7**	**2**	**2**	**2**	**2**	**1**	**0**	**0**

2. *Asidopsis opaca* (Say, 1824) (Fig. 2)

Distribution in North America. This species ranges from southern Saskatchewan and Alberta to southeastern New Mexico (Chaves County, USNM) and western Texas (Brewster, Jeff Davis and Presidio Counties, USNM).

Canadian grasslands records. SASKATCHEWAN. Grasslands National Park; Great Sand Hills; Sceptre; Tompkins; Webb. ALBERTA. Empress; Medicine Hat; Milk River; Writing on Stone Provincial Park.

Biological information. Wise (1981) reported that this species is abundant and active during the middle and end of the summer in a montane community in New Mexico. Acorn (2011) mentioned that this species can be found on sand hill soils scavenging for food with species of *Eleodes*.

3. *Asidopsis polita* (Say, 1824)

Distribution in North America. This species ranges from southern Saskatchewan and Alberta south at least to central New Mexico (Torrance County, USNM) and northwestern Texas (Lamb County, CNC).

Canadian grasslands records. SASKATCHEWAN. Borden Bridge; Craven; Elbow; Eston; Fort Qu'Appelle; Grasslands National Park; Rosefield; Saint Victor; Saskatchewan Landing Provincial Park; Saskatoon; Swift Current. ALBERTA. Aden; Calgary; Empress; Hanna; Kipp; Lethbridge; Medicine Hat; Milk River; Ralston; Suffield; Taber; Tilley.

Biological information. This species can be found on sandstone exposures and in badlands along with *Glyptasida sordida* (Acorn 2011).

Table 3. Darkling beetles occurring in Canadian grasslands that are known to attack live shoots of crops in the larval stage (known as false wireworms).

Species
Subfamily TENEBRIONINAE Latreille, 1802
BLAPSTINUS Dejean, 1821
B. substriatus Champion, 1885
ELEODES Eschscholtz, 1829
(Subgenus *Blapylis* Horn, 1870)
E. pimelioides Mannerheim, 1843
(Subgenus *Eleodes* Eschscholtz, 1829)
E. hispilabris hispilabris (Say, 1824)
(Subgenus *Litheleodes* Blaisdell, 1909)
E. extricatus extricatus (Say, 1824)
(Subgenus *Melaneleodes* Blaisdell, 1909)
E. obsoletus obsoletus (Say, 1824)
E. tricostatus (Say, 1824)
(Subgenus *Metablapylis* Blaisdell, 1909)
E. nigrinus LeConte, 1858
(Subgenus *Promus* LeConte, 1862)
E. opacus (Say, 1824)
EMBAPHION Say, 1824
E. muricatum (Say, 1824)

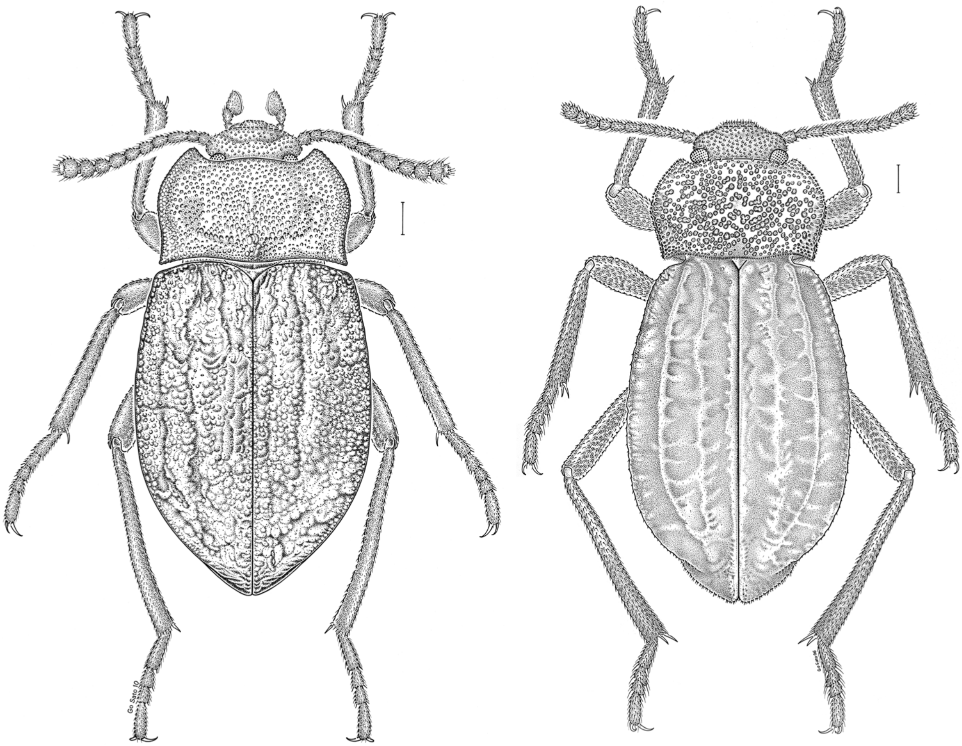

Fig. 2. Dorsal habitus of *Asidopsis opaca* (left) and *Glyptasida sordida* (right). Scale bar = 1 mm.

4. *Coniontis ovalis* LeConte, 1851 (Figs. 1, 8)

Distribution in North America. This species ranges from Vancouver Island to western Montana (Casey 1908, as *C. acerba*), and south to central Colorado (Casey 1908, as *C. inepta*) and west-central Nevada (Casey, 1890, as *C. alutacea*).

Canadian grasslands records. British Columbia. Anarchist Mountain; Apex Mountain; Armstrong; Aspen Grove; Basque; Boston Bar; Bowser; Canyon; Castlegar; Cawston; Cherryville; Chopaka; Christina Lake; Clinton; Colwood; Copper Mountain; Courtenay; Cranbrook; Creston; Departure Bay; Duncan; Faulder; Fraser Plateau; Hat Creek; Kalamalka Lake Provincial Park; Kamloops; Keremeos; Keremeos Creek; Kilpoola Lake; Lac La Hache; Langford; Lillooet; Lower Nicola; Lytton; Mandarte Island; Merritt; Metchosin; Mount Kobau; Mount Newton; Nanaimo; Nicola; Nicola Lake; Okanagan Falls; Oliver; Orofino Mountain; Osoyoos; Osoyoos Lake; Parksville; Pavilion Lake; Pavilion Mountain; Peachland; Penticton; Powell River; Princeton; Qualicum Beach; Quilchena; Robson; Saanich; Salmon Arm; Sanca; Savona; Sidney; Similkameen River; Skaha Lake; Snake Island; Soda Creek; Spence's Bridge; Squilax; Summerland; Ta Ta Creek; Trial Islands; Trinity Valley; Vancouver; Vaseux Creek; Vaseux Lake; Vernon; Victoria; Wardner; Wellington; Westbank; Westwick Lakes; Wynndel.

Biological information. Wallis and Turner (1972) reported that this species overwinters in drainage ditches fed by warm springs in central Washington State.

5. *Glyptasida sordida* (LeConte, 1853) (Fig. 2)

Distribution in North America. This species ranges from southern Alberta and southwestern Saskatchewan to northern Mexico (Lockwood and Pollock 2009).

Canadian grasslands records. SASKATCHEWAN. Maple Creek. ALBERTA. Calgary; 5 miles S Grassy Lake; Lethbridge; 30 miles S. Manyberries; Medicine Hat; Milk River; Sandy Point; Suffield; Taber.

Biological information. This species can be found on sandstone exposures and in badlands along with *Asidopsis polita* (Acorn 2011). Based on gut content, it feeds on forbs, grasses and sedges (Lavigne 1980). Throughout its range, *G. sordida* is known to occur from low altitude to over 3000 meters and in areas with annual precipitation between 15 and 92 cm (Lockwood and Pollock 2012).

6. *Melanastus acutus* (Horn, 1870) (Fig. 3)

Distribution in North America. This species is known from southern Saskatchewan, southern Alberta, and Nebraska.

Canadian grasslands records. SASKATCHEWAN. Saskatchewan Landing Provincial Park. ALBERTA. Lethbridge; Manyberries; Medicine Hat; Milk River.

Biological information. One of the specimens has the following label data "Hand picked ex *Opuntia* sp."

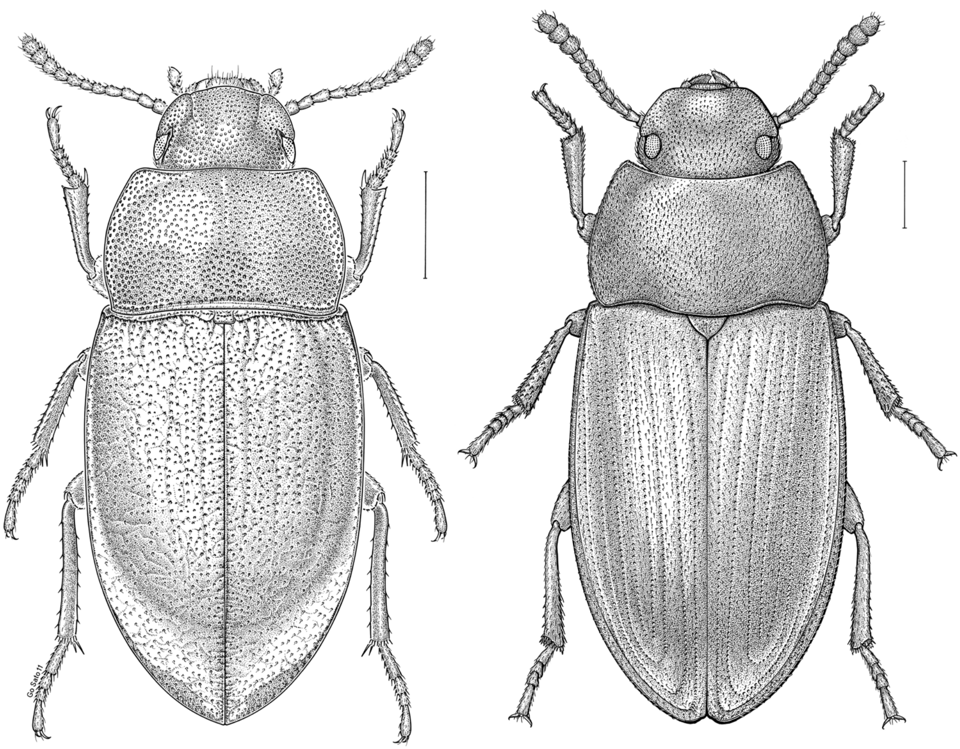

Fig. 3. Dorsal habitus of *Melanastus acutus* (left) and *Blapstinus substriatus* (right). Scale bar = 1 mm.

7. *Philolithus densicollis* (Horn, 1894) (Fig. 4)

Distribution in North America. This species is known from southeastern British Columbia, eastern Washington and northeastern Oregon (Boddy 1965).

Canadian grasslands records. British Columbia. "Southeastern British Columbia" (Boddy 1965: 137); Oliver (photo #625732 on BugGuide).

Biological information. Boddy (1965) stated, based on an observation reported by Hatch, that this species was so common at some occasions in the Yakima valley, Washington, as to being shovelled out of irrigation ditches. This species is known to feed on forbs (e.g., *Descurainia*), shrubs (e.g., *Eurotia*) as well as cryptogams (Rogers *et al*. 1988).

Subfamily Tenebrioninae Latreille, 1802

8. *Blapstinus discolor* Horn, 1870

Distribution in North America. This species ranges from south-central British Columbia to southern California, east to northern Utah (Davis 1970).

Canadian grasslands records. British Columbia. Osoyoos, 24.VI.1925, E.R. Buckell (2, CNC); idem, 9.VI.1958, H. & A. Howden (1, CNC).

Biological information. Rogers *et al*. (1988) reported that adults of this species and *B. substriatus* feed on a variety of diets including grasses, forbs, shrubs, pollen and other arthropods.

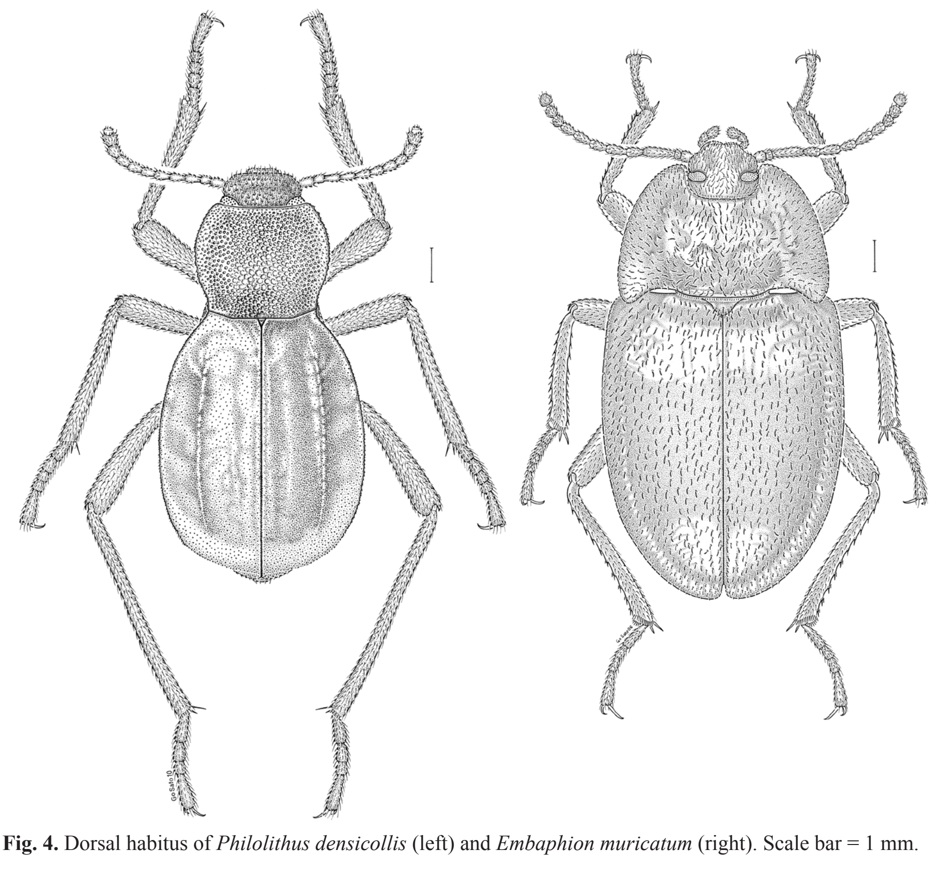

Fig. 4. Dorsal habitus of *Philolithus densicollis* (left) and *Embaphion muricatum* (right). Scale bar = 1 mm.

9. *Blapstinus intermixtus* Casey, 1890

Distribution in North America. This species ranges from south-central British Columbia to southern Arizona (Davis 1970).

Canadian grasslands records. British Columbia. 16 miles W Osoyoos, 5.VI.1968, Campbell & Smetana (4, CNC).

Biological information. We have found no information about the biology of this species.

10. *Blapstinus metallicus* (Fabricius, 1801)

Distribution in North America. This species ranges from Nova Scotia, including Sable Island, to southern Alberta, south to northern Colorado, southern Louisiana and southern Florida (Davis 1970).

Canadian grasslands records. Manitoba. Aweme; Baldur; Birds Hill Provincial Park; Brandon; Fort Garry; Ninette; Oak Lake; Rosebank; Sandilands; Shilo; Stonewall; Thornhill; Wawanesa; Winnipeg. Saskatchewan. Broadview; Canora; Craven; Douglas Provincial Park; Fort Qu'Appelle; Grandview Beach; Gull Lake; Indian Head; Kandahar; Katepwa; Kenosee; Lafleche; Mainprize Park; Maryfield; Old Wives; Punnichy; Saskatchewan Landing Provincial Park; Yorkton. Alberta. Calgary; Empress; Medicine Hat; Orion; Stettler; Tofield; Winterburn; Writing-on-Stone Provincial Park.

Biological information. This species is commonly found in swampy areas, along beaches and under leaf litter (Davis 1970). It has been reported in the literature as attacking cabbage, soybeans (Davis 1970) and tobacco (Morgan 1911).

11. *Blapstinus pratensis* LeConte, 1859

Distribution in North America. This species ranges from eastern South Dakota to southern Alberta, and south to southern Texas (Davis 1970).

Canadian grasslands records. Alberta. Near Grassy Lake; near Writing-On-Stone Provincial Park.

Biological information. This species has been recorded as attacking potato and corn roots (Davis 1970).

12. *Blapstinus substriatus* Champion, 1885 (Figs. 3, 8)

Distribution in North America. This species ranges from southern Manitoba to Vancouver Island, south to central California, southern Arizona, and southwestern Texas (Davis 1970).

Canadian grasslands records. Manitoba. Aweme; Birds Hill Provincial Park; Brandon; Elkhorn; Lower Fort Garry; Morden; Ninette; Niverville; Oak Lake; Petrel; Rosebank; Silverton; Thornhill; Treesbank; Vita; Wawanesa; Winnipeg. Saskatchewan. Abbey; Assiniboia; Avonlea; Big Beaver; Biggar; Bracken; Bromhead; Cadillac; Caton Creek; Claybank; Condie; Congress; Craven; Cypress Hill Provincial Park; Delisle; Douglas Provincial Park; Englefeld; Eston; Estuary; Forgan; Fort Qu'Appelle; Fox Valley; Grasslands National Park; Gravelbourg; Hanley; Heglund Island; Horizon; Indian Head; Kandahar; Killdeer; Lacadena; Morse; Neudorf; North Battleford; Northgate; Orkney; Oxbow; Pambrun; Pangman; Punnichy; Quinton; Regina; Roche Percee; Rockglen; Rosefield; Saskatoon; Sedley; Swift Current; Tantallon; Val Marie; Waldeck; Weyburn; Whitewood; Willows; Yorkton. Alberta. Brooks; Calgary; Claresholm; Cypress Hills; Drumheller; Edmonton; Elkwater; Empress; Etzikom; Foremost; Fort MacLeod; Jenner; Keith; Kinsella; Lake Newell; Lethbridge; Manyberries;

Medicine Hat; Milk River; Musidora; New Dayton; Onefour; Scandia; Walsh; Whitla; Winterburn. British Columbia. Aspen Grove; Baynes Lake; Brookmere; Cawston; Copper Mountain; Cranbrook; Creston; Duncan; Elko; Enderby; Fort Steele; Grindrod; Hat Creek; Kamloops; Kelowna; Langford; Lytton; Merritt; Metchosin; Midway; Mount Douglas; Mount Kobau; Mount Tolmie; Nanaimo; Nicola; Olalla; Oliver; Osoyoos; Parksville; Peachland; Princeton; Royal Oak; Saanich; Salmon Arm; Savona; Snake Island; Spence's Bridge; Summerland; Thetis Lake; Trinity Valley; Vancouver; Vernon; Victoria; Wellington; Wycliffe; Wynndel.

Biological information. This species, with populations reaching over half a million per acre, is known to cause "appreciable damage" in Saskatchewan by stem girdling wheat seedlings at soil level (misidentified as "*Blapstinus moestus*" in Beirne (1971) and Gavloski and Meers (2011)). Rogers *et al*. (1988) reported that adults of this species and *B. discolor* feed on a variety of diets including grasses, forbs, shrubs, pollen, and other arthropods.

13. *Eleodes* (*Blapylis*) *constrictus* LeConte, 1858

Distribution in North America. This species ranges from Vancouver Island south to west-central California and southeastward to northern Utah (Somerby 1972: Map 4).

Canadian grasslands records. British Columbia. Colwood; Duncan; Gabriola; Gordon Head; Kye Bay; Mandarte Island; Mount Newton; Mount Tolmie; Nanaimo; Parksville; Qualicum Beach; Royal Oak; Saanich; Saanichton; Saturna Island; Sidney; Tod Inlet; Tsawwassen; Victoria.

Biological information. No information was found regarding the biology of this species.

14. *Eleodes* (*Blapylis*) *novoverruculus* Boddy, 1957 (Fig. 9)

Distribution in North America. This species ranges from southern Alberta to south-central British Columbia, and south to northern Oregon, central Idaho and central Montana (Somerby 1972: Map 18).

Canadian grasslands records. Alberta. Lethbridge; Milk River; St. Mary River. British Columbia. Canal Flats; Chopaka; Columbia Lake; Cranbrook; Elko; Fort Steele; Kamloops; Kelowna; Keremeos Creek; Lumberton; Mount Kobau; Nicola Lake; Okanagan Falls; Okanagan Lake; Oliver; Osoyoos; Penticton; Radium; Radium Hot Springs; Skaha Lake; Summerland; Ta Ta Creek; Vaseux Creek; Vaseux Lake; Vernon; Wilmer; Wycliffe; Wynndel.

Biological information. This species of *Eleodes* feeds primarily on *Artemisia tridentata* and cryptogams in shrub-steppe ecosystems (Rogers *et al*. 1988).

15. *Eleodes* (*Blapylis*) *pimelioides* Mannerheim, 1843 (Fig. 5)

Distribution in North America. This species ranges from British Columbia south to southern California, northern Arizona and northern New Mexico.

Canadian grasslands records. British Columbia. Anarchist Mountain; Apex Mountain; Armstrong; Aspen Grove; Beach Grove; Boston Bar; Bowser; Cawston; Chopaka; Clinton; Colwood; Copper Mountain; Courtenay; Cranbrook; Crown Lake; Departure Bay; Enderby; Esquimalt; Faulder; Gordon Head; Gowlland Point; Hedley; Invermere; Kamloops; Keremeos; Lac du Bois; Langford; Lillooet; Lytton; Mandarte Island; Merritt; Metchosin; Missezula Lake; Mount Kobau; Nanaimo; Nicola; Nicola Lake; Okanagan Falls; Okanagan Landing; Oliver; 150 Mile House; Orofino Mountain; Osoyoos; Parksville; Pavilion Lake; Peachland; Penticton; Princeton; Qualicum Bay;

Saanichton; Salmon Arm; Savona; Sidney; Spence's Bridge; Summerland; Trinity Valley; Vancouver; Vaseux Creek; Vernon; Victoria; Wellington.

Biological information. No information was found regarding the biology of this species.

Note. *Eleodes pimelioides* and *E. rotundipennis* are treated as a distinct species by Somerby (1972) who pointed out that the two species are closely related and that a few examples from northern Washington show intermediacy of the diagnostic features between the two forms. The few diagnostic character states listed in Somerby's key to separate the two forms are difficult to interpret. His drawings of the male (the parameres) and female (the valvifers) genitalia of the two forms are almost identical. We have seen several hundred Canadian specimens of the complex and we are unable to recognize more than one, more or less variable morph. Therefore *E. rotundipennis* is not recognized as a distinct species in this contribution.

16. *Eleodes* (*Blapylis*) *tenebrosus* Horn, 1870

Distribution in North America. This species ranges from south-central British Columbia south to southeastern Utah, southern Nevada, and east-central California (Somerby 1972: Map 3).

Canadian grasslands records. British Columbia. Anarchist Mountain, 3600 feet; Osoyoos.

Biological information. We have found no information about the biology of this species.

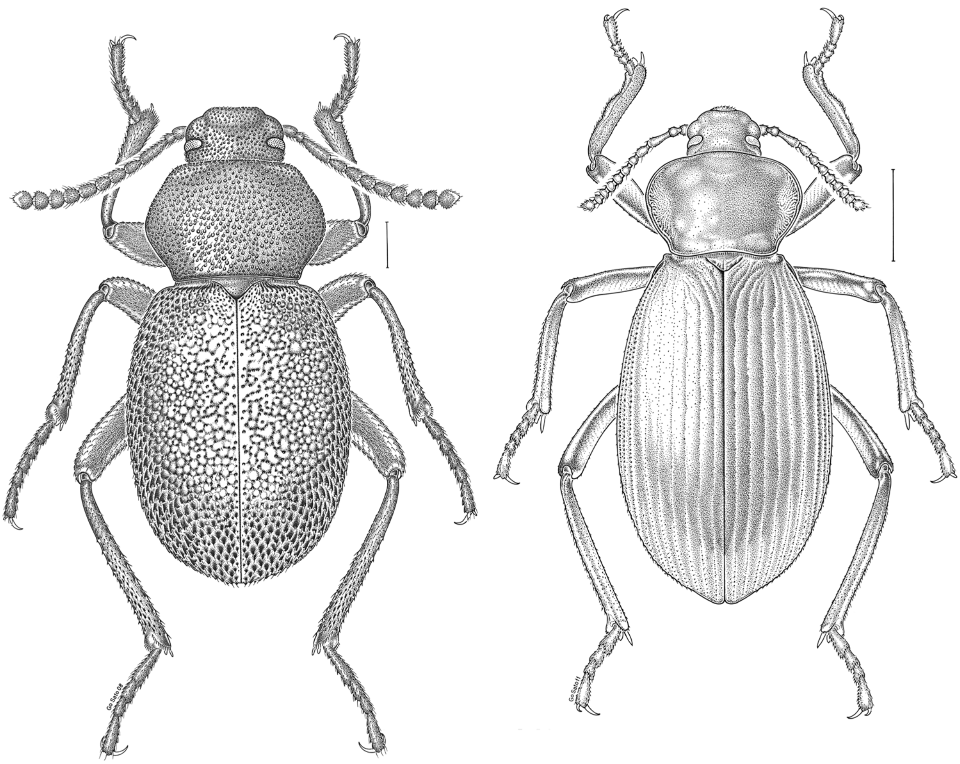

Fig. 5. Dorsal habitus of *Eleodes* (*Blapylis*) *pimelioides* (left) and *Eleodes* (*Eleodes*) *obscurus sulcipennis* (right). Scale bar = 1 mm.

17. *Eleodes* (*Eleodes*) *hispilabris connexus* LeConte, 1857

Distribution in North America. This subspecies is known from south-central British Columbia, southern Idaho, eastern Washington (Boddy 1965: 147) and northern Oregon (Blaisdell 1918: 167, as *Eleodes hispilabris* var. *imitabilis*).

Canadian grasslands records. British Columbia. Chopaka; Kalamalka Lake Park; Mount Kobau; Okanagan Falls; Oliver; Osoyoos; Penticton; Richter Pass; Skaha Lake; Summerland; Vaseux Creek; Vaseux Lake; Vernon; White Lake.

Biological information. The diet of this species in a shrub-steppe ecosystem in Washington State included forbs (e.g., *Descurainia*, *Sphaeralcea*), shrubs (e.g., *Eurotia*), cryptogams as well as arthropods (Rogers *et al*. 1988).

18. *Eleodes* (*Eleodes*) *hispilabris hispilabris* (Say, 1824)

Distribution in North America. This subspecies ranges from southern Manitoba to southern Alberta, and south to New Mexico and Texas (Blaisdell 1909).

Canadian grasslands records. Manitoba. Aweme; Boissevain; Brandon; Gilbert Plains; Hilton; Lauder; Melita; Miniota; Souris; Spruce Woods Provincial Park; Stockton; Treesbank; Wawanesa; Winnipeg. Saskatchewan. Avonhurst; Avonlea; Bromhead; Buffalo Pound Provincial Park; Cabri; Carlton; Claybank; Colonsay; Craven; Cypress Hills; Dewar Lake; Edenwold; Elbow; Eston; Findlater; Fort Qu'Appelle; Gascoigne; Grasslands National Park; Gravelbourg; Great Deer; Great Sand Hills; Gull Lake; Indian Head; Killdeer; Leader; Milestone; Morse; Pike Lake; Plato; Portreeve; Punnichy; Regina; Richmond; Roche Percee; Rockglen; Saint Victor; Saskatchewan Landing Provincial Park; Saskatoon; Sceptre; Swift Current; Val Marie; Webb; Willows; Wymark. Alberta. Alkali Creek; Blackfalds; Bow Island; Breed Creek; Brooks; Calgary; Chin; Coronation; Del Bonita; Drumheller; Dunmore; Elkwater; Empress; Foremost; Hussar; Jenner; Lethbridge; Manyberries; Medicine Hat; Milk River; Milo; Monarch; New Dayton; Onefour; Orion; Oyen; Ralston; Retlaw; Sage Creek; St. Mary River; Scandia; Taber; Winnifred.

Biological information. Acorn (2011) mentioned that this is one of the most common darkling beetle species on sand hills in western Canada along with *E. extricatus* and *E. tricostatus*. The species was observed feeding on plants of the genera *Bouteloua*, *Oxytropis* and *Sphaeralcea* (Kumar *et al*. 1976) and on a dead carabid (Lavigne 1980).

19. *Eleodes* (*Eleodes*) *obscurus sulcipennis* Mannerheim, 1843 (Fig. 5)

Distribution in North America. This subspecies ranges from south-central British Columbia south to Sonora, Chihuahua, Coahuila, and Durango in Mexico (Triplehorn pers. comm. in Cannings and Scudder 2009).

Canadian grasslands records. British Columbia. Osoyoos (Cannings and Scudder 2009: 82).

Biological information. Adults of this species are often found in or near burrows of ground squirrels and badgers (Boddy 1965).

Note. The first records of this species in British Columbia were published by Brittain (1913, 1914). Those records were subsequently used in Boddy (1965) and Bousquet and Campbell (1991). A recent search for specimens of this species in major collections in British Columbia and the CNC did not yield any specimens to substantiate the early presence of this species in the province (Cannings and Scudder 2009). However, several specimens collected in Osoyoos in the last 20 years suggest that this species does indeed occur in the province but this may represent a more recent northward expansion of its distribution from Washington State (Cannings and Scudder 2009).

20. *Eleodes* (*Litheleodes*) *extricatus convexinotus* Thomas, 2005 (Fig. 6)

Distribution in North America. This subspecies is known from southern Saskatchewan and southern Alberta and from Montana and Wyoming (Blaisdell 1909, 1942).

Canadian grasslands records. SASKATCHEWAN. Balgonie; Biggar; Colonsay; Dundurn; Elbow; Estuary; Grasslands National Park; Killdeer; Kyle; Lajord; Liberty; Mankota; Maple Creek; Morse; Ormiston; Portreeve; Regina; Richmond; Rockglen; Rosefield; Saskatoon; Strasbourg; Swift Current; Val Marie. ALBERTA. Bow Island; Brooks; Calgary; Drumheller; Elkwater; Empress; Foremost; Lethbridge; Little Bow Provincial Park; Lost River; Medicine Hat; Milk River; Monarch; Morrin; Scandia; Vulcan; Welling.

Biological information. No information was found regarding the biology of this species.

Note. The name *convexinotus* Thomas was proposed as a replacement name for *Eleodes extricata convexicollis* (Blaisdell 1909).

21. *Eleodes* (*Litheleodes*) *extricatus extricatus* (Say, 1824)

Distribution in North America. This subspecies ranges from southern Saskatchewan and southern Alberta to Arizona and Texas (Blaisdell 1909).

Canadian grasslands records. SASKATCHEWAN. Beaver Creek; Burstall; Divide; Elbow; Estuary; Great Sand Hills; Piapot; Pike Lake; Portreeve; Ravenscrag; Saskatchewan

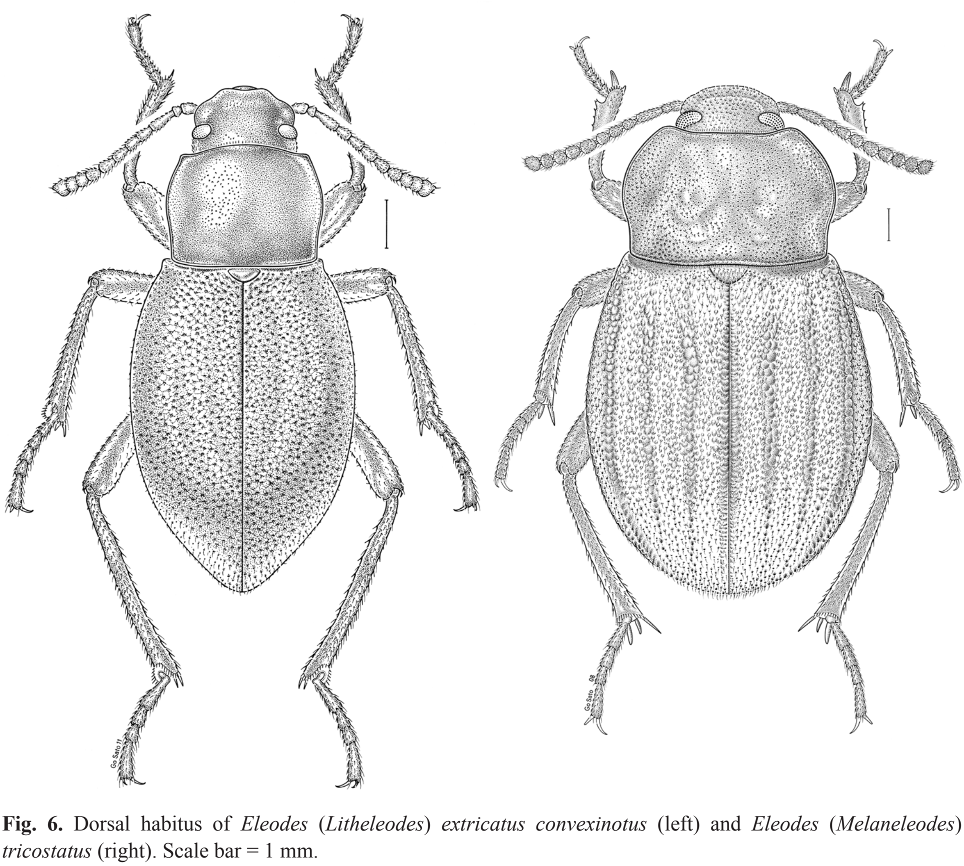

Fig. 6. Dorsal habitus of *Eleodes* (*Litheleodes*) *extricatus convexinotus* (left) and *Eleodes* (*Melaneleodes*) *tricostatus* (right). Scale bar = 1 mm.

Landing Provincial Park; Saskatoon; Tompkins; Val Marie; Waldeck. ALBERTA. Calgary; Empress; Jenner; Lethbridge; Magrath; Manyberries; Medicine Hat; Milk River; Monarch; Nemiskam; Onefour; Orion; St. Mary River; Taber; Writing-on-Stone Provincial Park.

Biological information. Acorn (2011) mentioned that this is the most common darkling beetle species on sand hills in western Canada along with *E. tricostatus* and *E. hispilabris*. In South Dakota, the taxon has been found in wheat fields, under dry cow dung and stones on sod (Kirk and Balsbaugh 1975). This subspecies was observed feeding on a dead red legged mite (Lavigne 1980).

Note. *Eleodes extricatus* currently includes two subspecies in Canada. We have studied many specimens and we believe that the two sympatric forms represent distinct species. Formal species status recognition will be published at a later date.

22. *Eleodes* (*Litheleodes*) *vandykei modificatus* Blaisdell, 1921

Distribution in North America. This subspecies is known only from southeastern British Columbia.

Canadian grasslands records. BRITISH COLUMBIA. Apex Mountain; Ashcroft; Aspen Grove; Basque; Chopaka; Faulder; Glenemma; Hat Creek; Kamloops; Keremeos Creek; Lac LeJeune; Lillooet; Lytton; Minnie Lake; Monte Creek; Mount Kobau; Naramata; Nicola; Oliver; Osoyoos; Peachland; Penticton; Princeton; Rattlesnake Hill; Roche Lake; Salmon Arm; Salmon Lake; Savona; Skaha Lake; Spence's Bridge; Summerland; Vaseux Creek; Vernon; Westbank; White Lake.

Biological information. We have found no information about the biology of this species.

23. *Eleodes* (*Melaneleodes*) *humeralis* LeConte, 1857

Distribution in North America. This species ranges from south-central British Columbia to central Utah and northern California (Tanner 1961). In Canada it is known only from the Okanagan valley in British Columbia.

Canadian grasslands records. BRITISH COLUMBIA. Chopaka; Mount Kobau; Oliver; Osoyoos; Penticton; Similkameen River; Skaha Lake; Vaseux Lake.

Biological information. Rogers *et al*. (1988) mentioned that this species feeds almost entirely on the shrubs *Artemisia tridentata* and *Chrysothamnus nauseosus* in a shrub-steppe ecosystems in south-central Washington State.

24. *Eleodes* (*Melaneleodes*) *obsoletus obsoletus* (Say, 1824)

Distribution in North America. This subspecies ranges from southern Manitoba to southern Alberta, south to New Mexico (Horn 1870) and Texas (Blaisdell 1909).

Canadian grasslands records. MANITOBA. Aweme; Boissevain; Brandon; Douglas; Treesbank. SASKATCHEWAN. Bracken; Craven; Cypress Hills; Estuary; Fort Qu'Appelle; Frenchman River; Grasslands National Park; Katepwa; Mankota; Maple Creek; Marengo; Maryfield; Regina; Rosefield; Saskatchewan Landing Provincial Park; Swift Current; Tantallon; Tunstall; Val Marie. ALBERTA. Bow Island; Calgary; Castor; Champion; Chin; Drumheller; Elkwater; Empress; Etzikom; Fort MacLeod; Hussar; Lethbridge; Lomond; Medicine Hat; Milk River; New Dayton; Oldman River; Ralston; Retlaw; St. Mary River; Scandia; Skiff.

Biological information. The species has been observed feeding on petals and stamens of *Chrysothamnus* (Lavigne 1980). In South Dakota, it has been collected under dry cow dung and stones on sod and in wheat fields (Kirk and Balsbaugh 1975).

25. *Eleodes* (*Melaneleodes*) *tricostatus* (Say, 1824) (Figs. 6, 9)

Distribution in North America. This species ranges from southern Manitoba to southern Alberta, south to New Mexico (Blaisdell 1909) and Texas (Horn 1870), and east to west central Wisconsin (Maxwell and Young 1998). It was also reported from Mexico and Arizona (Tanner 1961).

Canadian grasslands records. MANITOBA. Aweme; Bald Head Hills; Birds Hill Provincial Park; Birtle; Brandon; Carberry; Delta Beach; Glenboro; Lauder; Lyleton; McAuley; Melita; Millwood; Ninette; Portage La Prairie; Rosebank; Russell; St. Lazare; Shilo; Spruce Woods Provincial Park; Stony Mountain; Treesbank; Treherne; Wawanesa; Westbourne; Winnipeg. SASKATCHEWAN. Assiniboia; Balcarres; Borden Bridge; Broadview; Canora; Caton Creek; Chaplin; Claybank; Concrete Coulee; Cypress Hills Provincial Park; Douglas Provincial Park; Elbow; Estevan; Estuary; Flaxcombe; Fort Qu'Appelle; Fort Walsh; Glentworth; Good Spirit Lake Provincial Park; Grandview Beach; Great Deer; Great Sand Hills; Grenfell; Hague; Indian Head; Kenosee; Killdeer; Kyle; Lebret; MacDowall; Maple Creek; Morse; Mortlach; Mozart; Old Wives Lake; Paynton; Pike Lake Provincial Park; Pilot Butte; Plunkett; Punnichy; Regina; Roche Percee; Rockglen; Rosefield; Rush Lake; Saskatoon; Sceptre; Shamrock Regional Park; Sturgis; Sutherland; Swift Current; Tantallon; Vonda; Willows; Winter; Yorkton. ALBERTA. Brooks; Calgary; Chin; Cluny; Coronation; Cypress Hills; Edmonton; Elkwater; Empress; Foremost; Grainger; High River; Jenner; Keith; Lethbridge; Little Fish Lake Provincial Park; Lost River; Manyberries; Medicine Hat; Milk River; Monarch; Morrin; New Dayton; Onefour; Oyen; Redwater; St. Mary River; Salt Lake; Sedgewick; Sunnydale; Taber; Wetaskiwin; Wild Horse; Winterburn; Writing on Stone Provincial Park.

Biological information. Acorn (2011) mentioned that this is one of the most common darkling beetle species on sand hills in western Canada along with *E. extricatus* and *E. hispilabris*. In South Dakota, the species is found in corn fields, wheat fields, sod, under dry cow dung and stones (Kirk and Balsbaugh 1975).

26. *Eleodes* (*Metablapylis*) *nigrinus* LeConte, 1858

Distribution in North America. This species ranges from southern British Columbia, including Vancouver Island, to Nebraska, and south to New Mexico, Arizona, and northeastern California (Blaisdell 1929).

Canadian grasslands records. BRITISH COLUMBIA. Anarchist Mountain; Canal Flats; Cawston; Chopaka; Cowichan Bay; Cranbrook; Fairmont Hot Springs; Invermere; Keremeos Creek; Kimberley; Mount Kobau; Okanagan Falls; Oliver; Osoyoos; Penticton; Radium; Richter Pass; Skaha Lake; Summerland; Vaseux Creek; Vaseux Lake; Windermere.

Biological information. This species is known to feed on a variety of diets including the forb *Descurainia pinnata* and the shrubs *Artemesia tridentata* and *Eurotia lanata* (Rogers *et al.* 1988). Scudder (1994) listed this species as potentially rare and endangered in British Columbia.

27. *Eleodes* (*Promus*) *opacus* (Say, 1824) (Fig. 7)

Distribution in North America. This species ranges from southern Manitoba to southern Alberta, south to Texas (Blaisdell 1909).

Canadian grasslands records. MANITOBA. Aweme; Bald Head Hills; Baldur; Birds Hill Provincial Park; Boissevain; Brandon; Hilton; Lauder; Lyleton; Morden;

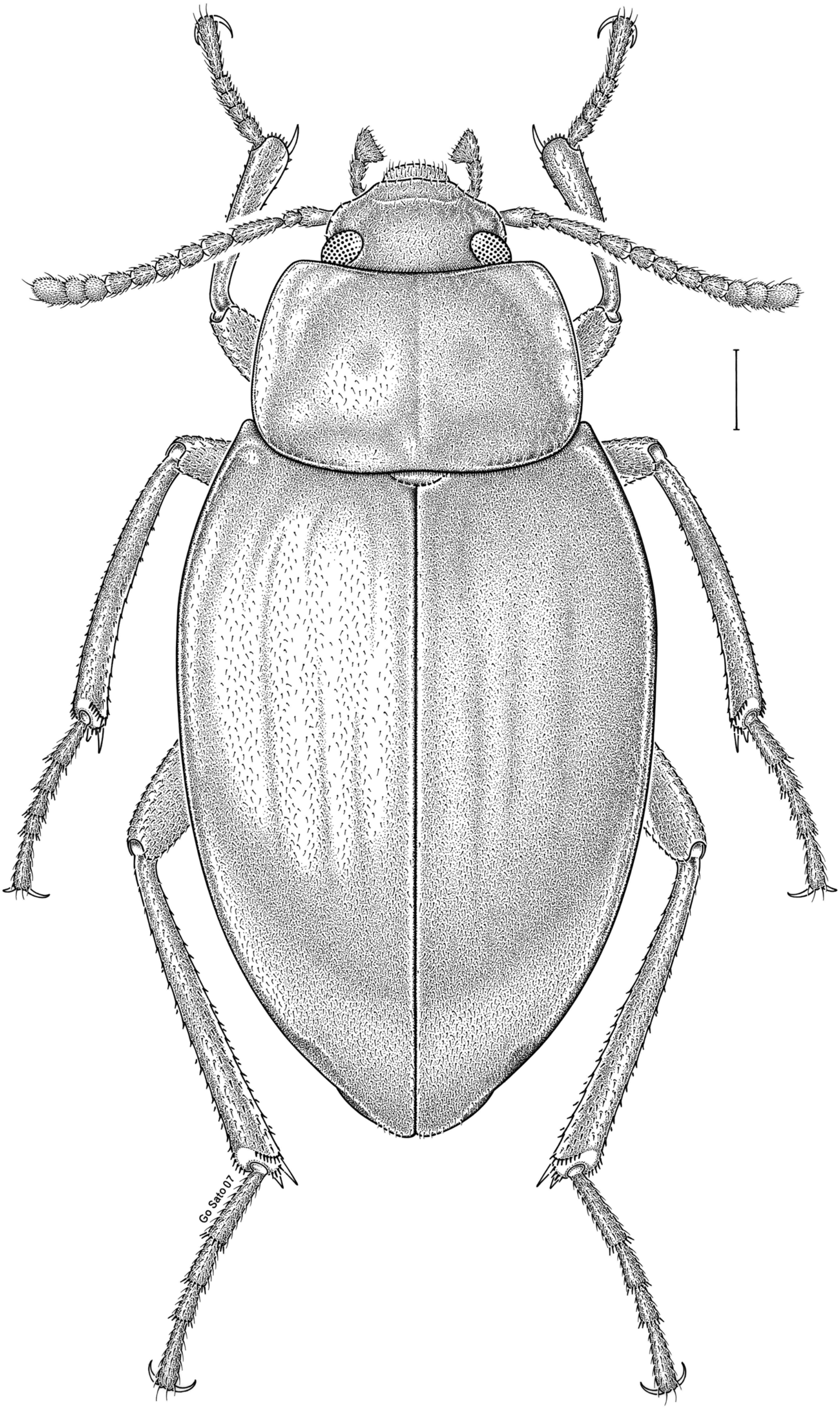

Fig. 7. Dorsal habitus of *Eleodes* (*Promus*) *opacus*. Scale bar = 1 mm.

Napinka; Rosebank; Spruce Woods Provincial Park; Treesbank; Winkler; Winnipeg. SASKATCHEWAN. Bradwell; Claybank; Echo Valley Provincial Park; Elrose; Estevan; Fox Valley; Grandview Beach; Grasslands National Park; Grenfell; Kenosee; Lebret; Mainprize Park; Maple Creek; Piapot; Pike Lake; Pilot Butte; Regina; Saskatchewan Landing Provincial Park; Saskatoon; Sceptre; Tompkins; Twelve Mile Lake. ALBERTA. Brooks; Chin; Craddock; Foremost; Legend; Lethbridge; Lost River; Medicine Hat; Milk River; Pearce; Scandia; Taber; Travers; Vauxhall; Whitla; Wilson; Wrentham; Writing-on-Stone Provincial Park.

Biological information. This species is found in South Dakota in wheat fields, corn fields, sod, under dry cow dung and stones (Kirk and Balsbaugh 1975).

28. *Embaphion muricatum* (Say, 1824) (Fig. 4)

Distribution in North America. This prairie species ranges from southern Alberta and southern Saskatchewean south to Texas (Blaisdell 1909).

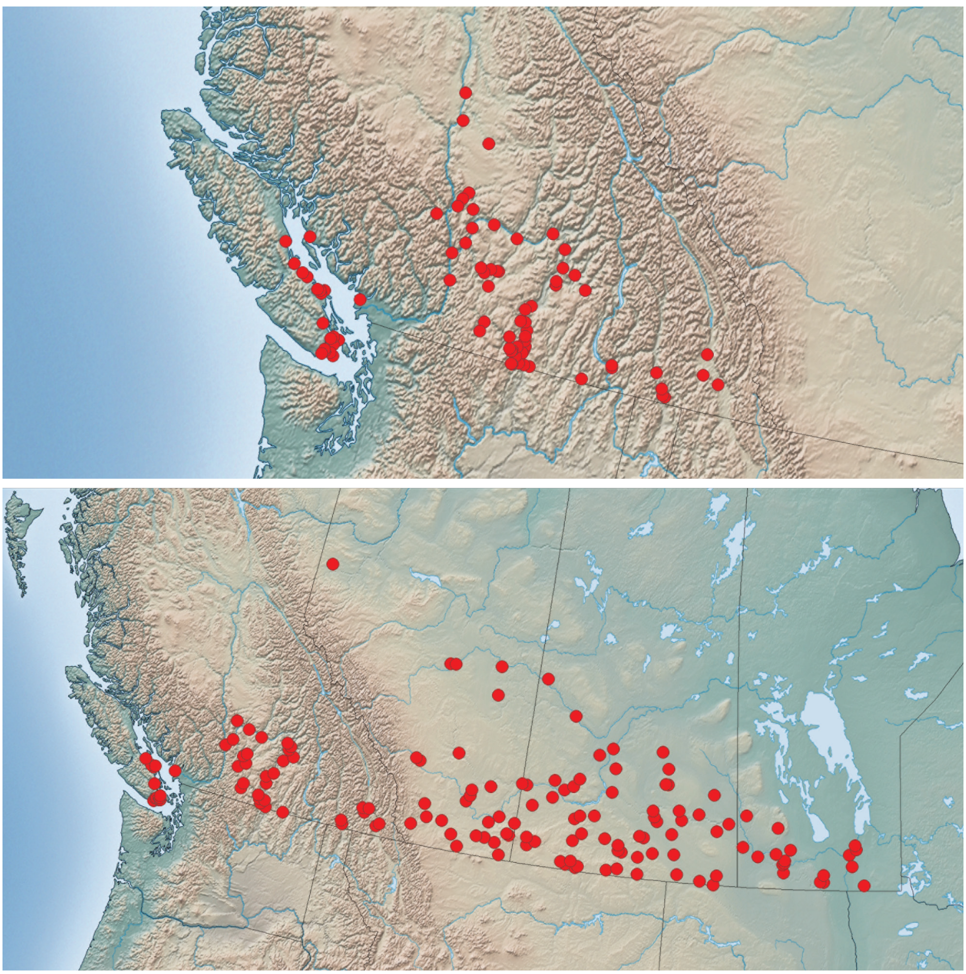

Fig. 8. Distribution map for *Coniontis ovalis* (top) and *Blapstinus substriatus* (bottom) in Canadian grasslands.

Canadian grasslands records. SASKATCHEWAN. Grasslands National Park; Tompkins. ALBERTA. Chin; Dunmore; Grassy Lake; Medicine Hat; Suffield.

Biological information. Under laboratory conditions, adults and larvae of this species fed on a wide variety of seeds but preferred wheat, hulless oats, and rye (Calkins and Kirk 1974).

29. *Helops convexulus* LeConte, 1861

Distribution in North America. This species ranges from southwestern Alberta to the Fraser Valley in southern British Columbia, and south to Colorado (Papp 1961).

Canadian grasslands records. BRITISH COLUMBIA. Aspen Grove; Baynes Lake; Canal Flats; Cawston; Columbia Lake; Cranbrook; Edgewater; Elko; Fort Steele; Kaleden; Kamloops; Marysville; Mount Kobau; Nicola; Nicola Lake; Oliver; Osoyoos; Penticton; Radium; Salmon Arm; Savona; Skookumchuck; Summerland; Vernon; White Lake; Wycliffe.

Biological information. We have found no information about the biology of this species.

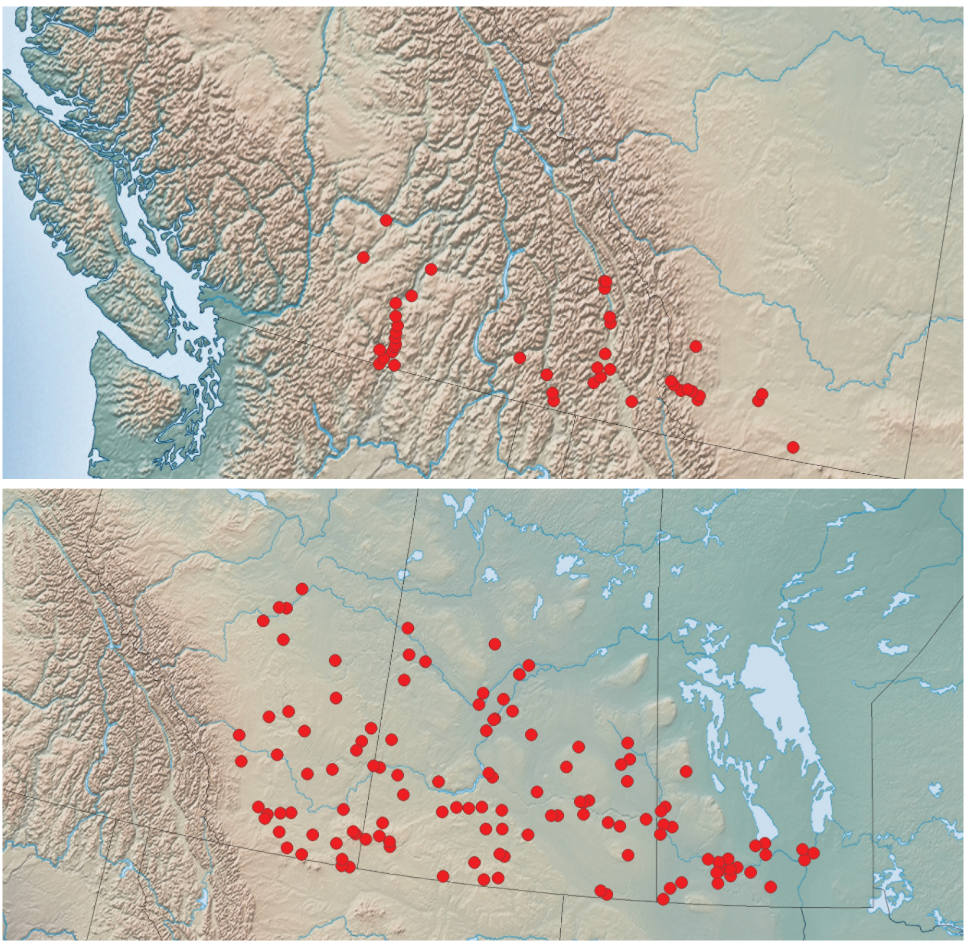

Fig. 9. Distribution map for *Eleodes* (*Blapylis*) *novoverruculus* (top) and *Eleodes* (*Melaneleodes*) *tricostatus* (bottom) in Canadian grasslands.

30. ***Mecysmus laticollis*** **Casey, 1890**

Distribution in North America. This genus, which contains five species in western North America, needs revision (Aalbu *et al.* 2002*b*). Based on a close examination of type material, *M. laticollis* appears to be only known from the type locality, El Paso in westernmost Texas, and the locality reported here.

Canadian grasslands records. ALBERTA. Taber Provincial Park.

Biological information. No information was found regarding the biology of this species.

Subfamily Diaperinae Latreille, 1802

31. ***Platydema americanum*** **Laporte & Brullé, 1831**

Distribution in North America. This species ranges from New Brunswick to southern British Columbia, and south to southern California, Texas and North Carolina (Triplehorn 1965).

Canadian grasslands records. MANITOBA. Aweme; Winnipeg. ALBERTA. Edmonton. BRITISH COLUMBIA. Copper Mountain; Cranbrook; Faulder; Kamloops; Lytton; Merritt; Oliver; Osoyoos; Peachland; Trinity Valley; Vernon.

Biological information. Although this species is broad-ranging in North America and is not restricted to grassland habitats, the adults are nevertheless commonly found in some grassland sites. Members of this genus are closely associated with fungi (Triplehorn 1965).

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References

Aalbu, R.L., Flores, G.E., and Triplehorn, C.A. 2002*a*. Tenebrionidae. *In* Biodiversidad, taxonomía y biogeografía de artrópodos de México: Hacia una síntesis de su conocimiento, Vol. 3. *Edited by* J.L. Bousquets and J.J. Morrone. Universidad Nacional Autónoma de México, México. pp. 499–512.

Aalbu, R.L., Triplehorn, C.A., Campbell, J.M., Brown, K.W., Somerby, R.E., and Thomas, D.B. 2002*b*. Tenebrionidae Latreille 1802. *In* American Beetles, Vol. 2: Polyphaga: Scarabaeoidea through Curculionoidea. *Edited by* R.H. Arnett, Jr., M.C. Thomas, P.E. Skelley, and J.H. Frank. CRC Press, New York. pp. 463–509.

Acorn, J.H. 2011. Sand hill arthropods in Canadian grasslands. *In* Arthropods of Canadian Grasslands, Vol. 2: Inhabitants of a Changing Landscape. *Edited by* K.D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 25–43.

Allsopp, P.G. 1980. The biology of false wireworms and their adults (soil-inhabiting Tenebrionidae) (Coleoptera): a review. Bulletin of Entomological Research, **70**: 343–379.

Beirne, B.P. 1971. Pest insects of annual crop plants in Canada. I, Lepidoptera; II, Diptera; III, Coleoptera. Memoirs of the Entomological Society of Canada, **78**: 1–124.

Blaisdell, F.E. 1909. A monographic revision of the Coleoptera belonging to the tenebrionide tribe Eleodiini inhabiting the United States, lower California, and adjacent islands. Smithsonian Institution, United States National Museum Bulletin, **63**: 1–524.

Blaisdell, F.E. 1918. Studies in the tenebrionid tribe Eleodiini. No. 3 (Coleop.). Entomological News, **29**: 162–169.

Blaisdell, F.E. 1929. Revised synopsis of the species of *Eleodes* belonging to the subgenus *Metablapylis* with description of two new species (Coleoptera). Pan-Pacific Entomologist, **5**: 163–166.

Blaisdell, F.E. 1942. Miscellaneous studies in the Coleoptera, no. 6 (Melyridae and Tenebrionidae). Transactions of the American Entomological Society, **68**: 129–149.

Boddy, D.W. 1965. Family Tenebrionidae. *In* The Beetles of the Pacific Northwest, Part IV: Macrodactyles, Palpicornes, and Heteromera. *Edited by* M.H. Hatch. University of Washington Press, Seattle. pp. 130–189.

Bouchard, P., Bousquet, Y., Davies, A.E., Alonso-Zarazaga, M.A., Lawrence, J.F., Lyal, C.H.C., Newton, A.F., Reid, C.A.M., Schmitt, M., Slipinski, S.A., and Smith, A.B.T. 2011. Family-group names in Coleoptera (Insecta). ZooKeys, **88**: 1–972.

Bouchard, P., Grebennikov, V.V., Smith, A.B.T., and Douglas, H. 2009. Biodiversity of Coleoptera. *In* Insect Biodiversity: Science and Society. *Edited by* R.G. Foottit and P.H. Adler. Blackwell Publishing, Oxford, U.K. pp. 265–301.

Bouchard, P., Lawrence, J.F., Davies, A.E., and Newton, A.F. 2005. Synoptic classification of the world Tenebrionidae (Insecta: Coleoptera) with a review of family-group names. Annales Zoologici, **55**: 499–530.

Bousquet, Y, Bouchard, P., Davies, A.E., and Sikes, D.S. 2013. Checklist of Beetles (Coleoptera) of Canada and Alaska. Second Edition. Pensoft, Sofia-Moscow.

Brittain, W.H. 1913. Report from Okanagan district. Proceedings of the Entomological Society of British Columbia, **2**: 13–16.

Brittain, W.H. 1914. Report from Okanagan district: insect pests of the year in the Okanagan. Proceedings of the Entomological Society of British Columbia, **4**: 14–19.

Calkins, C.O., and Kirk, V.M. 1974. Food preferences of *Embaphion muricatum*. Environmental Entomology, **3**: 247–248.

Cannings, R.A., and Scudder, G.G.E. 2009. *Eleodes obscurus* (Coleoptera: Tenebrionidae): confirmation of a Canadian population and possible northward expansion from Washington State into British Columbia in the Okanagan Valley. Journal of the Entomological Society of British Columbia, **106**: 81–82.

Casey, T.L. 1890. Coleopterological Notices. II. Annals of the New York Academy of Sciences, **5** [1889–91]: 307–504.

Casey, T.L. 1908. A revision of the tenebrionid subfamily Coniontinae. Proceedings of the Washington Academy of Sciences, **10**: 51–166.

Davis, J.C. 1970. Revision of the Genus *Blapstinus* Sturm of America North of Mexico with Notes on Extralimital Species (Coleoptera: Tenebrionidae). Ph.D. thesis, The Ohio State University, Columbus.

Doyen, J.T. 1974. Differential predation of darkling ground beetles (Coleoptera: Tenebrionidae) by Channel Islands fox. The Pan-Pacific Entomologist, **50**: 86–87.

Doyen, J.T. 1987. Review of the tenebrionid tribe Anepsiini (Coleoptera). Proceedings of the California Academy of Sciences, **44**: 343–371.

Floate, K., Bouchard, P., Holroyd, G., Poulin, R.G., and Wellicome, T. 2008. Does doramectin use on cattle indirectly affect the endangered burrowing owl? Rangeland Ecology & Management, **61**: 543–553.

Gavloski, J., and Meers, S. 2011. Arthropods of cereal crops in Canadian grasslands. *In* Arthropods of Canadian Grasslands, Vol. 2: Inhabitants of a Changing Landscape. *Edited by* K.D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 217–237.

Horn, G.H. 1870. On the revision of the Tenebrionidae of America, north of Mexico. Transactions of the American Philosophical Society, **14**: 253–404.

Kirk, V.M., and Balsbaugh, E.U., Jr. 1975. A list of the beetles of South Dakota. South Dakota State University Agricultural Experiment Station Technical Bulletin, **42**: 1–139.

Kumar, R., Lavigne, R.J., Lloyd, J.E., and Pfadt, R.E. 1976. Insects of the Central Plains Experiment Range, Pawnee National Grassland. Wyoming Agricultural Experiment Station, Science Monograph, **32**: 1–74.

Lavigne, R.J. 1980. Food of some shortgrass prairie Coleoptera. Entomological News, **91**: 37–42.

Lockwood, S.A., and Pollock, D.A. 2009. A review of the genus *Glyptasida* Casey (Coleoptera: Tenebrionidae: Asidini). Zootaxa, **2023**: 1–27.

Lockwood, S.A., and Pollock, D.A. 2012. Landscape and habitat attributes of species of *Glyptasida* Casey (Coleoptera: Tenebrionidae). The Coleopterists Bulletin, **66**: 15–22.

Marske, K.A., and Ivie, M.A. 2003. Beetle fauna of the United States and Canada. The Coleopterists Bulletin, **57**: 495–503.

Matthews, E.G., and Bouchard, P. 2008. Tenebrionid Beetles of Australia: Descriptions of Tribes, Keys to Genera, Catalogue of Species. Australian Biological Resources Study, Canberra.

Matthews, E.G., Lawrence, J.F., Bouchard, P., Steiner, W.E., and Slipinski, S.A. 2010. Tenebrionidae Latreille, 1802. *In* Handbook of Zoology: A Natural History of the Phyla of the Animal Kingdom, Vol. IV: Arthropoda: Insecta. Part 38: Coleoptera, Beetles. Vol. 2: Systematics (Part 2). *Edited by* R.A.B. Leschen, R.G. Beutel, and J.F. Lawrence. Walter de Gruyter, Berlin. pp. 574–659.

Maxwell, J.A., and Young, D.K. 1998. A significant eastern range extension for *Eleodes tricostatus* (Say) (Coleoptera: Tenebrionidae). The Coleopterists Bulletin, **52**: 90–92.

Morgan, A.C. 1911. Insect enemies of tobacco in the United States. *In* Yearbook of the United States Department of Agriculture - 1910. Government Printing Office, Washington (DC). pp. 281-296.
Papp, C.S. 1961. Checklist of Tenebrionidae of America, north of the Panama canal. Opuscula Entomologica, **26**: 97–140.
Parmenter, R.R., and MacMahon, J.A. 1988. Factors limiting populations of arid-land darkling beetles (Coleoptera: Tenebrionidae): predation by rodents. Environmental Entomology, **17**: 280–286.
Rogers, L.E., Woodley, N.E., Sheldon, J.K., and Beedlow, P.A. 1988. Diets of darkling beetles (Coleoptera: Tenebrionidae) within a shrub-steppe ecosystem. Annals of the Entomological Society of America, **81**: 782–791.
Scudder, G.G.E. 1994. An annotated systematic list of the potentially rare and endangered freshwater and terrestrial invertebrates in British Columbia. Entomological Society of British Columbia, Occasional Paper, **2**: 1–92.
Seely, M. 1985. Predation and environment as selective forces in the Namib Desert. *In* Species and Speciation. *Edited by* E.S. Vrba. Transvaal Museum Monograph, **4**: 161–165.
Shorthouse, J.D., and Larson, D.J. 2010. Introduction to the grasslands and grassland arthropods of Canada. *In* Arthropods of Canadian Grasslands, Vol. 1: Ecology and Interactions in Grassland Habitats. *Edited by* J.D. Shorthouse and K.D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 1–24.
Somerby, R.E. 1972. Systematics of *Eleodes* (*Blapylis*) with a Revision of the *caseyi* Group Using Taximetric Methods (Coleoptera: Tenebrionidae). Ph.D. thesis, University of California, Riverside.
Tanner, V.M. 1961. A check-list of the species of *Eleodes* and descriptions of new species (Coleoptera-Tenebrionidae). The Great Basin Naturalist, **21**: 55–78.
Triplehorn, C.A. 1965. Revision of Diaperini of America north of Mexico with notes on extralimital species (Coleoptera: Tenebrionidae). Proceedings of the United States National Museum, **117**: 349–458.
Wallis, R.L., and Turner, J.E. 1972. Insects overwintering in the warm microenvironment of drainage ditches in central Washington. Environmental Entomology, **1**: 107–109.
Wise, D.H. 1981. Seasonal and yearly patterns in the densities of darkling beetles (Coleoptera: Tenebrionidae) in a montane community. Environmental Entomology, **10**: 350–358.

Chapter 4
Weevils (Coleoptera: Dryophthoridae, Brachyceridae, Curculionidae) of the Prairies Ecozone in Canada

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Abstract. Weevils are a diverse group of plant-feeding beetles and occur in most terrestrial and freshwater ecosystems. This chapter documents the diversity and distribution of 295 weevil species found in the Canadian Prairies Ecozone belonging to the families Dryophthoridae (9 spp.), Brachyceridae (13 spp.), and Curculionidae (273 spp.). Weevils in the Prairies Ecozone represent approximately 34% of the total number of weevil species found in Canada. Notable species with distributions restricted to the Prairies Ecozone, usually occurring in one or two provinces, are candidates for potentially rare or endangered status.

Résumé. Les charançons forment un groupe diversifié de coléoptères phytophages et sont présents dans la plupart des écosystèmes terrestres et dulcicoles. Le présent chapitre décrit la diversité et la répartition de 295 espèces de charançons vivant dans l'écozone des prairies qui appartiennent aux familles suivantes : Dryophthoridae (9 spp.), Brachyceridae (13 spp.) et Curculionidae (273 spp.). Les charançons de cette écozone représentent environ 34 % du total des espèces de ce groupe présentes au Canada. Certaines espèces notables, qui ne se trouvent que dans cette écozone — habituellement dans une ou deux provinces — mériteraient d'être désignées rares ou en danger de disparition.

Introduction

Weevils (Curculionoidea) are one of the most diverse groups of insects. Worldwide, they currently include about 5,800 described genera and 62,000 species (Oberprieler *et al*. 2007; Ślipiński *et al.* 2011), most of these in the species-rich family Curculionidae. The total number of existing weevil species has been estimated at about 220,000 (Oberprieler *et al*. 2007), but it may well be higher as more hyperdiverse tropical genera are comprehensively studied.

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In Canada there are nearly 900 species of Dryophthoridae, Brachyceridae, and Curculionidae (Table 1; Bousquet *et al*. 2013). This temperate fauna is much less diverse at the species level than it is at tropical latitudes, but representatives of most subfamilies extend at least into southern Canada. Weevils feed on virtually all taxa of higher plants and on nearly all plant parts in both terrestrial and freshwater habitats. Although most weevils are closely associated with angiosperms, members of some groups develop more or less exclusively on gymnosperms, especially in the order Pinales (conifers) but also on Cycadales (cycads), Ephedrales, and Gnetales (Oberprieler *et al*. 2007). Weevil larvae generally feed on stressed, diseased, or dying plant parts, appearing to exploit the short stage between the life and death of plants in which their tissues are no longer strongly defended by chemical deterrents or toxins but still contain sufficient nutrients for rapid larval growth (Oberprieler *et al*. 2007).

Because of their generally strict association with particular species or genera of plants, many weevil species are regarded as major or minor pests of agricultural crops, of the

Table 1. Overall diversity of weevils (Dryophthoridae, Brachyceridae, Curculionidae) in Canada and in the Prairies Ecozone. Numbers are also given for each subfamily for the diverse family Curculionidae.

Family/Subfamily	Genera in Canada (#)	Genera in Prairies Ecozone (#)	Genera in Prairies Ecozone (%)	Species in Canada (#)	Species in Prairies Ecozone (#)	Species in Prairies Ecozone (%)
Dryophthoridae Schönherr, 1825	4	1	25.0	27	9	33.3
Brachyceridae Billberg, 1820	10	6	60.0	19	13	68.4
Curculionidae Latreille, 1802	238	109	45.8	823	273	33.2
Curculioninae Latreille, 1802	33	23	69.7	161	87	54.4
Bagoinae Thomson, 1859	2	2	100.0	13	5	38.5
Baridinae Schönherr, 1836	25	11	44.0	37	14	37.8
Ceutorhynchinae Gistel, 1848	31	24	77.4	85	54	62.8
Conoderinae Schönherr, 1833	4	1	25.0	10	2	20.0
Cossoninae Schönherr, 1825	13	3	23.1	29	4	13.8
Cryptorhynchinae Schönherr, 1825	7	3	42.9	16	6	37.5
Cyclominae Schönherr, 1826	1	1	100.0	26	16	61.5
Entiminae Schönherr, 1823	48	22	45.8	111	37	33.3
Hyperinae Marseul, 1863	2	1	50.0	12	9	75.0
Lixinae Schönherr, 1823	7	5	71.4	28	17	60.7
Mesoptiliinae Lacordaire, 1863	2	1	50.0	20	1	5.0
Molytinae Schönherr, 1823	14	3	21.4	56	7	12.5
Scolytinae Latreille, 1804	48	9	18.8	218	14	6.4
Platypodinae Shuckard, 1839	1	0	0.0	1	0	0.0
	252	**116**	**46.0**	**869**	**295**	**33.9**

forestry industry, and of ornamental plants (Campbell *et al*. 1989). Conversely, several species have been successfully used as biological control agents of various noxious weeds around the world (O'Brien 1995), in several cases achieving spectacular success in reducing populations of weeds to negligible levels. Weevils are also important pollinators of certain plants, in particular cycads, palms, and the more primitive lineages of dicotyledonous angiosperms. Weevils are often common as Quaternary fossils and play an important role in our understanding of recent past ecosystems, particularly in Asia and North America (Elias 2010).

No previous attempts have been made to document the curculionoid fauna of the Canadian Prairies Ecozone despite it being home to some of the most threatened of Canadian natural habitats and to some rare and potentially endemic species of weevils. Over the years, a number of species of Curculionidae (e.g., *Centrinogyna canadensis*, *Ceutorhynchus dubitans*, *C. handfordi*, *C. hearnei*, and *Asperosoma echinatum*) have been described from Canadian prairie localities but not (or rarely) recorded since or elsewhere. Herein we present an overview of the species of Dryophthoridae, Brachyceridae, and Curculionidae recorded from the Prairies Ecozone in the provinces of Alberta, Saskatchewan, and Manitoba.

Approach

We use data from Bousquet *et al*. (2013) as the authoritative source for all distribution records of weevils in the provinces and territories of Canada, as well as in Alaska (Table 2). The list in Table 2 does not include all weevil species found in Alberta, Saskatchewan, and Manitoba, but is restricted to species of dryophthorid, brachycerid, and curculionid weevils known or likely to be associated with grassland habitats, as well as wetlands and riparian (or other) parklands within the greater Prairies Ecozone. We do not include species recorded from the Cypress Upland Ecoregion, as this is a discrete outlier of the Montane Cordillera Ecozone that occurs on the lower slopes of the Rocky Mountains to the west. We identify as notable species (see "Systematic Review" section below) those with distributions restricted to the Prairies Ecozone and usually occurring in one or two provinces. These are likely to be endemic to these provinces within Canada and/or may be candidates for potentially rare or endangered status; however, we do acknowledge that their apparent rarity may be an artifact of inadequate collecting, especially for small-sized species that may be highly host specific. Species that cause economic damage to stored products (i.e., *Sitophilus* spp.) were discussed by White *et al*. (2011) and are therefore excluded here. We summarize known plant associations, feeding type, and species status as a pest or biological control agent. Weevil classification follows Bousquet *et al*. (2013).

Weevils of the Prairies Ecozone

General Biology

All weevils associated with the Prairies Ecozone in Canada are phytophagous. Two basic life history patterns can be generalized (Anderson 1993). One has larvae that feed internally on the host plants, mainly on reproductive structures, or in stems, or as leaf miners. These species tend to be host specific. The second pattern, predominantly in the curculionid subfamily Entiminae, has larvae that feed in the soil on the roots of the host plants, sometimes forming chambers in the soil or on the root in which the larvae live. These species tend to be unspecialized in terms of host associations. Across Curculionidae, the first pattern predominates, with most weevils being host specific to varying degrees. Certain genera have specific plant associations (e.g., *Ceutorhynchus* on Brassicaceae, *Tychius* on Fabaceae, *Dorytomus* on Salicaceae) (Anderson 1993). All prairie bark beetle species (curculionid subfamily Scolytinae) are phloeophagous (phloem-feeding) or phloeomycetophagous (feed on both phloem and associated symbiotic fungi) in broadleaved trees, and their larvae develop in parental galleries. Plant taxa most frequently serving as hosts in the Prairies Ecozone are Asteraceae, Brassicaceae, Cyperaceae, Fabaceae, Rosaceae, and Salicaceae.

Habitat Associations

Information on specific habitat associations is lacking for most prairie weevils. Certain higher taxa have species that often are limited to general habitats. For example, Bagoinae, Cyclominae, and Erirhininae (Stenopelmini) are almost exclusively found in wetlands (Anderson 1993). Taxa associated with Salicaceae are associated with riparian zones (adjacent to aquatic habitats) or other parklands (Anderson 1993). Generally, habitat associations are dictated by the occurrence of the host plants.

Most species of Scolytinae in the Prairie Provinces are associated with coniferous trees, which are found mainly northward and westward of the grassland biomes. The 14 scolytine species listed in Table 2 are associated with broadleaved trees and shrubs occurring within grassland habitats. All phloeomycetophagous species are in the tribe Xyloterini; the region may be climatically inhospitable for Xyleborinae, which dominate this feeding guild in warmer parts of North America.

Pests

A number of weevil species that occur in the Prairies Ecozone are known to be injurious to crops (Campbell *et al*. 1989). Generally, these are species introduced accidentally (adventive) into Canada from other regions of the world, and either attack specific cultivated plant species (e.g., the cabbage seedpod weevil *Ceutorhynchus obstrictus* on canola (*Brassica napus* L.)) (Dosdall and Cárcamo 2011) or feed on a broad number of host plants in the larval stage, including crops (e.g., root weevils in the curculionid subfamily Entiminae; see Bright and Bouchard (2008) for additional data).

The native *Hylurgopinus rufipes* and the non-native *Scolytus multistriatus* and *Scolytus schevyrewi* are all vectors of *Ophiostoma* spp. fungi, the causative agents of Dutch elm disease of *Ulmus* spp. *Scolytus schevyrewi* has also been observed to directly cause elm mortality (Negron *et al.* 2005).

Among bark beetles of the subfamily Scolytinae, some native *Hylesinus* spp. are minor pests of *Fraxinus* spp. These scolytines are now possibly at risk of extinction (Gandhi and Herms 2010) because of widespread ash mortality caused by *Agrilus planipennis* Fairmaire, 1888 (the emerald ash borer beetle). The native *Chaetophloeus heterodoxus* and *Phloeotribus liminaris* are both occasional pests of *Prunus* spp. and *Pyrus* sp. (Bright 1976; Campbell *et al*. 1989), although these are probably seldom cultivated in the Prairies Ecozone.

Biological Control Agents

A number of species of weevils have been intentionally introduced into the Prairies Ecozone for the control of noxious weeds (De Clerck-Floate and Cárcamo 2011). Weed biological control agents that have established in the Prairies Ecozone include *Hylobius transversovittatus*, *Mecinus janthinus*, *Microplontus edentulus, Mogulones crucifer*, *Rhinusa* *antirrhini*, *Larinus planus*, *Hadroplontus litura*, *Trichosirocalus horridus*, and *Rhinocyllus conicus*.

Systematic Review

Two hundred ninety-five weevil species occur in the Canadian Prairies Ecozone in the families Dryophthoridae (9 spp.), Brachyceridae (13 spp.), and Curculionidae (273 spp.) (Table 2). Weevils in the Prairies Ecozone represent approximately 34% of the total number of weevil species found in Canada (Table 1). Notable species highlighted below are those with distributions restricted to the Prairies Ecozone, usually occurring in one or two provinces. Host information is given when known.

Dryophthoridae Schönherr, 1825
Rhynchophorinae Schönherr, 1833

There are nine species of *Sphenophorus* in the Prairies Ecozone. These are all in wetlands or marginal wetland habitats. Where known, most hosts are in the Cyperaceae, generally the genus *Scirpus*.

Notable species. *Sphenophorus robustior*, *S. serratipes* (both from Manitoba), and *S. vomerinus* (Alberta) appear to be endemic to the ecozone; their hosts are unknown.

Brachyceridae Billberg, 1820
Erirhininae Schönherr, 1825

There are 13 species in six genera; all are widespread and associated with wetland habitats.

Notable species. *Grypus equiseti* is associated with *Equisetum*.

Curculionidae Latreille, 1802
Curculioninae Latreille, 1802

In this subfamily, one of the larger and more diverse subfamilies, there are 87 species in 23 genera in the Prairies Ecozone. Large genera are *Anthonomus* (18), *Dorytomus* (13), *Smicronyx* (13), and *Tychius* (10). Species in the genera *Dorytomus*, *Proctorus*, *Elleschus*, *Isochnus*, and *Tachyerges* are associated with Salicaceae and likely restricted to parkland habitats. All species of *Tychius* are associated with Fabaceae; three of these are adventive and in ruderal (weedy) habitats. The genus *Macrorhoptus* is of uncertain tribal placement and associated with Malvaceae.

Notable species. The hosts for the following species are unknown: *Anthonomus squamulatus* (Manitoba), *Dietzianus pygmaeus* (Manitoba), *Epimechus signum* (Saskatchewan), *Promecotarsus densus* (British Columbia, Alberta, Saskatchewan), *Promecotarsus fumatus* (Saskatchewan), and *Smicronyx centralis* (Alberta).

Coccotorus scutellaris (Manitoba) feeds on Rosaceae; *Smicronyx amoenus* (Saskatchewan, Manitoba), *Smicronyx humilis* (Saskatchewan, Manitoba), *Smicronyx incertus* (Manitoba), *Smicronyx sordidus* (Manitoba), and *Smicronyx utilis* (Alberta, Saskatchewan) feed on Asteraceae; *Smicronyx vestitus* (Alberta, Manitoba), *Tychius montanus* (Alberta), and *Tychius soltaui* (Alberta, Manitoba) feed on Fabaceae. *Macrorhoptus hispidus* (Alberta, Saskatchewan) feeds on Malvaceae and *Smicronyx congestus* (Manitoba) feeds on Convolvulaceae.

Bagoinae Thomson, 1859

Four species of the genus *Bagous* and one of *Pnigodes* are recorded from the Prairies Ecozone. All Bagoinae are associated with wetland habitats. The four *Bagous* species are all widely distributed in Canada, but *Pnigodes setosus* is known in Canada only from southern Alberta. It is more widely distributed in the central and southern United States and appears to be at the limit of its range in the shortgrass prairies of Canada.

Notable species. *Pnigodes setosus* (Alberta) is associated with Brassicaceae.

Baridinae Schönherr, 1836

Fourteen species of Baridinae in 11 genera are recorded from the Prairies Ecozone. Little is known of baridine biology and host associations, but the majority are likely associated with various grassland habitats (Anderson 1993). Adults are often associated with flowers of Asteraceae, but where known, larval hosts are other plants, usually monocotyledonous angiosperms. This group of weevils is in dire need of taxonomic study; hence, the potential Canadian endemics listed below may be revealed to be more widespread species once such studies become available.

Notable species. The hosts for the following species are unknown: *Apinocis subaequalis* (Manitoba), *Calandrinus grandicollis* (Alberta), *Calandrinus obsoletus* (Alberta), *Centrinogyna canadensis* (Alberta, Saskatchewan, Manitoba), *Baris strenua* (Manitoba), and *Onychobaris subtonsa* (Saskatchewan, Manitoba). *Apinocis subaequalis* and *Centrinogyna canadensis* are potential Canadian endemics.

Ceutorhynchinae Gistel, 1848

Ceutorhynchinae is one of the most diverse groups in the Prairies Ecozone. There are 54 species in 24 genera. One of the predominant genera is *Ceutorhynchus* with 21 species. Among the *Ceutorhynchus* are a number of apparently rare species known only from the type localities (and are thus potential Canadian endemics). Genera in the tribe Phytobiini are associated with wetland habitats (Anderson 1993). *Asperosoma echinatum* is a rare species (and potential Canadian endemic) known only from Manitoba and Ontario and associated with *Heuchera richardsoni* R.Br. (Saxifragiaceae) (Douglas *et al*. 2013).

Notable species. The hosts for the following species are unknown: *Ceutorhynchus carteri* (Alberta), *Ceutorhynchus convexipennis* (Manitoba), *Ceutorhynchus dubitans* (Saskatchewan), *Ceutorhynchus hearnei* (Manitoba), *Ceutorhynchus munki* (Manitoba), and *Sirocalodes sericans* (Manitoba, Ontario). *Ceutorhynchus handfordi* (Manitoba) and *Ceutorhynchus invisus* (Saskatchewan, Manitoba) feed on Brassicaceae. *Pelenomus congenialis* (Alberta) and *Pelenomus scoliasus* (Alberta, Manitoba) probably feed on Polygonaceae. *Asperosoma echinatum* (Manitoba, Ontario) feeds on Saxifragiaceae.

Ceutorhynchus carteri, *Ceutorhynchus convexipennis*, *Ceutorhynchus dubitans*, *Ceutorhynchus handfordi*, *Ceutorhynchus hearnei*, *Ceutorhynchus munki*, and *Asperosoma echinatum* are potential Canadian endemics.

Conoderinae Schönherr, 1833

Two species in the genus *Cylindrocopturus* are known from the Prairies Ecozone. *Cylindrocopturus medicatus* is restricted to Alberta (also recorded in the United States but only from Montana) and *C. deleoni* is limited to arid habitats in British Columbia and Alberta.

Notable species. The host for *Cylindrocopturus medicatus* (Alberta) is unknown.

Cossoninae Schönherr, 1825

Only four species in two genera (*Phloeophagus*, *Rhyncolus*) of Cossoninae are found in the Prairies Ecozone. Cossoninae are generally found associated with woody plants; thus, these species are likely in riparian parklands rather than grassland habitats.

Notable species. *Rhyncolus knowltoni* (Manitoba) feeds on Salicaceae.

Cryptorhynchinae Schönherr, 1825

Six species of this subfamily in three genera are found in the Prairies Ecozone. Four of the species are in the genus *Tyloderma*. Some *Tyloderma* are associated with wetlands, but at least two of the prairie species (*Tyloderma foveolatum* and *Tyloderma oenotherae*) are associated with Onagraceae in grassland habitats. *Gerstaeckeria basalis* is the only Canadian weevil associated with *Opuntia* cactus.

Notable species. *Gerstaeckeria basalis* (Alberta, Saskatchewan) feeds on Cactaceae, whereas *Tyloderma minimum* (Alberta) probably feeds on Polygonaceae.

Cyclominae Schönherr, 1826

There are 16 species in the genus *Listronotus* in the Prairies Ecozone. All are associated with wetland habitats.

Notable species. The hosts for *Listronotus californicus* (Alberta), *Listronotus montanus* (Alberta, Saskatchewan, Manitoba), and *Listronotus vitticollis* (Alberta, Saskatchewan, Manitoba) are unknown. *Listronotus echinodori* (Manitoba) feeds on Alismataceae.

Entiminae Schönherr, 1823

There are 37 species of Entiminae, commonly called broad-nosed weevils, in the Prairies Ecozone. Broad-nosed weevils are often among the most frequently adventive weevil species (Oberprieler *et al*. 2007); 12 recorded species are adventive and likely associated with human-altered habitats.

Notable species. *Ophryastes tuberosus* (Alberta), *Agronus carri* (British Columbia, Alberta), and *Minyomerus innocuus* (Alberta) probably feed on Malvaceae. *Tanymecus confusus* (Saskatchewan, Manitoba) and *Thecesternus affinis* (British Columbia, Alberta, Saskatchewan) feed on Asteraceae. *Dyslobus crinitus* (Alberta, Saskatchewan), *Dyslobus luteus* (British Columbia, Saskatchewan), *Dyslobus nigrescens* Pierce (British Columbia, Alberta), *Dyslobus ursinus* (British Columbia, Alberta), and *Panscopus torpidus* (British Columbia, Alberta) feed on Rosaceae.

Hyperinae Marseul, 1863

There are nine species in the genus *Hypera*. Some are found in wetlands and are associated with Polygonaceae. Three are adventive.

Notable species. *Hypera quadricollis* (Alberta, Manitoba) feeds on Polygonaceae.

Lixinae Schönherr, 1823

There are 17 species in five genera. Members of the genus *Lixus* are in wetland habitats, whereas *Scaphomorphus* are in prairie habitats. *Larinus planus* and *Rhinocyllus conicus* were introduced for the biological control of thistles.

Notable species. The hosts for *Scaphomorphus frontalis* (Alberta, Saskatchewan, Manitoba), *Scaphomorphus puberulus* (Alberta, Manitoba), and *Lixus laramiensis* (Alberta) are unknown. *Scaphomorphus erysimi* (British Columbia, Alberta, Manitoba) feeds on Brassicaceae; *Scaphomorphus poricollis* (British Columbia, Alberta, Saskatchewan) feeds on Asteraceae and Brassicaceae; and *Scaphomorphus trivittatus* (British Columbia, Alberta, Saskatchewan, Manitoba) feeds on Fabaceae.

Mesoptiliinae Lacordaire, 1863

Magdalis aenescens is the only species in the region; it is widespread and associated with riparian parklands. Most *Magdalis* are associated with conifers in boreal forest habitat (Anderson 1993).

Molytinae Schönherr, 1823

There are seven species in three genera of Molytinae in the Prairies Ecozone. Conotrachelus and Lepyrus include three species each and Hylobius includes one species.

Notable species. The host for *Conotrachelus nivosus* (Alberta) is unknown.

Scolytinae Latreille, 1804

There are 14 species in nine genera in the Prairies Ecozone; three of these are shared with Ontario and Quebec, but not British Columbia. *Hylesinus californicus* is known in Canada only from the Prairie Provinces, and *Chaetophloeus heterodoxus* and *Procryphalus mucronatus* are shared with British Columbia, but not with the eastern provinces. Members of Cryphalini breed in Salicaceae, Hylesenini mainly in *Fraxinus* and *Ulmus*, Hypoborini and Phloeotribini in *Prunus*, Scolytinae in *Ulmus*, and Xyloterini in several genera. Two are adventive.

Research Priorities

Despite the taxonomy of most Canadian weevils being generally well resolved, there are still taxa in need of revision. These include the genera *Ceutorhynchus* and *Pelenomus* of the Ceutorhynchinae and several of the Baridinae, most of which have not been studied since their original descriptions. A number of the species in these groups are still known only from their type localities. With the addition of new collection records and new methods for taxonomic study, the valid status of these taxa needs to be revisited. In addition, the listings of host associations for characteristic species given previously for each higher taxon show that, for a great many prairie weevil species, we know little if anything about their host plants and biology. Regional surveys in native prairie habitats with careful attention to host plant associations could help resolve these deficiencies.

Conclusions

In general, the weevil fauna of the Prairies Ecozone is quite rich, with one-third of the weevil fauna of Canada associated with this habitat type. Many of these species are widespread within the ecozone and extend into similar habitats in the bordering United States to the south. A significant part of the prairie fauna is widespread across Canada and the United States in wetland habitats. A few species are recorded only from one or more of the Prairie Provinces within the Prairies Ecozone; they are treated here as "potential Canadian endemics." These species are nearly all in the subfamilies Baridinae and Ceutorhynchinae, largely a reflection of the need for taxonomic revision in these groups. In particular, the genus *Ceutorhynchus* has six potential Canadian endemics, which are all still only recorded from their type localities.

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Table 2. Distribution of weevils (Dryophthoridae, Brachyceridae, Curculionidae) occurring in the Prairies Ecozone. Distribution abbreviations: AB = Alberta, AK = Alaska, BC = British Columbia, LB = Labrador, MB = Manitoba, NB = New Brunswick, NF = insular Newfoundland, NS = Nova Scotia, NT = Northwest Territories, NU = Nunavut, ON = Ontario, PE = Prince Edward Island, QC = Quebec, SK = Saskatchewan, YT = Yukon Territory. Key to superscripts: [A]adventive species, [H]Holarctic. Numbers 1 to 6 refer to figures.

	AK	YT	NT	NU	BC	AB	SK	MB	ON	QC	NB	NS	PE	LB	NF
Dryophthoridae															
Rhynchophorinae, Sphenophorini															
Sphenophorus aequalis aequalis Gyllenhal	-	-	-	-	x	x	x	x	x	x	-	x	-	-	-
Sphenophorus cicatristriatus Fåhraeus	-	-	-	-	-	x	x	x	-	-	-	-	-	-	-
Sphenophorus costipennis Horn	-	-	-	-	x	x	x	x	x	x	x	x	x	-	-
Sphenophorus mormon Chittenden	-	-	-	-	x	x	x	x	-	-	-	-	-	-	-
Sphenophorus robustior Chittenden	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-
Sphenophorus robustus Horn	-	-	-	-	x	-	-	x	x	-	-	-	-	-	-
Sphenophorus serratipes Chittenden	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
Sphenophorus striatipennis Chittenden	-	-	-	-	-	x	x	x	x	-	x	x	-	-	-
Sphenophorus vomerinus LeConte	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
Brachyceridae															
Erirhininae, Erirhinini															
Grypus equiseti (Fabricius) [H]	x	x	x	-	x	x	x	x	x	x	x	-	-	-	-
Grypus leechi (Cawthra)	-	-	-	-	x	x	x	x	x	-	-	-	-	-	-
Notaris aethiops (Fabricius) [H]	x	x	x	-	x	x	x	x	x	x	x	x	-	x	x
Notaris puncticollis (LeConte)	-	-	x	-	x	x	x	x	x	x	x	x	x	-	x
Tournotaris bimaculata (Fabricius) [H]	-	x	x	-	x	x	x	x	x	x	x	x	-	-	x
Erirhininae, Stenopelmini	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lissorhoptrus oryzophilus Kuschel	-	-	-	-	-	x	-	-	-	x	-	-	-	-	-
Lissorhoptrus simplex (Say)	-	-	-	-	-	x	-	-	x	x	-	-	-	-	-
Notiodes aeratus (LeConte)	-	-	-	-	-	x	x	-	-	-	-	-	-	-	-
Notiodes limatulus (Gyllenhal)	-	-	-	-	-	x	x	x	x	x	-	-	-	-	-

	AK	YT	NT	NU	BC	AB	SK	MB	ON	QC	NB	NS	PE	LB	NF
Notiodes ovalis (LeConte)	-	-	-	-	-	x	x	-	x	x	x	-	-	-	-
Notiodes punctatus (LeConte)	-	-	-	-	x	x	-	x	-	-	-	-	-	-	-
Erirhininae, Tanysphyrini															
Tanysphyrus ater Blatchley [A]	x	-	-	-	x	-	x	x	x	-	-	-	-	-	-
Tanysphyrus lemnae (Fabricius) [A]	-	-	-	-	x	x	x	x	x	x	x	x	-	-	-
Curculionidae															
Curculioninae, Acalyptini															
Acalyptus carpini (Herbst)	x	x	x	-	x	x	x	x	x	x	x	x	-	-	-
Curculioninae, Anthonomini															
Anthonomus confusus Dietz	-	-	-	-	x	x	-	-	-	-	-	-	-	-	-
Anthonomus corvulus LeConte	-	-	-	-	x	x	x	x	x	x	x	x	x	-	x
Anthonomus elongatus LeConte	-	-	-	-	-	-	x	x	x	x	x	x	x	-	-
Anthonomus haematopus Boheman	-	-	-	-	x	x	x	x	x	x	x	x	-	-	-
Anthonomus lecontei Burke	-	-	-	-	x	x	x	x	x	x	x	x	x	-	-
Anthonomus musculus Say	-	-	-	-	-	-	x	-	x	x	-	x	-	-	-
Anthonomus ochreopilosus Dietz	-	-	-	-	x	-	x	-	-	-	-	-	-	-	-
Anthonomus profundus LeConte	-	-	-	-	-	-	x	-	x	x	x	x	-	-	-
Anthonomus quadrigibbus Say	-	-	-	-	x	x	x	x	x	x	x	x	-	-	-
Anthonomus quesnelensis Sleeper	-	-	-	-	x	x	x	x	-	-	-	-	-	-	-
Anthonomus robustulus LeConte	-	-	-	-	-	x	x	-	-	-	x	-	-	-	-
Anthonomus rubricus Schenkling & Marshall	-	-	-	-	x	-	x	x	-	-	-	-	-	-	-
Anthonomus rufipes LeConte	-	-	-	-	-	x	x	-	-	x	-	-	-	-	-
Anthonomus signatus Say	-	-	-	-	x	x	x	x	x	x	x	x	x	-	x
Anthonomus sphaeralciae Fall	-	-	-	-	-	x	x	x	-	-	-	-	-	-	-
Anthonomus squamosus LeConte	-	-	-	-	x	x	x	x	-	-	-	-	-	-	-
Anthonomus squamulatus Dietz	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-
Anthonomus tectus LeConte	-	-	-	-	-	x	x	x	-	-	-	-	-	-	-

Chelonychus longipes Dietz	-	-	-	-	x	x	x	x	-	-	-	-	-	-	-
Coccotorus pumilae major (Brown)	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-
Coccotorus scutellaris (LeConte)	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-
Dietzianus pygmaeus (Dietz)	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-
Epimechus signum Clark & Burke	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
Pseudanthonomus crataegi (Walsh)	-	-	-	-	-	x	x	x	x	x	x	x	-	-	-
Pseudanthonomus rufulus Dietz	-	-	-	-	-	-	-	x	-	x	-	-	-	-	-
Pseudanthonomus validus Dietz	-	x	-	-	x	x	-	x	x	x	x	x	x	-	-
Curculioninae, Curculionini	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Curculio iowensis (Casey)	-	-	-	-	-	-	x	x	x	x	-	x	-	-	-
Curculioninae, Ellescini															
Dorytomus frostii Blatchley	x	x	x	-	x	x	x	x	x	x	-	-	-	-	-
Dorytomus hirtus LeConte	-	x	-	-	x	x	-	-	-	-	-	-	-	-	-
Dorytomus imbecillus Faust	x	x	x	x	-	x	-	-	x	x	-	-	-	-	-
Dorytomus inaequalis Casey	-	-	-	-	x	x	x	x	-	-	-	-	-	-	-
Dorytomus laticollis LeConte	x	-	-	-	x	x	x	x	x	x	x	x	-	-	-
Dorytomus luridus (Mannerheim)	x	x	x	-	x	x	x	-	-	x	x	x	-	-	-
Dorytomus mannerheimi (Gemminger)	x	-	x	-	x	x	x	x	-	x	-	-	-	-	-
Dorytomus marmoreus Casey	x	x	-	-	-	x	-	-	x	x	x	x	-	-	-
Dorytomus mucidus (Say)	-	-	-	-	-	x	x	-	-	x	-	-	-	-	-
Dorytomus parvicollis Casey	x	-	-	-	x	x	x	x	x	x	x	x	-	-	-
Dorytomus rufulus (Mannerheim)	x	x	x	-	x	x	x	-	x	x	-	x	-	-	-
Dorytomus squamosus LeConte	-	-	-	-	-	x	x	x	-	-	-	-	-	-	-
Dorytomus vagenotatus Casey	-	x	x	-	x	x	x	x	x	x	x	-	-	-	x
Elleschus bipunctatus (Linnaeus)	-	-	-	-	-	-	-	x	x	x	-	-	-	-	-
Elleschus borealis Carr	x	x	-	-	-	x	-	x	-	-	-	-	-	-	-
Elleschus ephippiatus (Say)	-	x	-	-	x	x	x	x	x	x	-	-	-	-	x
Elleschus scanicus (Paykull)	-	-	-	-	-	x	x		x	x	-	-	-	-	-
Proctorus armatus LeConte	x	-	x	-	x	x	x	x	x	x	x	-	-	-	-

	AK	YT	NT	NU	BC	AB	SK	MB	ON	QC	NB	NS	PE	LB	NF
Proctorus decipiens (LeConte)	x	x	x	-	x	x	x	x	x	x	x	x	-	-	-
Curculioninae, Mecinini															
Cleopomiarus hispidulus (LeConte)	-	-	-	-	-	-	-	x	x	x	x	-	-	-	-
Mecinus janthinus Germar[A]	-	-	-	-	x	x	-	-	-	x	-	x	-	-	-
Rhinusa antirrhini (Paykull)[A]	x	-	-	-	x	x	x	x	x	x	x	x	x	-	x
Curculioninae, Rhamphini															
Isochnus rufipes (LeConte)	-	-	-	-	x	x	x	x	x	x	x	x	-	-	x
Orchestes mixtus Blatchley	-	-	-	-	x	x	x	x	x	x	x	x	x	-	-
Orchestes pallicornis Say	-	-	-	-	x	x	-	x	x	x	x	x	x	-	x
Orchestes testaceus (Müller) [H]	x	-	-	-	x	x	x	x	x	x	x	x	-	-	x
Tachyerges ephippiatus (Say)	-	-	-	-	x	x	x	x	x	x	x	x	-	-	-
Tachyerges niger (Horn)	x	x	x	-	x	x	x	x	x	x	x	-	-	x	-
Tachyerges salicis (Linnaeus) [H]	-	-	x	-	x	x	x	x	x	x	x	x	-	-	x
Curculioninae, Smicronychini															
Promecotarsus densus Casey	-	-	-	-	x	x	x	-	-	-	-	-	-	-	-
Promecotarsus fumatus Casey	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
Smicronyx amoenus (Say)	-	-	-	-	-	-	x	x	-	-	-	-	-	-	-
Smicronyx centralis (Dietz)	-	-	-	-	-	x	x	-	-	-	-	-	-	-	-
Smicronyx commixtus Dietz	-	-	-	-	-	x	x	x	-	-	-	-	-	-	-
Smicronyx congestus Casey	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-
Smicronyx discoideus (LeConte)	-	-	-	-	-	-	x	x	x	-	-	-	-	-	-
Smicronyx fulvus LeConte	-	-	-	-	-	x	x	-	x	-	-	-	-	-	-
Smicronyx humilis (Dietz)	-	-	-	-	-	-	x	x	-	-	-	-	-	-	-
Smicronyx incertus (Dietz)	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-
Smicronyx lineolatus Casey	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-
Smicronyx sordidus LeConte	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-
Smicronyx tessellatus Dietz	-	-	-	-	-	-	-	x	x	-	-	-	-	-	-

Smicronyx utilis Buchanan	-	-	-	-	-	x	x	-	-	-	-	-	-	-	-
Smicronyx vestitus LeConte	-	-	-	-	-	x	-	x	-	-	-	-	-	-	-
Curculioninae, Tychiini															
Lignyodes fraxini (LeConte)	-	-	-	-	-	-	x	-	x	x	-	-	-	-	-
Lignyodes helvolus (LeConte)	-	-	-	-	-	-	x	x	x	x	x	-	-	-	-
Lignyodes horridulus (Casey)	-	-	-	-	-	-	x	-	x	x	x	-	-	-	-
Sibinia maculata (LeConte)	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
Tychius aratus Say	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
Tychius liljebladi Blatchley	-	-	-	-	-	x	x	x	-	x	-	-	-	-	-
Tychius lineellus LeConte	-	-	-	-	x	x	x	-	-	-	-	-	-	-	-
Tychius meliloti Stephens [A]	-	-	-	-	x	-	x	x	x	x	x	x	x	-	-
Tychius montanus Clark	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
Tychius picirostris (Fabricius) [A]	-	-	-	-	x	x	x	x	x	x	x	x	x	-	x
Tychius semisquamosus LeConte	-	-	-	-	x	-	x	-	-	-	-	-	-	-	-
Tychius soltaui Casey	-	-	-	-	-	-	x	x	-	-	-	-	-	-	-
Tychius stephensi Schönherr [A]	-	-	-	-	x	x	x	-	x	x	x	x	x	-	-
Tychius tectus LeConte [H]	x	x	-	-	x	x	x	x	-	-	-	-	-	-	-
Curculioninae, Incertae Sedis															
Macrorhoptus hispidus Dietz	-	-	-	-	-	x	x	-	-	-	-	-	-	-	-
Bagoinae															
Bagous mamillatus Say	-	-	-	-	-	x	-	-	x	x	-	-	-	-	-
Bagous nebulosus LeConte	-	-	-	-	x	-	x	-	-	-	x	-	-	-	-
Bagous planatus LeConte	-	-	-	-	-	-	x	-	x	x	x	-	-	-	-
Bagous transversus LeConte	-	-	-	-	x	x	x	x	x	x	-	x	-	-	-
Pnigodes setosus LeConte	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
Baridinae, Apostasimerini															
Apinocis subaequalis (Casey)	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-
Calandrinus grandicollis LeConte	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-

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Calandrinus obsoletus Casey	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
Centrinogyna canadensis Casey	-	-	-	-	-	x	x	x	-	-	-	-	-	-	-
Cylindridia prolixa (LeConte)	-	-	-	-	-	-	-	x	x	x	x	x	-	-	-
Idiostethus tubulatus (Say)	-	-	-	-	-	-	x	-	x	x	-	-	-	-	-
Odontocorynus salebrosus (Casey)	-	-	-	-	-	x	x	x	x	x	x	-	-	-	-
Stethobaris ovata (LeConte)	-	-	-	-	-	-	-	x	x	x	x	x	-	-	-
Baridinae, Baridini															
Baris interstitialis (Say)	-	-	-	-	-	-	x	-	x	x	-	-	-	-	-
Baris strenua (LeConte)	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-
Baris striata (Say)	-	-	-	-	-	-	-	x	x	-	-	-	-	-	-
Cosmobaris scolopacea Germar [A]	-	-	-	-	x	-	x	x	x	x	x	-	-	-	-
Rhoptobaris scolopax (Say)	-	-	-	-	x	x	x	-	-	-	-	-	-	-	-
Baridinae, Madarini															
Onychobaris subtonsa LeConte	-	-	-	-	-	-	x	x	-	-	-	-	-	-	-
Ceutorhynchinae, Ceutorhynchini															
Allosirocalus angulatus (LeConte)	-	-	-	-	x	x	-	-	-	-	-	-	-	-	-
Allosirocalus consanguineus (Dietz)	-	-	-	-		x	x	x	-	-	-	-	-	-	-
Amalus scortillum (Herbst) [A, 1]	-	-	-	-	x	x	x	x	x	x	x	x	-	-	x
Ceutorhynchus americanus Buchanan	x	x	x	-	x	x	x	x	x	x	x	x	-	-	-
Ceutorhynchus carteri W.J. Brown	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
Ceutorhynchus convexipennis Fall	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-
Ceutorhynchus dubitans W.J. Brown	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
Ceutorhynchus erysimi (Fabricius) [A,1]	-	-	-	-	x	x	-	-	x	x	x	x	x	-	-
Ceutorhynchus handfordi W.J. Brown	-	-	-	-	-	-	x	x	-	-	-	-	-	-	-
Ceutorhynchus hearnei W.J. Brown	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-
Ceutorhynchus invisus Fall	-	-	-	-	-	-	x	x	-	-	-	-	-	-	-
Ceutorhynchus lecontei Colonnelli	-	-	-	-	x	x	x	-	-	-	-	-	-	-	-

Ceutorhynchus munki W.J. Brown	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-
Ceutorhynchus neglectus Blatchley	-	x	-	-	x	x	x	x	x	x	x	-	-	-	-
Ceutorhynchus obstrictus (Marsham) [A]	-	-	-	-	x	x	x	-	x	x	x	-	-	-	-
Ceutorhynchus omissus Fall	-	-	-	-	-	x	x	x	x	x	x	x	-	-	-
Ceutorhynchus oregonensis Dietz	-	x	-	-	x	x	-	x	x	x	-	x	-	-	-
Ceutorhynchus pauxillus Dietz	-	-	-	-	-	x	x	x	-	-	-	-	-	-	-
Ceutorhynchus pervestitus Fall	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
Ceutorhynchus querceti (Gyllenhal) [H]	x	-	x	-	x	x	-	x	-	x	x	x	x	-	x
Ceutorhynchus rapae Gyllenhal [A]	x	x	-	-	x	x	x	x	x	x	-	-	-	-	-
Ceutorhynchus semirufus LeConte	-	-	-	-	-	x	-	-	x	x	x	-	-	-	x
Ceutorhynchus subpubescens LeConte	-	x	x	-	-	x	x	x	-	-	-	-	-	-	-
Ceutorhynchus zimmermanni Gyllenhal	-	-	-	-	-	-	x	x	x	-	-	-	-	-	-
Glocianus punctiger (Sahlberg) [A]	x	x	-	-	x	x	x	x	x	x	x	x	x	-	x
Hadroplontus litura (Fabricius) [A, 2]	-	-	-	-	x	x	x	-	x	-	-	x	-	-	-
Microplontus edentulus (Schultze) [A]	-	-	-	-	-	x	x	-	-	-	-	-	-	-	-
Mogulones crucifer (Pallas) [A]	-	-	-	-	x	x	-	-	-	-	-	-	-	-	-
Nedyus apicalis (Dietz)	-	-	-	-	-	x	x	x	x	x	x	-	-	-	-
Sirocalodes sericans (LeConte)	-	-	-	-	-	-	-	x	x	-	-	-	-	-	-
Trichosirocalus horridus (Panzer) [A, 2]	-	-	-	-	x	x	x	x	-	-	-	-	-	-	-
Ceutorhynchinae, Cnemogonini															
Acanthoscelidius acephalus (Say)	-	-	-	-	x	x	x	x	x	x	x	x	x	-	-
Auleutes epilobii (Paykull) [H]	-	x	x	-	x	x	x	x	x	x	x	x	x	-	x
Cnemogonus lecontei Dietz	x	x	x	-	x	x	-	x	x	x	x	-	-	-	-
Dietzella zimmermannii (Gyllenhal)	-	-	-	-	x	-	x	-	x	x	x	-	-	-	x
Parauleutes nebulosus (LeConte)	-	-	-	-	x	-	x	x	x	x	x	x	x	-	-
Ceutorhynchinae, Phytobiini															
Euhrychiopsis lecontei (Dietz)	x	x	x	-	x	x	x	x	x	x	-	-	-	-	-
Neophytobius cavifrons (LeConte)	-	-	-	-	x	x	-	-	-	-	-	-	-	-	-

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Pelenomus asperulus Dietz	x	x	-	-	-	x	-	-	x	-	-	-	-	-	-
Pelenomus congenialis (Dietz)	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
Pelenomus fuliginosus (Dietz)	-	-	-	-	x	x	-	-	x	x	x	-	-	-	-
Pelenomus scoliasus (Dietz)	-	-	-	-	-	x	-	x	-	-	-	-	-	-	-
Pelenomus squamosus LeConte	-	x	-	-	x	x	-	-	x	x	x	-	-	-	-
Pelenomus sulcicollis (Fåhraeus)	-	-	-	-	-	x	-	x	x	x	x	-	-	-	-
Pelenomus ventralis (Sleeper)	-	x	-	-	x	x	-	-	-	-	-	-	-	-	-
Phytobius leucogaster (Marsham) [H]	-	x	x	-	x	x	x	x	x	x	-	-	-	-	x
Rhinoncus longulus LeConte	-	-	-	-	x	x	x	x	x	x	x	x	x	-	-
Rhinoncus pericarpius (Linnaeus) [A]	-	-	-	-	x	x	x	-	x	x	-	-	-	-	x
Rhinoncus pyrrhopus Boheman	-	-	x	-	x	-	x	x	x	x	-	-	x	-	-
Rhinoncus triangularis (Say)	-	-	-	-	-	x	x	x	x	x	-	-	-	-	-
Ceutorhynchinae, Scleropterini															
Acallodes ventricosus LeConte	-	-	-	-	-	-	-	x	x	-	-	-	-	-	-
Asperosoma echinatum (Fall)	-	-	-	-	-	-	-	x	x	-	-	-	-	-	-
Homorosoma sulcipenne (LeConte)	-	x	-	-	-	-	x	x	x	x	-	-	-	-	-
Prorutidosoma decipiens (LeConte)	x	x	-	-	x	x	x	x	x	x	-	-	x	-	-
Conoderinae, Zygopini															
Cylindrocopturus deleoni Buchanan	-	-	-	-	x	x	-	-	-	-	-	-	-	-	-
Cylindrocopturus medicatus Carr	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
Cossoninae, Cossonini															
Cossonus americanus Buchanan	-	-	-	-	-	-	x	-	-	x	x	x	-	-	x
Cossoninae, Rhyncolini															
Phloeophagus canadensis Van Dyke	x	-	-	-	x	x	x	x	-	x	x	-	-	-	-
Rhyncolus brunneus Mannerheim	x	x	x	-	x	x	x	x	x	x	x	x	x	-	x
Rhyncolus knowltoni (Thatcher)	-	-	-	-	-	x	x	x	-	-	-	-	-	-	-

Cryptorhynchinae, Cryptorhynchini															
Cryptorhynchus lapathi (Linnaeus) [H]	-	-	-	-	x	x	x	x	x	x	x	x	x	-	x
Gerstaeckeria basalis (LeConte)	-	-	-	-	-	x	x	-	-	-	-	-	-	-	-
Tyloderma foveolatum (Say)	-	-	-	-	-	-	-	x	x	-	-	-	-	-	-
Tyloderma minimum Blatchley	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
Tyloderma nigrum Casey	-	-	-	-	-	-	x	-	x	x	x	-	-	-	-
Tyloderma oenotherae Wibmer	-	-	-	-	-	x	x	x	-	-	-	-	-	-	-
Cyclominae, Listroderini															
Listronotus appendiculatus (Boheman)	-	-	-	-	x	x	x	x	x	x	x	-	-	-	-
Listronotus californicus (Dietz)	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
Listronotus delumbis (Gyllenhal)	-	-	-	-	x	x	x	x	x	x	x	x	-	-	-
Listronotus echinodori O'Brien	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-
Listronotus filiformis (LeConte)	-	x	x	-	x	x	x	x	-	x	-	-	-	-	-
Listronotus frontalis LeConte	-	-	-	-	x	x	x		x	x	-	-	-	-	-
Listronotus lutulentus (Boheman)	-	-	-	-	-	-	-	x	x	x	x	-	-	-	-
Listronotus maculicollis (Kirby)	x	x	-	-	x	x	x	x	-	x	x	x	-	-	-
Listronotus montanus (Dietz)	-	-	-	-	-	x	x	x	-	-	-	-	-	-	-
Listronotus oregonensis oregonensis (LeConte) [3]	-	-	-	-	-	-	x	x	x	x	x	x	x	-	-
Listronotus oregonensis tesselatus Casey	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
Listronotus punctiger LeConte	-	-	-	-	x	x	-	x	-	-	-	-	-	-	-
Listronotus sparsus (Say)	-	-	x	-	-	x	-	x	x	x	x	x	x	-	-
Listronotus squamiger (Say)	-	-	-	-	x	x	x	x	x	x	x	x	-	-	-
Listronotus tuberosus LeConte	-	-	-	-	-	-	x	x	x	x	x	-	-	-	-
Listronotus vitticollis (Kirby)	-	-	-	-	-	x	x	x	-	-	-	-	-	-	-
Entiminae, Alophini															
Lepidophorus pumilus Buchanan	-	-	-	-	x	x	-	-	-	-	-	-	-	-	-
Trichalophus alternatus (Say)	x	x	-	-	x	x	x	x	x	-	-	-	-	-	-
Trichalophus simplex LeConte	-	-	x	-	-	x	x	x	-	-	-	-	-	-	-

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Entiminae, Hormorini															
Hormorus undulatus (Uhler) [4]	-	-	-	-	-	x	-	x	x	x	x	x	x	-	x
Entiminae, Ophryastini															
Ophryastes sulcirostris (Say)	-	-	x	-	-	x	x	x	-	-	-	-	-	-	-
Ophryastes tuberosus LeConte	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
Entiminae, Otiorhynchini															
Agronus carri Buchanan	-	-	-	-	x	x	-	-	-	-	-	-	-	-	-
Otiorhynchus ovatus (Linnaeus) [A]	x	x	x	-	x	x	x	x	x	x	x	x	x	x	x
Otiorhynchus raucus (Fabricius) [A, 5]	-	-	-	-	x	x	x	-	x	x	-	x	-	-	-
Otiorhynchus sulcatus (Fabricius) [A]	x	-	-	-	x	x	x	x	x	x	x	x	x	-	x
Entiminae, Peritelini															
Nemocestes horni Van Dyke	x	-	-	-	x	-	x	-	x	x	x	x	-	-	x
Entiminae, Phyllobiini															
Evotus naso (LeConte)	-	-	x	-	x	x	x	-	-	-	-	-	-	-	-
Entiminae, Polydrusini															
Polydrusus impressifrons (Gyllenhal) [A]	-	-	-	-	-	-	-	x	x	x	x	x	-	-	-
Entiminae, Sciaphilini															
Barypeithes pellucidus (Boheman) [A]	-	-	-	-	x	-	-	x	x	x	x	x	x	-	x
Sciaphilus asperatus (Bonsdorff) [A]	-	-	-	-	x	x	-	x	x	x	x	x	x	-	x
Entiminae, Sitonini															
Sitona californicus (Fåhraeus)	-	-	-	-	x	x	-	-	-	-	-	-	-	-	-
Sitona cylindricollis (Fåhraeus) [A]	-	x	x	-	x	x	x	x	x	x	x	x	x	-	-
Sitona hispidulus (Fabricius) [A]	x	-	x	-	x	x	x	-	x	x	x	x	x	-	x
Sitona lepidus Gyllenhal [A]	-	-	-	-	x	x	x	x	x	x	x	x	x	-	x
Sitona lineatus (Linnaeus) [A]	-	-	-	-	x	x	x	-	-	-	-	-	-	-	-
Sitona lineellus (Bonsdorff) [H, 5]	x	x	x	-	x	x	x	x	x	x	x	x	x	x	x

Entiminae, Tanymecini															
Minyomerus innocuus Horn	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
Tanymecus confusus Say	-	-	x	-	-	-	x	x	-	-	-	-	-	-	-
Entiminae, Thecesternini															
Thecesternus affinis (LeConte)	-	-	-	-	x	x	x	-	-	-	-	-	-	-	-
Entiminae, Trachyphloeini															
Cathormiocerus aristatus (Gyllenhal) [A]	-	-	-	-	-	-	x	x	x	x	-	x	x	-	-
Romualdius bifoveolatus (Beck) [A]	-	-	-	-	x	x	-	-	x	x	x	x	x	-	x
Entiminae, Tropiphorini															
Anametis granulata (Say)	-	-	-	-	x	x	x	x	x	x	-	-	-	-	-
Cimbocera pauper Horn	-	-	-	-	x	x	x	-	-	-	-	-	-	-	-
Dyslobus alternatus (Horn)	-	-	-	-	x	x	x	-	-	-	-	-	-	-	-
Dyslobus crinitus Bright	-	-	-	-	-	x	x	-	-	-	-	-	-	-	-
Dyslobus luteus (Horn)	-	-	-	-	x	-	x	-	-	-	-	-	-	-	-
Dyslobus nigrescens (Pierce)	-	-	-	-	x	x	-	-	-	-	-	-	-	-	-
Dyslobus ursinus (Horn)	x	-	-	-	x	x	-	-	-	-	-	-	-	-	-
Panscopus aequalis (Horn)	-	-	-	-	x	x	x	x	-	-	-	-	-	-	-
Panscopus ovalis Pierce	-	-	-	-	x	x	x	-	-	-	-	-	-	-	-
Panscopus torpidus (LeConte)	-	-	-	-	x	x	-	-	-	-	-	-	-	-	-
Phyxelis rigidus (Say)	-	-	-	-	-	x	x	x	x	x	x	x	x	-	x
Hyperinae, Hyperini															
Hypera castor (LeConte)	-	-	-	-	-	-	x	x	-	x	x	x	x	-	-
Hypera compta (Say)	-	-	-	-	x	-	x	-	x	x	x	-	-	-	-
Hypera diversipunctata (Schrank) [H]	x	x	-	-	-	x	x	-	x	-	-	-	-	-	-
Hypera eximia (LeConte)	-	-	-	-	-	x	-	x	x	-	-	-	-	-	-
Hypera meles (Fabricius) [A]	-	-	-	-	-	-	x	-	x	x	x	x	x	-	-
Hypera postica (Gyllenhal) [A]	-	-	-	-	-	x	x	-	x	x	x	x	x	-	-
Hypera quadricollis (LeConte)	-	-	-	-	-	x	-	x	-	-	-	-	-	-	-

	AK	YT	NT	NU	BC	AB	SK	MB	ON	QC	NB	NS	PE	LB	NF
Hypera rumicis (Linnaeus) [A]	-	-	-	-	-	x	x	x	x	-	-	-	-	-	-
Hypera trivittata (Say)	-	-	x	-	x	x	x	x	-	-	-	-	-	-	-
Lixinae, Cleonini															
Scaphomorphus erysimi (Fall)	-	-	-	-	x	x	-	x	-	-	-	-	-	-	-
Scaphomorphus frontalis (LeConte)	-	-	-	-	-	x	x	x	-	-	-	-	-	-	-
Scaphomorphus poricollis (Mannerheim) [4]	-	-	-	-	x	x	x	-	-	-	-	-	-	-	-
Scaphomorphus puberulus (LeConte)	-	-	-	-	-	x	-	x	-	-	-	-	-	-	-
Scaphomorphus trivittatus (Say)	-	-	-	-	x	x	x	x	-	-	-	-	-	-	-
Stephanocleonus confusus R.S. Anderson	-	-	x	-	-	x	x	-	-	-	-	-	-	-	-
Stephanocleonus cristaticollis (Csiki)	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
Stephanocleonus immaculatus R.S. Anderson	-	-	x	-	x	x	x	x	x	-	-	-	-	-	-
Stephanocleonus parshus R.S. Anderson	-	-	x	-	x	x	x	x	x	x	-	-	-	-	-
Stephanocleonus plumbeus LeConte	-	-	-	-	-	x	x	x	-	x	-	-	-	-	x
Lixinae, Lixini															
Larinus planus (Fabricius) [A]	-	-	-	-	x	x	-	-	x	x	-	x	-	-	-
Lixus caudifer LeConte	-	-	-	-	x	-	x	x	-	-	-	-	-	-	-
Lixus laramiensis Casey	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
Lixus parcus LeConte	-	-	-	-	-	x	x	-	x	-	-	-	-	-	-
Lixus rubellus Randall [3]	-	-	x	-	x	x	x	x	x	x	x	-	-	-	-
Lixus terminalis LeConte	x	-	-	-	-	x	-	x	x	-	-	-	-	-	-
Lixinae, Rhinocyllini															
Rhinocyllus conicus (Frölich) [A]	-	-	-	-	x	x	x	-	x	x	-	x	-	-	-
Mesoptiliinae, Magdalidini															
Magdalis aenescens LeConte	x	-	-	-	x	x	-	-	-	-	-	-	-	-	-
Molytinae, Conotrachelini															
Conotrachelus corni W.J. Brown	-	-	-	-	-	-	-	x	x	x	-	-	-	-	-
Conotrachelus nenuphar (Herbst)	-	-	-	-	x	-	x	x	x	x	x	x	-	-	x

Conotrachelus nivosus LeConte	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
Molytinae: Hylobiini															
Hylobius transversovittatus (Goeze)	-	-	-	-	x	x	-	x	x	-	-	x	-	-	-
Molytinae, Lepyrini															
Lepyrus nordenskioeldi canadensis Casey	x	-	x	x	x	x	x	-	-	-	-	-	-	-	-
Lepyrus oregonus tesselatus Van Dyke	-	-	-	-	x	x	x	-	-	-	-	-	-	-	-
Lepyrus palustris (Scopoli) [H]	-	-	x	-	x	x	x	x	x	x	-	-	-	x	-
Scolytinae, Cryphalini															
Procryphalus mucronatus (LeConte) [6]	x	-	-	-	x	x	-	-	-	-	-	-	-	-	-
Trypophloeus populi Hopkins	-	-	-	-	x	x	x	x	-	-	x	-	-	-	-
Scolytinae, Hylesinini															
Hylesinus aculeatus Say	-	-	-	-	-	x	x	x	x	x	x	x	-	-	-
Hylesinus californicus (Swaine)	-	-	-	-	-	x	x	x	-	-	-	-	-	-	-
Hylesinus criddlei (Swaine)	-	-	-	-	-	x	x	x	x	x	-	-	-	-	-
Hylurgopinus rufipes (Eichhoff)	-	-	-	-	-	-	x	x	x	x	x	x	-	-	-
Scolytinae, Hypoborini															
Chaetophloeus heterodoxus (Casey) [6]	-	-	-	-	x	-	x	x	-	-	-	-	-	-	-
Scolytinae, Phloeotribini															
Phloeotribus liminaris (Harris)	-	-	-	-	-	-	x	x	x	x	x	x	-	-	-
Scolytinae, Scolytini															
Scolytus multistriatus (Marsham) [A]	-	-	-	-	x	x	x	x	x	x	x	x	-	-	-
Scolytus schevyrewi Semenov [A]	-	-	-	-	x	x	x	x	x	-	-	-	-	-	-
Scolytinae, Xyloterini															
Trypodendron betulae Swaine	x	-	x	-	x	x	x	x	x	x	x	x	x	-	-
Trypodendron lineatum (Olivier)	x	x	-	-	x	x	x	x	x	x	x	x	x	-	x
Trypodendron retusum (LeConte)	x	x	-	-	x	x	x	x	x	x	x	x	x	-	-
Xyloterinus politus (Say)	-	-	-	-	x	-	-	x	x	x	x	x	x	-	-
Total	**45**	**42**	**42**	**2**	**150**	**214**	**196**	**187**	**155**	**146**	**106**	**89**	**45**	**5**	**38**

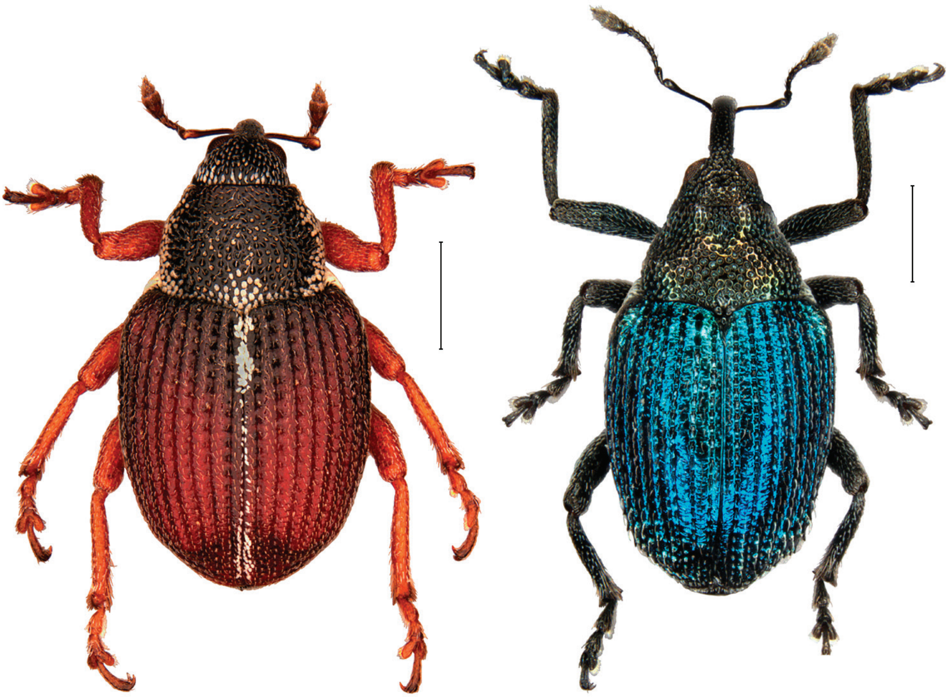

Fig. 1. Dorsal habitus photo of *Amalus scortillum* (left) and *Ceutorhynchus erysimi* (right). Scale bar = 0.5 mm.

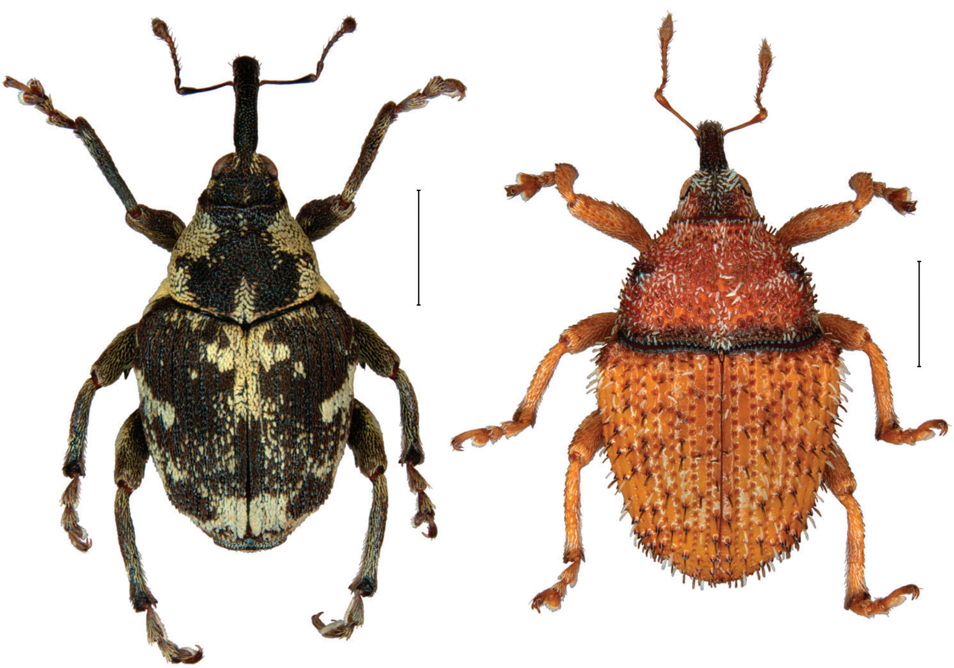

Fig. 2. Dorsal habitus photo of *Hadroplontus litura* (left) and *Trichosirocalus horridus* (right). Scale bar = 1 mm.

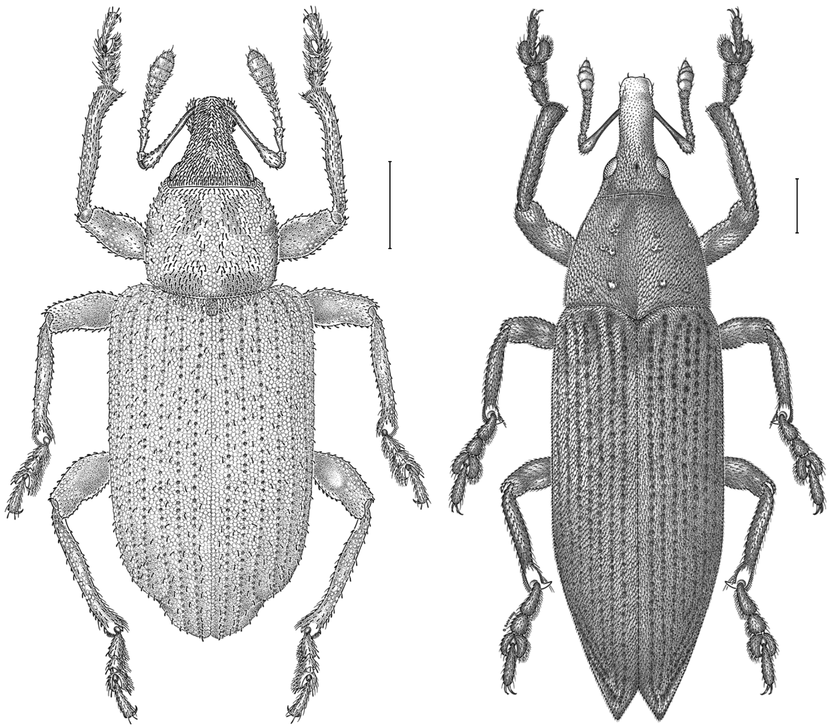

Fig. 3. Dorsal habitus drawing of *Listronotus oregonensis oregonensis* (left) and *Lixus rubellus* (right). Scale bar = 1 mm.

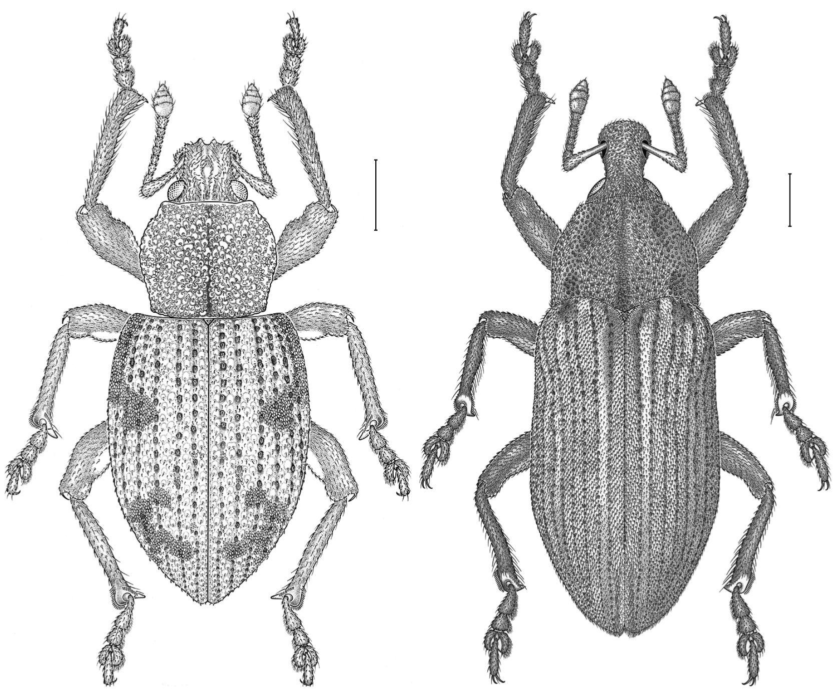

Fig. 4. Dorsal habitus drawing of *Hormorus undulatus* (left) and *Scaphomorphus poricollis* (right). Scale bar = 1 mm.

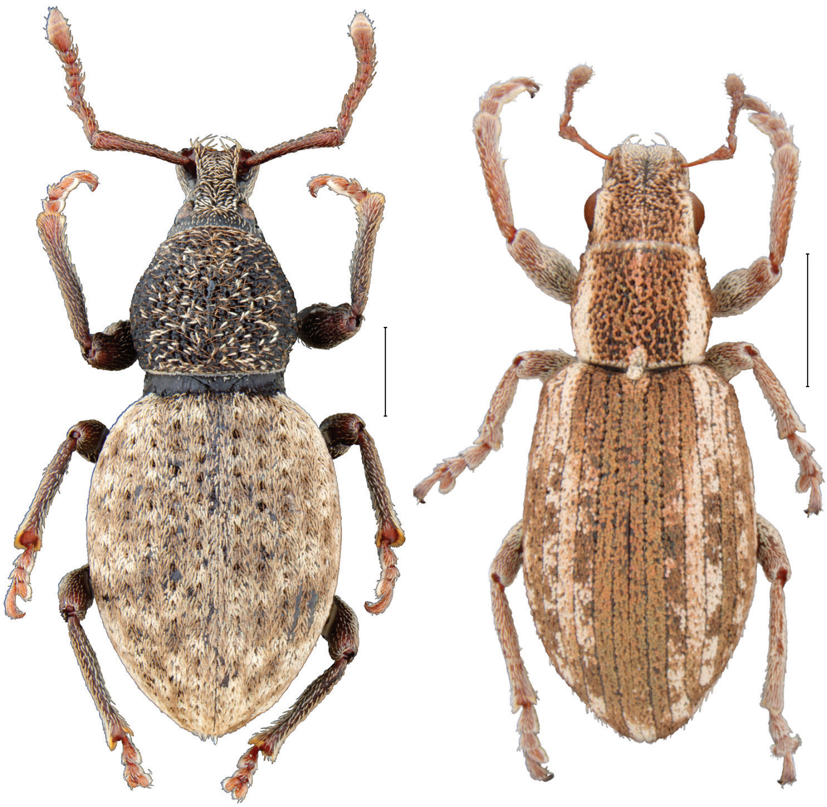

Fig. 5. Dorsal habitus photo of *Otiorhynchus raucus* (left) and *Sitona lineellus* (right). Scale bar = 1 mm.

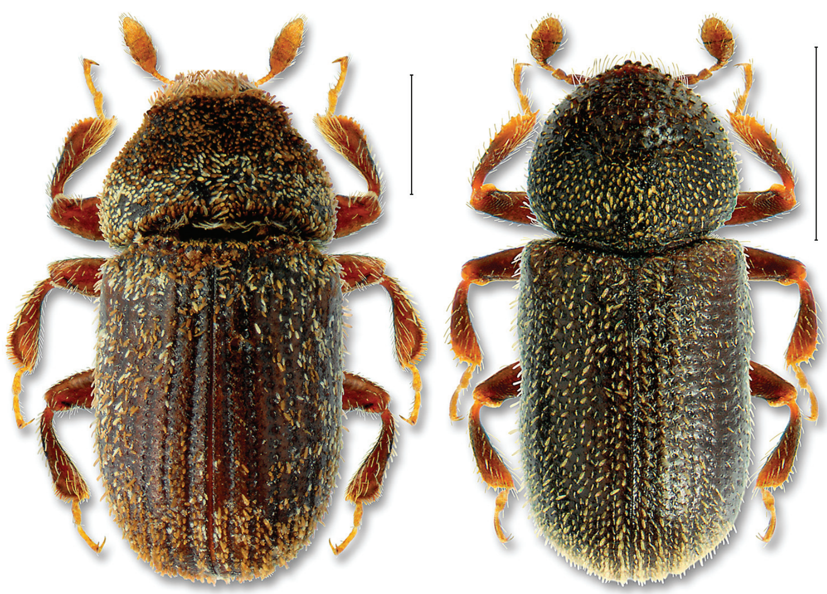

Fig. 6. Dorsal habitus photo of *Chaetophloeus heterodoxus* (left) and *Procryphalus mucronatus* (right). Scale bar = 0.5 mm.

References

Anderson, R.S. 1993. Weevils and plants: phylogenetic versus ecological mediation of evolution of host plant associations in Curculionidae (Curculioninae). Memoirs of the Entomological Society of Canada, **165**: 197–232.

Bousquet, Y., Bouchard, P., Davies, A.E., and Sikes, D.S. 2013. Checklist of Beetles (Coleoptera) of Canada and Alaska, 2nd edition. Pensoft, Sofia, Bulgaria.

Bright, D.E. 1976. The Bark Beetles of Canada and Alaska. Coleoptera: Scolytidae. The Insects and Arachnids of Canada. Part 2. Agriculture Canada, Research Branch, Ottawa, Ontario.

Bright, D.E., and Bouchard, P. 2008. The Weevils of Canada and Alaska: Vol. 2. The Broad-Nosed Weevils of Canada and Alaska (Coleoptera: Curculionidae, Entiminae). The Insects and Arachnids of Canada. Part 25. NRC Research Press, Ottawa, Ontario.

Campbell, J.M., Sarazin, M.J., and Lyons, D.B. 1989. Canadian Beetles (Coleoptera) Injurious to Crops, Ornamentals, Stored Products, and Buildings. Agriculture Canada, Research Branch, Ottawa, Ontario.

De Clerck-Floate, R., and Cárcamo, H. 2011. Biological control of arthropods: new denizens of Canada's grassland agroecosystems. *In* Arthropods of Canadian Grasslands, Vol. 2: Inhabitants of a Changing Landscape. *Edited by* K.D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 291–321.

Dosdall, L.M., and Cárcamo, H.A. 2011. Biology and integrated management of the cabbage seedpod weevil in Prairie canola crops. Prairie Soils and Crops, **4**: 14–23.

Douglas, H., Bouchard, P., Anderson, R.S., de Tonnancour, P., Vigneault, P., and Webster, R. 2013. New Curculionoidea (Coleoptera) records for Canada. ZooKeys, **309**: 13–48.

Elias, S.A. 2010. Advances in Quaternary Entomology. Developments in Quaternary Sciences, 12. Elsevier, Amsterdam, Netherlands.

Gandhi, K.J.K., and Herms, D.A. 2010. North American arthropods at risk due to widespread *Fraxinus* mortality caused by the alien emerald ash borer. Biological Invasions, **12**: 1839–1846.

Negron, J.F., Witcosky, J.J., Cain, R.J., LaBonte, J.R., Duer, D.A., McElwey, S.J., Lee, J.C., and Seybold, S.J. 2005. The banded elm bark beetle: a new threat to elms in North America. American Entomologist, **51**: 84–94.

Oberprieler, R.G., Marvaldi, A.E., and Anderson, R.S. 2007. Weevils, weevils, weevils everywhere. *In* Linnaeus Tercentenary: Progress in Invertebrate Taxonomy. *Edited by* Z.-Q. Zhang and W.A. Shear. Zootaxa, **1668**: 491–520.

O'Brien, C.W. 1995. Curculionidae, premiere biological control agents (Coleoptera: Curculionoidea). Memoirs of the Entomological Society of Washington, **14**: 119–128.

Ślipiński, S.A., Leschen, R.A.B., and Lawrence, J.F. 2011. Order Coleoptera Linnaeus, 1758. *In* Animal Biodiversity: An Outline of Higher-Level Classification and Survey of Taxonomic Richness. *Edited by* Z.-Q. Zhang. Zootaxa, **3148**: 203–208.

White, N.D.G., Fields, P.G., Demianyk, C.J., Timlick, B., and Jayas, D.S. 2011. Arthropods of stored cereals, oilseeds, and their products in Canada: artificial ecosystems on grasslands. *In* Arthropods of Canadian Grasslands, Vol 2: Inhabitants of a Changing Landscape. *Edited by* K.D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 267–289.

Chapter 5
Moths and Butterflies of the Prairies Ecozone in Canada

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Abstract. The Prairies Ecozone of southern Manitoba, Saskatchewan, and Alberta supports a diverse fauna, with 2,232 species of butterflies and moths (order Lepidoptera) recorded to date in 61 families. By far the best known Lepidoptera are the butterflies, with 177 species known to occur in the ecozone. The species known to occur in the Prairies Ecozone are listed by province. The Lepidoptera fauna of this ecozone is reviewed in terms of diversity, state of knowledge of the major groups, postglacial and relict patterns, recent changes in distribution, and endangered and threatened species.

Résumé. L'écozone des prairies du sud du Manitoba, de la Saskatchewan et de l'Alberta abrite une faune diversifiée qui compte 2 232 espèces de papillons diurnes et de nuit (Ordre Lepidoptera) répertoriées à ce jour, représentant 61 familles. L'écozone comprend 177 espèces de papillons diurnes, qui sont beaucoup mieux connus que les papillons de nuit. Les espèces présentes dans l'écozone des Prairies sont regroupées par province. Le chapitre examine la diversité de cette entomofaune, l'état de nos connaissances sur les groupes principaux, les tendances de répartition géographique postglaciaires et relictuelles, les changements de répartition récents ainsi que les espèces en voie de disparition ou menacées.

Introduction

The Prairies Ecozone comprises a large portion of southern Alberta, Saskatchewan, and Manitoba. It was delimited and subdivided by the Ecological Stratification Working Group (1996), and we follow those limits herein. Shorthouse (2010) provides a map of the ecoregions within the Prairies Ecozone. The order Lepidoptera, the butterflies and moths, is one of the most diverse insect groups in the Prairies Ecozone, with 2,232 species recorded in 61 families, this representing about 43% of the Lepidoptera fauna of Canada. At least 173 species are restricted (within Canada) to grassland habitat in the Prairies Ecozone. Our

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knowledge of the Lepidoptera varies greatly from group to group, and only some groups are sufficiently well-known to be used effectively in biodiversity studies.

Lepidoptera Data Sources

Detailed distributional information has been published for some groups of moths in some of the recent fascicles of *The Moths of America North of Mexico* series, including the tortricid tribes Sparganothini and Atteriini (Powell and Brown 2012) and many groups of cutworm moths (Noctuidae): Plusiinae (Lafontaine and Poole 1991); Cuculliinae and Psaphidinae (Poole 1995); Noctuini: Noctuina (Lafontaine 1998); Noctuini: Agrotina (Lafontaine 2004); and Apameini (Mikkola *et al.* 2009). Other fascicles have little detailed distributional information. Recent works on the Sphingidae (Tuttle 2007) and Saturniidae (Tuskes *et al.* 1996) include range maps. Detailed distribution maps also appear in a series of memoirs on the inchworm moths (Geometridae) of Canada by McGuffin (1967, 1972, 1977, 1981, 1987) and Bolte (1990) that cover about 70% of the Canadian geometrid fauna. A long-term project on the forest Lepidoptera of Canada resulted in a four-volume series covering approximately 1,000 species of Lepidoptera that feed on trees and shrubs in Canada, and these also give distribution maps (McGugan 1958; Prentice 1962, 1963, 1965).

The *Butterflies of Canada* (Layberry *et al.* 1998) is based on a distributional database on the butterflies of Canada maintained by Agriculture and Agri-Food Canada that contains about 400,000 records from public and private collections in Canada. *The Butterflies of Canada* includes distribution maps for every species. Butterflies have also been treated in detail at the provincial level for Alberta (Bird *et al.* 1995), Saskatchewan (Hooper 1973, 1986), and Manitoba (Klassen *et al.* 1989). Guppy and Shepard (2001) include most of the Alberta prairies in their coverage of British Columbia butterflies.

Many smaller taxonomic works also include distribution records of Lepidoptera in western Canada, and a bibliography of Canadian records is in preparation (GRP, unpublished bibliography). A checklist of the Lepidoptera of Alberta (Pohl *et al.* 2010, 2011, 2012, 2013) lists species and associates them with major ecoregions in Alberta. A number of sites in the parkland and grasslands of southern Alberta have been extensively surveyed by C.D. Bird in the past 15 years; the survey areas include a site near Nevis and sites in Big Knife Provincial Park, Buffalo Lake Conservation Area, Dry Island Buffalo Jump Provincial Park, East Arrowwood Coulee, Erskine and vicinity, Lowden Springs Natural Area, Rochon Sands Provincial Park, and Tolman Bridge (CDB, unpublished reports submitted to Alberta Parks and Protected Areas, available from the Alberta Lepidopterists' Guild 2014). Hooper (1987, 1988*a*, 1988*b*, 1988*c*, 1990*a*, 1990*b*, 1990*c*, 1991*a*, 1991*b*, 1992, 1993, 1994, 1996*a*, 19996*b*, 2006*a*, 2006*b*, 2006*c*, 2007) published a list of Saskatchewan macrolepidoptera with brief notes on distribution. Brodie (1929) published a list of Manitoba Lepidoptera, but it does not contain detailed distributional information. In addition to these references, the vast amount of unpublished distributional information on Lepidoptera associated with the specimens in several collections has been consulted, including the Canadian National Collection of Insects, Arachnids, and Nematodes in Ottawa, Ontario; the Strickland Museum at the University of Alberta; the Northern Forestry Centre collection at the Canadian Forest Service laboratory in Edmonton, Alberta; the Royal Saskatchewan Museum in Regina, Saskatchewan; and the C.D. Bird collection in Erskine, Alberta. These sources form the basis of the analysis of distribution patterns discussed below.

Lepidoptera Classification and Habits

The classification scheme presented here incorporates all relevant published names, and nomenclature changes that the authors are aware of, up to the end of 2013. This includes significant catalogues such as Brown (2005), Pelham (2008), Lee *et al.* (2009), and Lafontaine and Schmidt (2010, 2011, 2013), as well as many smaller works too numerous to mention here. The terms “butterfly” and “moth” are merely groupings of convenience and do not reflect natural groups in the context of Lepidoptera evolutionary history. Similarly, the butterflies and the larger moths previously associated in a group called the “Macrolepidoptera” and the families of smaller moths referred to as “microlepidoptera” do not represent natural groups (Regier *et al.* 2009; Mutanen *et al.* 2010); for convenience of discussion, however, we have arranged the 61 families of Lepidoptera that occur in the Prairies Ecozone of western Canada into three groupings that represent different habits and different levels of knowledge.

The first group is the microlepidoptera (Group I), which in the Prairies Ecozone includes 42 families of mostly small-sized moths with larvae that are concealed feeders. A total of 706 species of microlepidoptera are known from the Prairies Ecozone. The actual number of species in the ecozone is probably at least double this number, but our poor knowledge of them precludes a better estimate. The microlepidoptera families can be arranged in four subgroups on the basis of larval habits. The first consists of 12 families (including the large family Gracillariidae) that are mainly leaf miners. The larvae are called leaf miners because they feed on the tissues between the upper and lower leaf surfaces; this results in a characteristic clear patch in the leaf where the green chlorophyll has been removed. Many species can be identified in the larval stage by considering both the shape and position of the mine on the host plant and the identity of the host. The adults are small (typically 5–10 mm wingspan) and have narrow wings, usually with a hair-like fringe that is wider than the wing. The leaf-mining microlepidoptera are poorly known, especially in central and western North America. The second subgroup consists of the case-bearers. Four families (Adelidae, Incurvariidae, Tineidae, and Coleophoridae) are small, narrow-winged case-bearing moths, like the leaf miners, but the larvae conceal themselves in a case made of silk and debris or cut-out pieces of plant; the larvae are often miners when small and build a case when they get larger. A fifth family of case-bearers, the Psychidae, or bagworms, are variable in size and some have broader wings; the females of most psychid species are wingless and many are larviform. The third subgroup of microlepidoptera families is the borers, in which the larvae may bore in the stems of plants, or in the flower heads, fruit, and roots. Adults are variable in size and appearance: The ghost moths (family Hepialidae) are large moths with 25 to 100 mm wingspans; the clear-winged moths (family Sesiidae) are medium-sized wasp mimics; and most other families in the subgroup (e.g., Carposinidae, Momphidae) are small moths similar to leaf miners. The fourth and largest subgroup of the microlepidoptera is the leaf rollers. Most members of the large families Tortricidae and Gelechiidae fall into this category. The adults are generally larger than leaf miners (wing expanses of 15–30 mm are typical) and the wings are more triangular than those in other groups, with only a narrow fringe. The larvae most commonly roll or fold a leaf and tie it with silk, or tie several leaves together, and feed in the protected enclosure. This group includes agricultural pests (e.g., oblique-banded leaf roller, *Choristoneura rosaceana*; codling moth, *Cydia pomonella*) and forest pests (e.g., spruce budworm, *Choristoneura fumiferana*). A significant portion of the recorded microlepidoptera are known from only one or two localities in the area, and so little can be said of range limits or distribution patterns.

For discussion purposes, we treat the remaining Lepidoptera in two groups, the butterflies (Group II; Papilionoidea, *sensu* Heikkilä *et al.* 2012) and the macromoths (Group III). Six families and 177 species of butterflies occur in the Prairies Ecozone. The combination of colourful patterns, diurnal flight, and abundance of identification aids has made butterflies the most popular insect group with amateur entomologists. As a result, the distribution of butterflies in Canada in general and the Prairies Ecozone in particular is so well-known that it is these patterns that form the primary basis for the analysis of distribution patterns given below. As in the macromoths, most butterfly larvae are exposed while feeding and rely on cryptic coloration, warning coloration, or spines for protection. Most butterfly larvae are covered with a dense layer of short hair that gives them a fuzzy appearance (e.g., Lycaenidae, Hesperiidae, Pieridae, and some Nymphalidae) or are armed with an impressive array of branching spines (e.g., most Nymphalidae). Others, such as the monarch (*Danaus plexippus*) and some of the swallowtails (Papilionidae), are distasteful to predators and have a warning coloration. Many butterflies are powerful fliers and some are strongly migratory; several butterfly species occur in the ecozone as seasonal colonizers or strays.

The third group (Group III) comprises the macromoths. A total of 1,349 species in 13 families of macromoths occur in the Prairies Ecozone in Canada; this constitutes 78% of the entire known macromoth fauna from the three Prairie Provinces (GRP, unpublished data). The Crambidae and Pyralidae, often considered to be microlepidoptera, are included here since they are more closely related to the other families of macromoths than to the microlepidoptera. Three families, inchworm moths (Geometridae), erebid moths (Erebidae), and cutworm moths (Noctuidae), make up 78% of the Group III fauna. The cutworm moths alone, with 635 known species in the ecozone, make up 28% of the entire Lepidoptera fauna there. The larvae of macromoths are usually exposed when feeding, but are also usually protected by spines (Saturniidae), tufts of hair (Lasiocampidae, some Erebidae and Noctuidae), cryptic coloration (Geometridae, Drepanidae, Notodontidae, Noctuidae), or nocturnal habits (many Noctuinae). The hot, arid environments of the prairie grasslands present special challenges to many larval Lepidoptera, and many noctuid larvae hide during the day in the soil and leaf litter and feed only at night (e.g., tribes Leucaniini and Noctuini). Typical wingspans of most macromoths are between 25 and 40 mm, although some species may be as small as 12 mm (e.g., Erebidae: *Hypenodes*). Our largest resident Lepidoptera is the cecropia moth (*Hyalophora cecropia*), with a wingspan up to 150 mm. The macromoths contain some familiar pests such as tent caterpillars (Lasiocampidae: *Malacosoma* species), bertha armyworm (Noctuidae: *Mamestra configurata*), pale-western cutworm (Noctuidae: *Agrotis orthogonia*), redbacked cutworm (Noctuidae: *Euxoa ochrogaster*), and armyworm (Noctuidae: *Mythimna unipuncta*). Except for the few economically important species, distributional information on most macromoths remains rather spotty. A few groups are popular with amateur collectors and are better known; these include sphinx moths (family Sphingidae), giant silk moths (family Saturniidae), tiger moths (Erebidae: subfamily Arctiinae), and a group of erebid moths called underwing moths (Erebidae: genus *Catocala*).

Lepidoptera Diversity in the Prairies Ecozone

The Prairies Ecozone supports an extremely diverse fauna of butterflies and moths, with 2,232 species recorded in 61 families (Table 1). This represents approximately 43% of the Canadian Lepidoptera fauna of about 5,200 species (GRP, unpublished data), occurring in an ecozone that makes up only 5% of the national land base. The diversity of the Prairies Ecozone is influenced by the presence of species from two major North American biogeographical realms, the Boreal Plains and Boreal Shield ecozones and the Montane Cordillera Ecozone. Boreal forest species occur in spruce (*Picea* spp.) and trembling aspen (*Populus tremuloides* Michx.) groves, particularly along the northern and eastern portions of the ecozone, where the aspen parkland forms a transition between the grasslands and the boreal forest. Similarly, many species found primarily in the Montane Cordillera Ecozone have ranges that extend into the Prairies Ecozone and/or have disjunct populations in the Cypress Hills, which straddle the Alberta–Saskatchewan border. A significant number of species associated with deciduous forests in eastern Canada occur in southern Manitoba because they track the westernmost extent of their larval host trees, particularly bur oak (*Quercus macrocarpa* Michx.) and American elm (*Ulmus americana* L.). At a smaller scale, Lepidoptera diversity tracks the changes in plant diversity of the seven ecoregion subdivisions of the Prairies Ecozone (Ecological Stratification Working Group 1996; Shorthouse 2010).

The proportion of species in each family that are inhabitants of true "grassland" habitat within the Prairies Ecozone varies widely across macromoth families, from 62% (393 species) in the Noctuidae and 36% (52 species) in the Erebidae, to only 18% (49 species) in the Geometridae and only one species each in the Notodontidae and Drepanidae. This difference is because Notodontidae, Drepanidae, and most of the Geometridae feed on woody plants as larvae, whereas the cutworm groups in Noctuidae (Noctuinae) are dominated by species adapted to feeding on non-woody plants, particularly grasses. In Alberta, where a transition occurs from grassland through parkland and into boreal, there is a shift in composition of the moth fauna from one that is dominated by species feeding on woody plants in the boreal region to one dominated by species feeding on herbaceous plants, driven primarily by the shift to a greater proportion of herbaceous-feeding Noctuidae (Figs. 1–3). Of note is that although species richness of Geometridae there decreases considerably from boreal forest to grasslands (Fig. 3), the proportion of woody plant specialists changes little, with an approximate 8% drop in woody-plant dependent Geometridae versus a corresponding drop of 16% in Noctuidae (Fig. 2). This underscores the importance of trees and shrubs to ecosystem diversity in prairie habitats in Alberta (Fig. 2).

In the microlepidoptera families, only about 33% of the species that occur in the Prairies Ecozone occur in grassland habitats, but this value is biased because the microlepidoptera fauna of woody plants is much better known and collected than that associated with herbaceous plants. Examples of poorly known microlepidoptera groups that have undergone radiation in grassland habitats are the grass miner moths (Elachistidae: Elachistinae) and the gelechiid tribe Gnorimoschemini. Butterflies occur most commonly in open habitats, and 62% (109 species) of the butterfly fauna of the ecozone occur in grassland habitat.

Table 1 lists the 61 families of Lepidoptera known from the Prairies Ecozone in Canada, as well as the number of species known from grasslands habitats versus other habitats in the Prairies Ecozone. Table 2 summarizes the number of species restricted to the Prairies Ecozone and Tables 3-5 summarize the conservation status of Prairies Ecozone Lepidoptera. A checklist of the Lepidoptera known to occur in the Prairies Ecozone is included in Table 6.

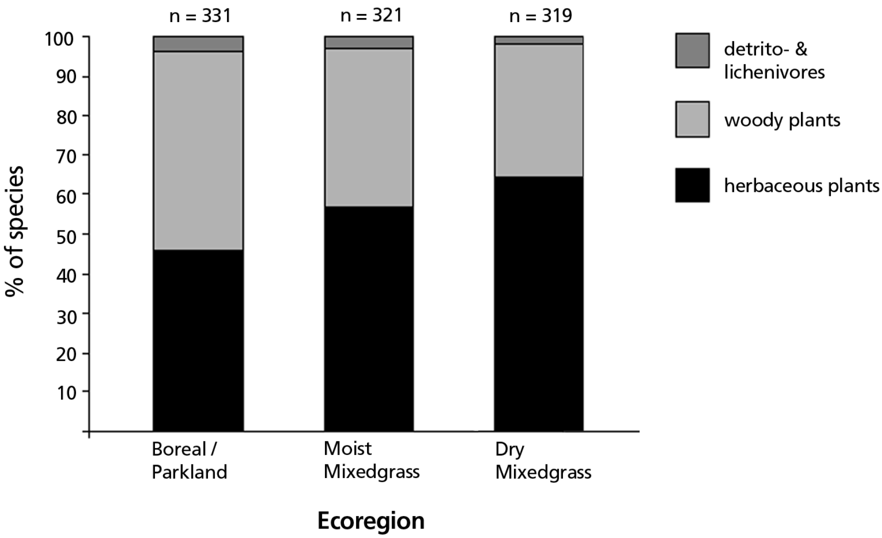

Fig. 1. Comparison of macromoth fauna among three sites in Alberta by larval feeding guild. Boreal/Parkland site = Ministik Hills (Schmidt 2001); Moist Mixedgrass prairie = Mackenzie Crossing, Red Deer River (CDB, unpublished report available from Alberta Lepidopterists' Guild 2014; BCS, unpublished data); Dry Mixedgrass prairie = Dinosaur Provincial Park, Red Deer River (GGA and BCS, unpublished data). Species with unknown larval hosts were assigned a feeding guild according to host data for the nearest available higher level taxon (e.g., genus or tribe). The herbaceous plant group includes graminoids.

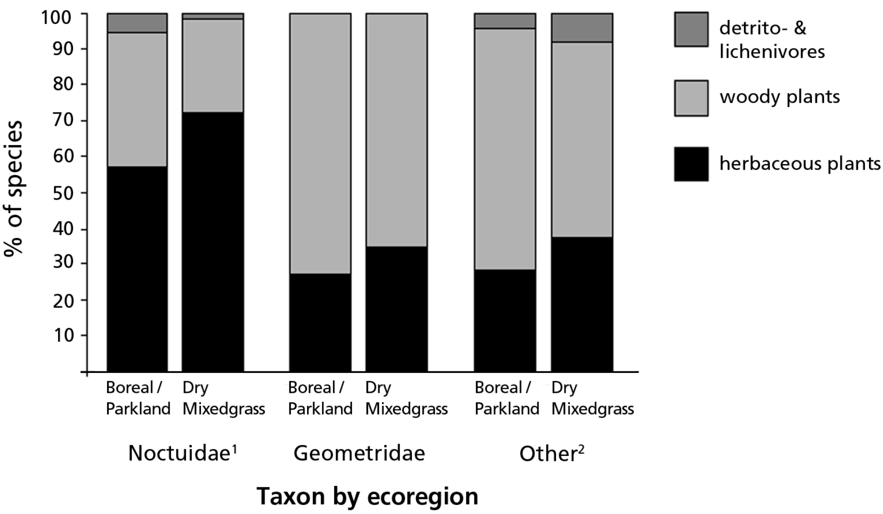

Fig. 2. Comparison of feeding guilds among a southern boreal and dry mixedgrass prairie within macromoth family groups. Boreal/Parkland site = Ministik Hills (Schmidt 2001); Dry Mixedgrass prairie = Dinosaur Provincial Park, Red Deer River (GGA and BCS, unpublished data). Species with unknown larval hosts were assigned a feeding guild according to host data for the nearest available higher level taxon (e.g., genus or tribe). The herbaceous plant group includes graminoids. [1] Broadly defined to include Nolidae and Erebidae, but excluding Lymantriinae and Arctiinae. [2] Sphingidae, Saturniidae, Lasiocampidae, Uraniidae, Drepanidae, Notodontidae, Arctiinae, and Lymantriinae; the latter two are now included in the Erebidae (see Lafontaine and Schmidt 2010 and references therein).

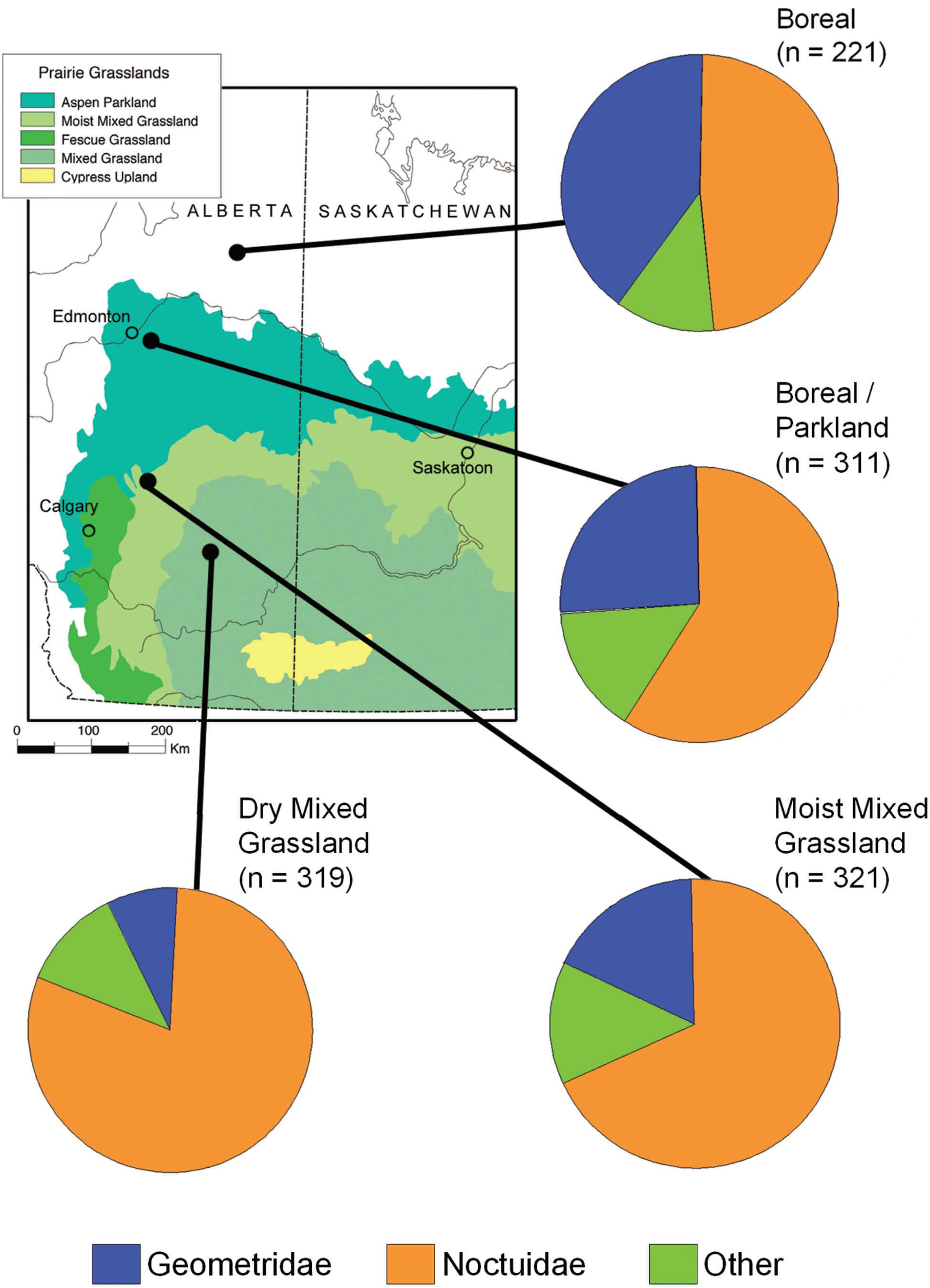

Fig. 3. Faunal shifts in species composition of macromoths over a latitudinal gradient through the Boreal Plains and Prairies ecozones of Alberta. Moth family categories as defined in Fig. 2. Boreal site = Touchwood Lake (Pohl *et al.* 2004); Boreal/Parkland site = Ministik Hills (Schmidt 2001); Moist Mixed grassland = Mackenzie Crossing, Red Deer River (CDB, unpublished report available from Alberta Lepidopterists' Guild 2014; BCS, unpublished data); Dry Mixed Grassland = Dinosaur Provincial Park, Red Deer River (GGA and BCS, unpublished data). Map modified from Shorthouse (2010).

Table 1. Total numbers of Lepidoptera species that are grasslands specialists within the Prairies Ecozone, inhabitants of other habitats within the ecozone, total inhabitants of the ecozone, and inhabitants in the ecozone in Alberta (AB), Saskatchewan (SK), and Manitoba (MB).

Family	Grasslands in Ecozone	Other Habitats in Ecozone	Total Prairies Ecozone	Zone in AB	Zone in SK	Zone in MB
Acanthopteroctetidae		1	1	1	1	1
Hepialidae	1	1	2	2	2	1
Nepticulidae		3	3	2	0	1
Opostegidae		1	1	1	0	0
Adelidae	1	1	2	2	1	1
Incurvariidae		1	1	1	1	1
Prodoxidae	3	2	5	5	1	0
Tischeriidae	1	1	2	1	1	2
Psychidae		1	1	1	0	1
Tineidae	2	14	16	14	11	10
Bucculatricidae		2	2	1	1	2
Gracillariidae		26	26	20	19	19
Yponomeutidae		2	2	2	2	0
Ypsolophidae	2	5	7	7	4	5
Plutellidae	1	3	4	4	2	1
Glyphipterigidae		4	4	2	2	3
Argyresthiidae		4	4	4	4	2
Lyonetiidae		2	2	2	1	2
Heliodinidae		1	1	0	0	1
Bedelliidae		1	1	1	0	1
Autostichidae		2	2	2	1	0
Blastobasidae		7	7	4	3	5
Oecophoridae		6	6	5	3	5
Elachistidae	19	36	55	39	33	35
Batrachedridae		1	1	1	1	1
Coleophoridae	7	24	31	26	16	20
Momphidae	3	5	8	8	7	6
Scythrididae	2	5	7	5	5	5
Cosmopterigidae	3	7	10	6	7	5
Gelechiidae	50	81	131	98	66	75
Alucitidae		3	3	3	2	2
Pterophoridae	14	13	27	27	19	23
Carposinidae		3	3	3	3	2
Schreckensteiniidae		1	1	1	0	1
Epermeniidae	1	1	2	1	1	2
Choreutidae		2	2	2	1	0
Tortricidae	111	180	291	259	205	231
Cossidae	1	2	3	3	3	3
Sesiidae	9	14	23	20	13	15

Family	Grasslands in Ecozone	Other Habitats in Ecozone	Total Prairies Ecozone	Zone in AB	Zone in SK	Zone in MB
Limacodidae		2	2	1	1	2
Zygaenidae		2	2		0	2
Thyrididae	1	1	2	1	2	2
Subtotal microlepidoptera	**232**	**474**	**706**	**588**	**445**	**496**
Papilionidae	5	4	9	6	7	5
Hesperiidae	33	12	45	28	36	37
Pieridae	10	8	18	15	15	16
Riodinidae	1		1		1	
Lycaenidae	20	18	38	29	36	27
Nymphalidae	40	26	66	58	59	54
Subtotal butterflies	**109**	**68**	**177**	**136**	**154**	**139**
Pyralidae	49	47	96	80	57	61
Crambidae	51	54	105	92	80	83
Drepanidae	1	7	8	8	8	7
Lasiocampidae	1	4	5	4	5	5
Saturniidae	4	7	11	6	6	10
Sphingidae	10	21	31	24	25	29
Uraniidae		1	1	1	1	1
Geometridae	49	216	265	228	224	224
Notodontidae	1	37	38	22	33	38
Erebidae	52	94	146	109	120	130
Euteliidae	1	1	2	1	2	2
Nolidae		6	6	4	6	6
Noctuidae	393	242	635	528	517	495
Subtotal macromoths	**612**	**737**	**1349**	**1107**	**1084**	**1091**
Total	**953**	**1279**	**2232**	**1831**	**1683**	**1726**

Distribution Patterns

This analysis of distribution patterns of Lepidoptera of the Prairies Ecozone is drawn mainly from the distributional data on macromoths and butterflies because most of the microlepidoptera, except for the forest species, have not been extensively collected and the limits of their distributions are incompletely known. There are three main terrestrial habitat types within the Prairies Ecozone: (1) deciduous woodlands, (2) prairie thickets, and (3) open aridlands. We examine each of these habitat types and give examples of distribution patterns associated with them.

The Prairies Ecozone encompasses a nationally and globally unique assemblage of Lepidoptera communities. Many Prairies Ecozone species are known also from relict prairie habitats in Ontario, as well as from dune and grassland habitats in the Maritimes. However, a significant portion of the fauna has western Cordilleran/grassland affinities, as 20% of the prairie moth fauna occur also in British Columbia (but not east of the Prairie Provinces). An additional 70% have either transcontinental or predominantly eastern distributions. At least 173 species are believed to occur in Canada only in the ecozone (see Table 6). About 10% of butterflies (18 species) and 9% of macromoths (119 species) of the ecozone are found nowhere else in Canada (Table 2); most are Great Plains species that are at the northern edge of their distribution. Of the macromoth species restricted in Canada to the ecozone, all but 11 occur exclusively or primarily in grassland habitats. Several of the exceptions are restricted to the aspen parkland (see "Deciduous Woodlands" section below), but two are Montane Cordillera species occurring marginally in prairie grassland (*Anarta alta* and *Apamea unita*), and an additional three species are restricted to oak savanna and shrubby habitats in Manitoba (*Anisota manitobensis*, *Catocala whitneyi*, *Acronicta falcula*), but are not known to occur in similar habitats in Ontario or elsewhere in Canada. Sixteen macromoth and butterfly species are restricted to Manitoba alone (Table 2), representing mostly tallgrass prairie and oak savanna specialists of the American Midwest. By comparison, the grassland fauna of Saskatchewan is almost entirely shared with that of Alberta; the five species nationally unique to Saskatchewan are species that either could occur in Alberta, or have not been collected since their original description. Thirty-four Prairies Ecozone species are known in Canada only from Alberta.

Three of the most poorly known North American macromoths were described from the Prairies Ecozone: *Euxoa unica*, *Agrotis kingi,* and *Animomyia hardwicki*, which to this day are known only from the type series collected many years ago. *Schinia verna* is another species globally endemic to the Canadian Prairies, and *Aspitates aberrata* is nearly so. Additionally, the micromoth *Coleotechnites biopes* is globally endemic to the Cypress Hills within the Prairies Ecozone.

Deciduous Woodlands

Woodland habitats occur in northern parts of the ecoregion that transition to cooler and/or wetter climatic conditions than are found in the south, as well as in riparian gallery forest along the major river valleys in the prairie grasslands. Species in the Prairies Ecozone associated with woodland habitats are mostly more typical of the Boreal Shield and Boreal Plains ecozones to the north, or of the Montane Cordillera Ecozone to the west (these species are shown with a lower case 'p' in Table 6). Although most species of woodland habitats in the Prairies Ecozone are boreal species at the margin of their core range, exceptions exist where incursions of other faunal elements occur (e.g., oak savanna and eastern deciduous forest); a few examples are given below.

Table 2. Summary of Prairies Ecozone butterflies and macromoths that are restricted to the Prairie Provinces. Abbreviations: AB = Alberta; MB = Manitoba; SK = Saskatchewan.

Region	Species
AB, SK, MB	38
AB, SK	37
SK, MB	7
AB, MB	1
AB	34
SK	5
MB	16
Total	**138**

Aspen forests dominate the landscape in the Aspen Parkland and Lake Manitoba Plain ecoregions, with smaller amounts of spruce (*Picea* spp.), birch (*Betula* spp.), and tamarack (*Larix laricina* (Du Roi) K. Koch) (Bird 1961). These ecoregions are high in diversity because such a large portion of the boreal zone species and many grassland species occur in the patchwork of habitats that they contain. The combination of both boreal and grasslands elements is reflected in proportions of woody-feeding Noctuoidea species, which are intermediate between those of boreal and grasslands sites (Figs. 1 and 2). The transitional nature of the Aspen Parkland and Lake Manitoba Plain ecoregions results in very few species being specifically characteristic of these ecoregions; rather, these ecoregions consist of species of the Boreal Shield and Boreal Plains ecozones that can tolerate the drier, warmer habitats that abound along with the more ubiquitous portions of the grassland fauna. In Canada, *Hemileuca nevadensis, Grammia margo*, *Melaporphyria immortua,* and *Dysstroma rutlandia* are endemic to the Aspen Parkland Ecoregion.

Forests in the Southwest Manitoba Uplands Ecoregion in the Pembina Hills (e.g., Spruce Woods Provincial Park) and Turtle Mountain (Turtle Mountain Provincial Park) are also dominated by aspen groves, with smaller proportions of balsam poplar (*Populus balsamifera* L.), balsam fir (*Abies balsamea* (L.)), and white spruce (*Picea glauca* (Moench) Voss) in well-drained areas, and tamarack and black spruce (*Picea mariana* (Mill.) BSP) in wet areas. The Aspen Parkland Ecoregion is transitional, whereas the Southwest Manitoba Uplands Ecoregion has more affinities in its plant and insect faunas with those of the Boreal Plains Ecozone than with those of the Prairies Ecozone; these areas classified as Southwest Manitoba Uplands Ecoregion are essentially disjunct islands of Boreal Plains Ecozone habitat within the Prairies Ecozone.

In the Cypress Upland Ecoregion in southwestern Saskatchewan and southeastern Alberta, the spruce and aspen forests mix with Montane Cordillera plants such as lodgepole pine (*Pinus contorta* Dougl. *ex.* Loud. var. *latifolia* Engelm.). A significant portion of boreal zone species are replaced in these forests by species associated with the Montane Cordillera Ecozone; this disjunct upland community may be better classified as an outpost of the Montane Cordillera Ecozone than as Prairies Ecozone. Montane Cordillera Lepidoptera that occur in this ecoregion include butterflies such as Rocky Mountain Parnassian (*Parnassius smintheus*), margined white (*Pieris marginalis*), and Edith's checkerspot (*Euphydryas editha*), as well as moths (e.g., *Xestia speciosa*). The gelechiid moth *Coleotechnites biopes* is globally endemic to the Cypress Hills. Within Canada, Bernadette's checkerspot (*Euphydryas bernadetta*) occurs only in the Cypress Hills.

Trees more characteristic of the Mixedwood Plains Ecozone occur in pockets across southern Manitoba and adjacent Saskatchewan. The most obvious of these are bur oak and Manitoba maple (*Acer negundo* L.), but small numbers of eastern cottonwood (*Populus deltoides* Bartr. *ex.* Marsh. ssp. *deltoides*), narrow-leaf cottonwood (*P. angustifolia* James), hackberry (*Celtis occidentalis* L.), basswood (*Tilia americana* L.), ironwood (*Ostrya virginiana* (Mill.) K. Koch), ash (*Fraxinus* spp.), and American elm also occur. Lepidoptera species associated with these trees are at the northern limit of their range here and some otherwise occur only as far north as southern Ontario. Examples include two skipper butterflies, the southern cloudywing (*Thorybes bathyllus*) and sleepy duskywing (*Erynnis brizo*); the hackberry butterfly (*Asterocampa celtis*); and moths such as the scarlet underwing moth (*Catocala coccinata*) and oakworm moth (*Anisota virginiensis*). *Anisota manitobensis* and *Acronicta exilis* are two species dependent on oak savanna habitats within their Canadian range.

A final type of deciduous woodland habitat in the Plains Ecozone are riparian forests, usually cottonwoods (*Populus* spp.), which occur along stream and river margins. Many *Populus* feeding species of the Aspen Parkland and Lake Manitoba Plain ecoregions may occur in these gallery forests, but some species are specialized to them, such as the two-tailed swallowtail (*Papilio multicaudata*) and Weidemeyer's admiral (*Limenitis weidemeyerii*). Although constituting a relatively minor spatial portion of the grasslands ecoregion, riparian woodlands are critical determinants of Lepidoptera diversity here: well over half of the species in the non-Noctuidae categories (Fig. 1) rely on woody plants for larval hosts, in contrast to the sharp decrease in the proportion of woody-dependent species of Noctuidae in the grasslands. Another interesting faunal difference between riparian and transition zone woodlands is the presence of several eastern deciduous forest species in southern riparian woodlands, which are otherwise absent farther north. Examples include *Phigalia titea, Hyalophora cecropia,* and several species of *Catocala*.

Prairie Thickets

Areas where shrubs abound, such as protected hillsides, valley bottoms in the rolling prairie, and margins of wet sloughs, form a distinctive habitat within the Prairies Ecozone and offer shelter to a wide range of wildlife. On hillsides and drier sites, shrubs such as wolfberry (*Symphoricarpos occidentalis* Hook.), silverberry (*Elaeagnus commutata* Bernh. *ex.* Rydb.), and buffaloberry (*Shepherdia argentea* Nutt.) dominate, with saskatoon (*Amelanchier alnifolia* (Nutt.) Nutt.), chokecherry (*Prunus virginiana* L.), and various species of willow (*Salix* spp.) predominating in wetter areas. These shrub communities support the fauna that feeds on the shrubs themselves, as well as birds and mammals that use them for protection and nesting sites. Shrubs with a particularly diverse Lepidoptera fauna are willow, cherry (*Prunus* spp.), and saskatoon, host to many Geometridae and a number of Noctuidae genera such as *Acronicta* and *Lithophane*. The Weidemeyer's admiral, a target species for conservation status (Committee on the Status of Endangered Wildlife in Canada (COSEWIC) 2012), is dependent on willow and cherry thickets in southernmost Alberta. The owlet moths *Orthosia segregata* and *Sympistis chionanthi* are associated with the plants of the olive family (*Shepherdia* and *Elaeagnus* species, respectively). Shrubs in the honeysuckle family, such as *Symphoricarpos* and *Lonicera* species, also have a varied and specialized fauna, such as *Sphinx vashti*, *Hemaris diffinis*, *Callizzia amorata*, and several species of *Sympistis*. Although more typical of boreal and deciduous forest than prairie thickets, hazel (*Corylus* spp.) hosts two species (*Acronicta falcula*, *Bagisara rectifascia*) known in Canada only from southwestern Manitoba. These appear to be cases of a prairie climate determining the distribution of southern moths on a widespread host plant.

Open Aridlands

Open aridland habitat can be subdivided into three groups: grasslands, badlands, and dunes. Grasslands are frequently further classified into three groups, defined mainly by the dominant grasses (Coupland 1961; Sims *et al.* 1978): (1) tallgrass prairie, which occurs mainly along the more moist eastern edge of the Great Plains and is characterized by grasses such as big bluestem (*Andropogon gerardi* Vitman) and prairie dropseed (*Sporobolus heterolepis* (Gray) Gray); (2) shortgrass prairie, which occurs mainly in southern Alberta and southwestern Saskatchewan and is characterized by grass species such as blue grama (*Bouteloua gracilis* (HBK) Lag.), buffalo grass (*Buchloe dactyloides* (Nutt.) Engelm.), and speargrass (*Stipa comata* Trin. & Rupr.); and (3) mixed prairie, which is characterized by a wide range of both short and tall types of grasses such as June grass (*Koeleria* *gracilis* (Ledeb.) J.A. Schultes f.). Some characteristic plants of the grasslands are ball cactus (*Escobaria vivipara* (Nutt.) Buxbaum), two species of prickly-pear cactus (*Opuntia fragilis* (Nutt.) Haw. and *O. polyacantha* Haw.), gumweed (*Grindelia squarrosa* (Pursh) Dunal), blazingstar (*Liatris punctata* Hook.), pasture sage (*Artemisia frigida* Willd.), and linear-leaved wormwood (*Artemisia dracunculus* L.).

Some Lepidoptera species are widely distributed in the ecozone grasslands and also occur to varying degrees in other areas of Canada. The great spangled fritillary (*Speyeria cybele*) and long dash skipper (*Polites mystic*) occur across most of southern Canada in grassy habitats and throughout the Prairies Ecozone. Others such as the uncas skipper (*Hesperia uncas*) occur throughout the Prairies Ecozone and are restricted to it in Canada. Others are mainly distributed in the Prairies Ecozone, but occur in relict prairie habitat elsewhere: The garita skipperling (*Oarisma garita*) also occurs on Great La Cloche Island near Manitoulin Island in Ontario, in relict prairie habitat in the Peace River area of Alberta and British Columbia, and in a few areas of the dry interior of British Columbia; the plains skipper (*Hesperia assiniboia*), bertha armyworm (*Mamestra configurata*), and Uhler's arctic (*Oeneis uhleri*) also occur in grassland habitat in the Peace River area; the gorgone checkerspot (*Chlosyne gorgone*) and Melissa blue (*Plebejus melissa*) occur in a few areas in Ontario; and the latter also occurs in southern British Columbia.

Some species are highly restricted within the ecozone. Poweshiek skipperling (*Oarisma poweshiek*), Dakota skipper (*Hesperia dacotae*), and Ottoe skipper (*Hesperia ottoe*) are restricted to tallgrass prairie in southern Manitoba and are threatened or endangered in Canada. The latter has not been seen since the late 1980s and may be extirpated from Canada (COSEWIC 2005). Two rare moths (*Catocala whitneyi*, *Schinia lucens*) are dependent on leadplant (*Amorpha* spp.), which is rare in Canada. Shasta blue (*Plebejus shasta*) and Ridings' satyr (*Neominois ridingsii*) are associated with shortgrass prairie. Four species of skippers, simius roadside skipper (*Notamblyscirtes simius*), Oslar's roadside skipper (*Amblyscirtes oslari*), pahaska skipper (*Hesperia pahaska*), and rhesus skipper (*Polites rhesus*), are widely distributed in shortgrass prairie in the western Great Plains of the United States, where they are associated with blue grama grass but have been recorded only two, eight, four, and seven times, respectively, in Canada. It has not been determined whether these represent stragglers or if permanent colonies exist in Canada. Another group of highly restricted species in the grasslands are those associated with yucca plants (*Yucca* spp.), restricted in Canada to two tiny sites in southeastern Alberta. This group includes three micromoths (*Tegeticula yuccasella*, *T. corruptrix*, and *Prodoxus quinquepunctella*) and a skipper (*Megathymus streckeri*).

The badlands are a localized and specialized habitat of heavily eroded sites, usually along rivers. The three most extensive and significant badlands are prehistoric in their origins, originating when the associated rivers were very large and eroded extensive areas adjacent to them. These three areas are along the Red Deer River (e.g., Dinosaur Provincial Park, Alberta), the Milk River (e.g., Writing-on-Stone Provincial Park, Alberta), and the Frenchman River (e.g., Grasslands National Park near Val Marie, Saskatchewan). Plants such as rabbitbrush (*Chrysothamnus nauseosus* (Pall.) Britt.) and sand-lily (*Mentzelia decapetala* (Sims) Urban & Gilg) are characteristic. Some Lepidoptera associated with badlands are the sagebrush checkerspot butterfly (*Chlosyne acastus*) and the moths *Sideridis uscripta, Euxoa misturata*, *E. citricolor*, *Abagrotis discoidalis*, *Protogygia enalaga*, and *P. querula*. Most species associated with the badlands of the Prairies Ecozone are widely distributed in the Great Basin in the western United States but find suitable xeric habitat in the isolated pockets of badlands habitat in Canada.

Areas of open active dunes are not common in the Prairies Ecozone but do have a specialized moth fauna (Acorn 2011). Numerous species are restricted entirely to dune habitats, several of which have been targeted for conservation work (e.g., *Copablepharon* spp., *Schinia avemensis*; see "Endangered and Threatened Species" section below). Characteristic plants of open dunes are Indian rice grass (*Oryzopsis hymenoides* (R. & S.) Ricker), prairie sand reed (*Calamovilfa longifolia* (Hook.) Scribn.), sand dropseed (*Sporobolus cryptandrus* (Torr.) A. Gray), and sand dock (*Rumex venosus* Pursh). The largest dune areas are the Great Sand Hills of Saskatchewan, but smaller dunes occur throughout the ecozone. Several species of cutworms are specialized to dunes, including *Copablepharon* spp., *Euxoa perpolita, E. aurulenta, E. scandens*, *Sideridis artesta*, and *Sympistis riparia*. A geometrid moth, *Animomyia hardwicki*, is known globally only from the type material collected in the Great Sand Hills. No butterflies are restricted to dunes, although several such as *Lycaena rubidus*, *Neominois ridingsii*, and *Oeneis alberta* are often associated with sandy prairie habitats near dunes. The dune moth fauna varies considerably across the ecoregion, likely reflecting regional climate differences, local moisture regimes, and differences in geological parent material of the sand. For example, at least two species (*Pygarctia spraguei*, *Schinia bimatris*) are known in Canada only from the Spirit Sands in Manitoba.

Lepidoptera Migrants and Vagrants

A total of 28 species of Lepidoptera occur in the Prairies Ecozone only as regular seasonal migrants or occasional strays. The number of tropical and subtropical moths and butterflies that migrate northward each summer is much greater in eastern and central North America than in the west. The Atlantic Coast, Mississippi Valley, and the Great Plains form natural flyways for migrants coming from the south, whereas the complex patterns of mountain ranges, desert areas, and diverse habitats in western United States and Canada seem to limit the northward movement of species. The most famous of the migrants is the monarch (*Danaus plexippus*); the population in the Prairies Ecozone and in eastern Canada overwinters in Mexico, whereas those that occur in the Montane Cordillera Ecozone to the west overwinter in California. The painted lady (*Vanessa cardui*) is another regular migrant. Four others, the sachem (*Atalopedes campestris*), American lady (*Vanessa virginiensis*), variegated fritillary (*Euptoieta claudia*), and question mark (*Polygonia interrogationis*), are infrequent migrants into the ecozone. Another group of powerful fliers, the sphinx moths (Sphingidae), includes only one regular migrant in the ecozone (*Hyles lineata*) and one that has been reported only twice (*Eumorpha labruscae*). Two other families of Lepidoptera show a fair proportion of vagrant species: the Noctuidae and Crambidae. Among pest species of Noctuidae that migrate regularly into the Prairies Ecozone are the fall armyworm (*Spodoptera frugiperda*), variegated cutworm (*Peridroma saucia*), and black cutworm (*Agrotis ipsilon*). Among the Crambidae, two pest species are migrants: the alfalfa webworm (*Loxostege cereralis*) and beet webworm (*Loxostege sticticalis*). The only migratory species of microlepidoptera in the Prairies Ecozone is the diamond back moth (*Plutella xylostella*), which can occasionally overwinter in western Canada (Dosdall 1994), but often travels in huge windblown swarms numbering many millions of moths and has even reached Greenland. The spread of the diamond back moth and other pest migrants has probably been greatly aided by human activity.

Recent Changes in Distribution

Recent changes in Lepidoptera distribution involve both expanding and contracting ranges. Natural changes in distribution can be difficult to detect because they tend to be slower and more subtle than the dramatic changes caused by human activity. Unfortunately, most expanding ranges involve introduced species and most contracting ranges involve native species that are becoming less widespread or less common with the destruction of their natural habitats.

Introduced Species

The presence of introduced species in Canada, and their impact, is most significant in British Columbia, where 126 introduced species of Lepidoptera have been reported (Pohl *et al*., in press), mainly in the greater Vancouver area. Most of these species have not been able to spread over the mountains into central Canada. The second most important area in Canada for accidental introductions of exotic species is in the Atlantic provinces, where about 50 introduced species occur. Again, most of these species have not spread westward as far as the Prairies Ecozone, but the yellow underwing moth (*Noctua pronuba*) has arrived recently, and the potato stem borer (*Hydraecia micacea*) is expected to be reported in the next few years. At present, at least 42 introduced species occur in the Prairies Ecozone. The spurge hawkmoth (*Hyles euphorbiae*) was introduced as a possible biological control agent for spurges, especially leafy spurge (*Euphorbia esula* L.). Two other species were originally introduced into eastern Canada and have spread into the Prairies Ecozone. The cabbage white (*Pieris rapae*) was introduced near Quebec City in about 1860 and has become abundant in urban and agricultural areas of North America; it now occurs throughout the Prairies Ecozone. The European skipper (*Thymelicus lineola*) was introduced at London, Ontario, in about 1910 and has spread widely in eastern North America but more locally in central and western North America. The spread of this species in central Alberta is relatively well-documented (Schmidt *et al.* 2003) and continues today. It feeds on a variety of grasses, but timothy grass (*Phleum pratense* L.), a common pasture grass, is preferred.

Native Species

Most of the changes in the range of native species are due to human activities and are dealt with in the following section. Documentation of natural changes in native species ranges is difficult because it requires enough survey effort so that negative evidence (lack of records) can be reliably taken as valid evidence that the species is, or was, absent. Expansions of range into central Alberta have been documented for the butterfly species *Lethe anthedon* (Schmidt *et al.* 2003) and *Poanes hobomok* (Pohl *et al.* 2010). Another species that has naturally expanded into the Prairies Ecozone is the dayflying arctiine moth *Ctenucha virginica*, which arrived in the aspen parkland of Alberta from the boreal forest to the north in the 1970s (Pohl *et al.* 2010).

Several changes in butterfly distribution and flight times have been noted in Manitoba in recent years. The northern broken-dash (*Wallengrenia egeremet*) was collected for the first time in Manitoba in 2006, and it appears to have established a permanent population there (Semmler and Westwood 2013). There have also been significant northward range expansions in Manitoba by the common buckeye (*Junonia coenia*) and Baltimore checkerspot (*Euphydryas phaeton*) in recent years (Taylor *et al.* 2008; Taylor and Westwood 2010). Additionally, Westwood and Blair (2010) examined 19 butterfly species in southeastern Manitoba and found that, over the period 1974–2004, 13 of these species had extended their flight periods later into the summer in more recent years, likely due to climate change.

Table 3. Lepidoptera of conservation concern in the Prairies Ecozone. Ranks are from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (2011) and the Canadian Endangered Species Conservation Council (CESCC) (2011). Abbreviations: AB = Alberta; MB = Manitoba; ON = Ontario; QC = Quebec; SK = Saskatchewan.

Taxon	COSEWIC (or CESCC) Rank	Occurrence and Habitat
Prodoxidae		
Prodoxus quinquepunctella	Endangered	AB: prairie coulees
Tegeticula corruptrix	Endangered	AB: prairie coulees
Tegeticula yuccasella	Endangered	AB: prairie coulees
Hesperiidae		
Atrytonopsis hianna	Not evaluated (sensitive CESCC)	SK, MB: virgin prairie; ON: sandy oak savanna
Erynnis martialis	Under review (secure CESCC)	MB, ON, QC: open woods, sandy areas, alvars
Hesperia dacotae	Threatened	SK, MB: prairie
Hesperia ottoe	Endangered	MB: native prairie
Hesperia pahaska	Not evaluated (may be at risk CESCC)	SK, MB: prairie, open pine forest
Hesperia uncas	Not evaluated (at risk CESCC)	AB, SK, MB: prairie
Megathymus streckeri	Not evaluated	AB: prairie coulees
Oarisma poweshiek	Threatened	MB: prairie
Pyrgus scriptura	Not evaluated (may be at risk CESCC)	AB, SK: shortgrass prairie
Riodinidae		
Apodemia mormo (prairie pop.)	Threatened	SK: prairie badlands
Nymphalidae		
Danaus plexippus	Special Concern	Distributed across southern Canada
Limenitis weidemeyerii	Special Concern	AB: prairie coulees
Neominois ridingsii	Not evaluated (extirpated/sensitive CESCC)	AB, SK; formerly MB: prairie
Speyeria edwardsii	Not evaluated (may be at risk CESCC)	AB, SK, MB: prairie, foothills
Speyeria idalia	Not evaluated (extirpated CESCC)	SK, MB, ON: tallgrass prairie, forest clearings
Saturniidae		
Anisota manitobensis	Not evaluated (may be at risk CESCC)	MB: bur oak parkland
Hemileuca nevadensis	Not evaluated (may be at risk CESCC)	AB, SK, MB: parkland dunes; ON: fens
Noctuidae		
Copablepharon longipenne	Endangered	AB, SK, MB: prairie dunes
Copablepharon grandis	Special Concern	AB, SK, MB: prairie dunes
Melaporphyria immortua	Data Deficient	AB, SK, MB: aspen parkland
Papaipema aweme	Endangered	MB, ON: prairie
Schinia avemensis	Endangered	AB, MB: prairie dunes
Schinia bimatris	Endangered	MB: prairie dunes
Schinia lucens	Not evaluated	MB, ON: prairie
Schinia sanguinea	Not evaluated	SK, ON: prairie
Schinia verna	Threatened	AB, SK, MB: prairie

Endangered and Threatened Species

The Prairies Ecozone is home to numerous species with very specific habitat requirements, and some of these species occur in only a few places in Canada or even globally. Through a combination of factors such as high human population density, agricultural land conversion, and small or limited populations, there are more Lepidoptera species of conservation concern in this ecozone than in any other in Canada (Table 3).

Hall *et al.* (2011) provide an excellent summary of federal and provincial conservation efforts in relation to prairie insects. The primary means of protecting insect species is assessment by COSEWIC and subsequent listing in the *Species at Risk Act*. In contrast to the in-depth assessments of a small number of species by COSEWIC, the Wild Species reports of the National General Status Working Group of the Canadian Wildlife Service present and track the general conservation status of large numbers of Canadian species, without the detail required for legal protection. The most recent report (Canadian Endangered Species Conservation Council (CESCC) 2011) listed 302 butterfly species and 236 of the better known macromoth species. In that report, a number of species occurring in the grasslands of western Canada are given rankings of less than "secure" (Table 4). The high number of "undetermined" species attests to the fact that, even among these "better known" butterflies and selected macromoths, information upon which to base conservation decisions is spotty.

Provincial Lepidoptera conservation efforts vary widely. In Alberta and Saskatchewan, insects are not formally recognized as "wildlife," and so they are not afforded any specific protection under their respective Provincial Wildlife Acts (Alberta Environment and Sustainable Resource Development 2012; Saskatchewan Conservation Data Centre 2012). However, insects can still be designated as endangered or threatened species there, which garners them some conservation management. Saskatchewan has not designated any Lepidoptera species, but Alberta has assessed three Lepidoptera species, and has designated one – Weidemeyer's admiral (*Limenitis weidemeyerii*) - as a "species of special concern". In Manitoba, most of the federally listed Lepidoptera species that occur in the province are listed under the Manitoba Endangered Species Act (Table 5) (Manitoba Wildlife Branch 2012).

Most of the threatened and endangered species in the Prairies Ecozone are at risk because of conversion of natural prairie habitat into agricultural lands, the patches of

Table 4. National General Status ranks of Lepidoptera species occurring in the Prairies Ecozone in Canada, summarized from the Canadian Endangered Species Conservation Council (CESCC) (2011). Abbreviations: AB = Alberta; MB = Manitoba; SK = Saskatchewan.

	Butterflies			**Selected Macromoths**		
Rank	**AB**	**SK**	**MB**	**AB**	**SK**	**MB**
Extinct	0	0	0	0	0	0
Extirpated	0	0	1	1	0	0
At risk	0	0	2	0	0	0
May be at risk	1	8	13	1	0	3
Sensitive	20	21	7	5	5	10
Secure	104	107	112	72	58	54
Undetermined	37	11	7	12	25	38
Not assessed	0	0	1	0	0	0
Exotic	2	2	2	2	1	1
Accidental	2	10	13	2	6	7

Table 5. Lepidoptera species protected under the Manitoba *Endangered Species Act* (Manitoba Wildlife Branch 2012).

Species	Status
Dusky dune moth (*Copablepharon longipenne*)	Endangered
Gold-edged gem (*Schinia avemensis*)	Endangered
Pale yellow dune moth (*Copablepharon grandis*)	Endangered
Poweshiek skipperling (*Oarisma poweshiek*)	Endangered
Uncas skipper (*Hesperia uncas*)	Endangered
Verna's flower moth (*Schinia verna*)	Endangered
White flower moth (*Schinia bimatris*)	Endangered
Dakota skipper (*Hesperia dacotae*)	Threatened
Ottoe skipper (*Hesperia ottoe*)	Threatened
Ridings' satyr (*Neominois ridingsii*)	Extirpated

remaining native prairie becoming too small and fragmented to support them. Hall *et al.* (2011) identified threats to host plants, stabilization of dunes, and cattle disturbance as the top three threats to insects (including Lepidoptera) in the Prairies Ecozone. The three species of yucca moths (family Prodoxidae) and the skipper *Megathymus streckeri* are examples of insects that are limited by their host plant *Yucca glauca* Nutt., which occurs in Canada only in a tiny area of southeastern Alberta. Dune specialists such as *Schinia avemensis*, *S. bimatris, Copablepharon longipenne*, and *C. grandis* are examples of species that are dependent on relatively small, specialized habitats.

The Edwards' fritillary (*Speyeria edwardsii*) and Ridings' satyr (*Neominois ridingsii*) occurred across the southern portion of the Prairies Ecozone in Canada in the early part of the 20th century, but the former has not been recorded in Manitoba since 1934 and the latter has not been seen since 1953. It is likely that these and other species are disappearing from seemingly suitable habitat because these prairie remnants are too small to support populations of butterflies that tend to wander away from the core habitat, and the colony gradually declines and disappears. Another example of a shifting range is the Dakota skipper (*Hesperia dacotae*). It was historically recorded at only 10 sites in Canada, all in Manitoba. Surveys in 2002 confirmed that it had disappeared from virtually all of its former tallgrass prairie sites, although it was fortunately discovered in a number of new colonies in mixedgrass and shortgrass habitat, including in Saskatchewan (COSEWIC 2003). This highlights the need for more basic survey work focused on highly impacted and fragmented habitats such as tallgrass prairie.

Probably the most critical area in the Prairies Ecozone, in terms of habitat frailty, habitat loss, and threatened and endangered species, is the remnant tallgrass prairie in southern Manitoba. Most of the habitat is not protected and we still know little of the status of the Lepidoptera species confined to this habitat. The core range of the tallgrass prairies in the Upper Midwest are one of the most severely impacted native ecosystems in North America, compounding the need for focusing Lepidoptera conservation efforts on this region in particular (Metzler *et al.* 2005).

A roadblock to protection of Lepidoptera species at risk is the lack of solid information on host plants, range, and population size. For example, in the case of *Melaporphyria immortua*, a moth that has not been observed in decades, the lack of even basic biological data resulted in a "Data Deficient" designation after a conservation status assessment (Table 3).

Table 6. Checklist of Lepidoptera species reported to occur in the Prairies Ecozone of Canada. The following is a list of all Lepidoptera species that are known to occur in the Prairies Ecozone. The classification scheme presented here incorporates all relevant published names, and nomenclature changes that the authors are aware of, up to the end of 2013. *Species checklist available at* [*http://dx.doi.org/10.5886/g46dj1kp*](http://dx.doi.org/10.5886/g46dj1kp)

Key:
First column: * Indicates species restricted (in Canada) to the Prairies Ecozone
Second column: Status in Prairies Ecozone:
G: species that occur in grasslands habitat
p: species that occur in other habitats within the Prairies Ecozone
Next three columns: Occurrence only in Alberta (AB), Saskatchewan (SK), and Manitoba (MB):
AB; SK; MB: confirmed occurrence in the respective province
P: probable occurrence in that province
U: unconfirmed occurrence in that province
H: occurrence only in human habitats (e.g., greenhouses, buildings)
M: migrants
S: occasional strays
Last column: I indicates species introduced to North America

	Status	Occurrence			Introduced?
Superfamily Acanthopteroctetoidea					
Family Acanthopteroctetidae					
Acanthopteroctetes bimaculata Davis, 1969	p	AB	SK	MB	
Superfamily Hepialoidea					
Family Hepialidae					
Gazoryctra novigannus (Barnes & Benjamin, [1926])	G	AB	SK		
Sthenopis purpurascens (Packard, 1863)	p	AB	SK	MB	
Superfamily Nepticuloidea					
Family Nepticulidae					
Subfamily Nepticulinae					
Tribe Trifurculini					
Ectoedemia populella Busck, 1907	p			MB	
Ectoedemia canutus Wilkinson & Scoble, 1979	p	AB			
Ectoedemia marmaropa (Braun, 1925)	p	AB			
Family Opostegidae					
Subfamily Oposteginae					
Pseudopostega cretea (Meyrick, 1920)	p	AB			
Superfamily Adeloidea					
Family Adelidae					
Subfamily Adelinae					
Cauchas cockerelli (Busck, 1915)	p	AB			
Adela purpurea Walker, 1863	G	AB	SK	MB	
Family Incurvariidae					
Paraclemensia acerifoliella (Fitch, 1854)	p	AB	U	MB	
Family Prodoxidae					
Subfamily Prodoxinae					
Lampronia aenescens (Walsingham, 1888)	p	AB			
Lampronia sublustris Braun, 1925	p	AB	SK		
Tegeticula yuccasella (Riley, 1872) *	G	AB			
Tegeticula corruptrix Pellmyr, 1999 *	G	AB			
Prodoxus quinquepunctella (Chambers, 1875) *	G	AB			
Superfamily Tischerioidea					
Family Tischeriidae					
Astrotischeria solidagonifoliella (Clemens, 1859)	p			MB	
Coptotriche admirabilis (Braun, 1925)	G	AB	SK	MB	

	Status	Occurrence			Introduced?
Superfamily Tineoidea					
Family Psychidae					
Subfamily Naryciinae					
Dahlica triquetrella (Hübner, 1812)	p	AB		MB	I
Family Tineidae					
Subfamily Meessiinae					
Homostinea curviliniella Dietz, 1905 *	p			MB	
Subfamily Myrmecozelinae					
Haplotinea insectella (Fabricius, 1794)	p	H	H	H	I
Subfamily Nemapogoninae					
Nemapogon acapnopennella (Clemens, 1863)	p	AB	SK	MB	
Nemapogon roburella (Dietz, 1905)	p	AB			
Subfamily Tineinae					
Tinea irrepta Braun, 1926	G	AB	SK	MB	
Tinea pellionella (Linnaeus, 1758)	p	H			I?
Niditinea fuscella (Linnaeus, 1758)	p	AB			
Niditinea orleansella (Chambers, 1873)	p	AB	SK	MB	
Monopis crocicapitella (Clemens, 1859)	p	AB	SK		
Monopis laevigella ([Denis & Schiffermüller], 1775)	p	AB	SK	P	
Monopis monachella (Hübner, 1796)	p	AB	SK	MB	
Monopis spilotella Tengström, 1848	p	AB	SK	MB	
Elatobia carbonella (Dietz, 1905)	p	AB	SK		
Tineola bisselliella (Hummel, 1823)	p	H	H	H	I?
Subfamily Acrolophinae					
Amydria effrentella Clemens, 1859	G	AB	SK	MB	
Amydria obliquella Dietz, 1905	p			MB	
Superfamily Gracillarioidea					
Family Bucculatricidae					
Bucculatrix canadensisella Chambers, 1875	p	AB	SK	MB	
Bucculatrix pomifoliella Clemens, 1860	p			MB	
Family Gracillariidae					
Subfamily Gracillariinae					
Caloptilia acerifoliella (Chambers, 1875)	p	AB			
Caloptilia alnivorella (Chambers, 1875)	p	AB	SK	MB	
Caloptilia anthobaphes (Meyrick, 1921)	p	AB	SK		
Caloptilia betulivora McDunnough, 1946	p	AB	SK		
Caloptilia cornusella (Ely, 1915)	p	AB	SK	MB	
Caloptilia fraxinella (Ely, 1915)	p	AB	SK		
Caloptilia invariabilis (Braun, 1927)	p	AB		U	
Caloptilia negundella (Chambers, 1876)	p	AB	SK	MB	I
Caloptilia rhoifoliella (Chambers, 1876)	p	P	SK	MB	
Caloptilia stigmatella (Fabricius, 1781)	p	AB	SK	MB	
Caloptilia strictella (Walker, 1864)	p	AB	SK	MB	
Gracillaria syringella (Fabricius, 1794)	p	AB	SK	P	I
Micrurapteryx salicifoliella (Chambers, 1872)	p	AB	SK	MB	
Parectopa albicostella Braun, 1925	p	AB	SK	MB	
Parectopa pennsylvaniella (Engel, 1907)	p	AB	SK	MB	
Parornix arbutifoliella (Dietz, 1907) *	p			MB	
Parornix conspicuella (Dietz, 1907)	p	AB	SK	MB	
Parornix vicinella (Dietz, 1907) *	p			MB	
Acrocercops astericola (Frey & Boll, 1873)	p	AB	SK		
Acrocercops pnosmodiella (Busck, 1902)	p			MB	
Subfamily Lithocolletinae					
Phyllonorycter apparella (Herrich-Schäffer, 1855)	p	AB	SK	MB	
Phyllonorycter nipigon (Freeman, 1970)	p	AB	SK	P	
Phyllonorycter salicifoliella (Chambers, 1875)	p	AB	SK	MB	

	Status	Occurrence			Introduced?
Cameraria hamadryadella (Clemens, 1859)	p			MB	
Cameraria macrocarpae Freeman, 1970	p			MB	
Subfamily Phyllocnistinae					
Phyllocnistis populiella Chambers, 1875	p	AB	SK	MB	
Superfamily Yponomeutoidea					
Family Yponomeutidae					
Subfamily Yponomeutinae					
Tribe Yponomeutini					
Swammerdamia caesiella (Hübner, 1796)	p	AB	SK		I?
Euhyponomeutoides gracilariella (Busck, 1904)	p	AB	SK		
Family Ypsolophidae					
Subfamily Ypsolophinae					
Ypsolopha canariella (Walsingham, 1881)	G	AB	SK	MB	
Ypsolopha dentella (Fabricius, 1775)	p	AB			I
Ypsolopha dentiferella (Walsingham, 1881)	G	AB	SK	MB	
Ypsolopha dorsimaculella (Kearfott, 1907)	p	AB	SK	MB	
Ypsolopha falciferella (Walsingham, 1881)	p	AB	SK	MB	
Ypsolopha flavistrigella (Busck, 1906)	p	AB			
Ypsolopha senex (Walsingham, 1889)	p	AB		MB	
Family Plutellidae					
Plutella vanella Walsingham, 1881	p	AB			
Plutella xylostella (Linnaeus, 1758)	G	M	M	M	I?
Pseudoplutella porrectella (Linnaeus, 1758)	p	AB			I?
Rhigognostis interrupta (Walsingham, 1881)	p	AB	SK		
Family Glyphipterigidae					
Subfamily Glyphipteriginae					
Glyphipterix urticae Heppner, 1985	p	AB	SK	MB	
Glyphipterix haworthana (Stephens, 1834)	p			MB	
Glyphipterix montisella (Chambers, 1875)	p	AB	SK		
Glyphipterix chambersi Heppner, 1985	p			MB	
Family Argyresthiidae					
Argyresthia conjugella Zeller, 1839	p	AB	SK	P	I
Argyresthia goedartella (Linnaeus, 1758)	p	AB	SK	P	
Argyresthia oreasella Clemens, 1860	p	AB	SK	MB	
Argyresthia pygmaeella (Hübner, [1813])	p	AB	SK	MB	
Family Lyonetiidae					
Subfamily Lyonetiinae					
Lyonetia prunifoliella (Hübner, 1796)	p	AB	SK	MB	
Subfamily Cemiostominae					
Paraleucoptera albella (Chambers, 1871)	p	AB		MB	
Family Heliodinidae					
Neoheliodines nyctaginella (Gibson, 1914)	p			MB	
Family Bedelliidae					
Bedellia somnulentella (Zeller, 1847)	p	AB		MB	
Superfamily Gelechioidea					
Family Autostichidae					
Subfamily Symmocinae					
Taygete sylvicolella (Busck, 1903)	p	AB			
Subfamily Glyphidocerinae					
Glyphidocera hurlberti Adamski, 2000	p	AB	SK		
Family Blastobasidae					
Subfamily Holcocerinae					
Holcocera chalcofrontella Clemens, 1863	p			MB	
Holcocera immaculella McDunnough, 1930	p	AB	SK	MB	
Calosima dianella Dietz, 1910 *	p			MB	

	Status	Occurrence			Introduced?
Subfamily Blastobasinae					
Blastobasis glandulella (Riley, 1871)	p		SK	MB	
Hypatopa insulatella (Dietz, 1910)	p	AB			
Hypatopa titanella McDunnough, 1961	p	AB	SK		
Pigritia murtfeldtella (Chambers, 1874)	p	AB		MB	
Family Oecophoridae					
Subfamily Oecophorinae					
Tribe Oecophorini					
Decantha tistra Hodges, 1974	p	AB	SK		
Epicallima argenticinctella (Clemens, 1860)	p			MB	
Brymblia quadrimaculella (Chambers, 1875)	p	AB	P	MB	
Polix coloradella (Walsingham, 1888)	p	AB	SK	MB	
Hofmannophila pseudospretella (Stainton, 1849)	p	U	P	MB	I
Eido trimaculella (Fitch, 1856)	p	AB	SK	MB	
Family Elachistidae					
Subfamily Elachistinae					
Tribe Elachistini					
Perittia cygnodiella (Busck, 1921)	p	AB	SK		
Elachista dasycara Kaila, 1999 *	G	AB	SK		
Elachista subalbidella Schläger, 1847	p	AB		MB	
Elachista ossuaria Kaila, 1997	p	AB			
Elachista aspila Kaila, 1997 *	G	AB			
Elachista symmorpha Braun, 1948 *	G	AB			
Elachista aphyodes Kaila, 1997	G	AB			
Elachista adempta Braun, 1948	G	AB	SK		
Elachista achrantella Kaila, 1997	G	P	SK		
Elachista perniva Kaila, 1997	G		SK		
Elachista virgatula Kaila, 1997	p	AB	SK	MB	
Elachista cana Braun, 1920	G	AB			
Elachista miriella Kaila, 1999	p		SK		
Elachista neithanella Kaila, 1999	G	AB	SK		
Elachista albidella Nylander, 1848	p			MB	
Subfamily Depressariinae					
Tribe Depressariini					
Agonopterix gelidella (Busck, 1908)	p	AB	SK	MB	
Agonopterix curvilineella (Beutenmüller, 1889)	p			MB	
Agonopterix clarkei (Keifer, 1936)	p			MB	
Agonopterix pulvipennella (Clemens, 1864)	G		SK	MB	
Agonopterix fusciterminella Clarke, 1941	p	AB	SK	MB	
Agonopterix chrautis Hodges, 1974	p	AB	SK		
Agonopterix rosaciliella (Busck, 1904)	p	AB	SK		
Agonopterix canadensis (Busck, 1902)	G	AB	SK	MB	
Agonopterix arnicella (Walsingham, 1881)	p	AB			
Agonopterix argillacea (Walsingham, 1881)	p	AB	SK	MB	
Agonopterix posticella (Walsingham, 1881)	G	AB			
Depressariodes canella (Busck, 1904)	p	AB	SK	MB	
Depressariodes ciniflonella (Lienig & Zeller, 1846)	p	AB	SK	MB	
Depressariodes fulva (Walsingham, 1882)	G	AB	SK	MB	
Bibarrambla allenella (Walsingham, 1882)	p	AB	SK	MB	
Semioscopis packardella (Clemens, 1863)	p	AB	SK	MB	
Semioscopis merriccella Dyar, 1902	p	AB	P	U	
Semioscopis inornata Walsingham, 1882	p	AB	SK	MB	
Semioscopis megamicrella Dyar, 1902	p	AB	SK	U	
Semioscopis aurorella Dyar, 1902	p	AB	P	MB	
Depressaria atrostrigella Clarke, 1941	p	AB	SK	MB	
Depressaria artemisiae Nickerl, 1864	G	AB	P	MB	

	Status	Occurrence			Introduced?
Depressaria cinereocostella Clemens, 1864	p			MB	
Depressaria pastinacella (Duponchel, 1838)	p	AB	SK	P	I
Depressaria eleanorae Clarke, 1941	p	AB	SK	MB	
Depressaria alienella Busck, 1904	p	AB	SK	MB	
Depressaria whitmani Clarke, 1941	G	AB			
Nites grotella (Robinson, 1869)	p	AB	SK	MB	
Tribe Amphisbatini					
Psilocorsis quercicella Clemens, 1860	p			MB	
Psilocorsis cryptolechiella (Chambers, 1872)	p			MB	
Psilocorsis reflexella Clemens, 1860	p		SK	MB	
Subfamily Ethmiinae					
Ethmia apicipunctella (Chambers, 1875)	G			MB	
Ethmia monticola (Walsingham, 1880)	G	AB	SK	MB	
Ethmia longimaculella (Chambers, 1872)	G			MB	
Ethmia albicostella (Beutenmüller, 1889)	p	AB	SK	MB	
Subfamily Stenomatinae					
Antaeotricha schlaegeri (Zeller, 1854)	p		SK	MB	
Antaeotricha leucillana Zeller, 1854	p		SK	MB	
Gonioterma mistrella (Busck, 1907)	G			MB	
Subfamily Agonoxeninae					
Tribe Blastodacnini					
Blastodacna bicristatella (Chambers, 1875)	p	AB			
Blastodacna curvilineella (Chambers, 1872)	p	AB	SK	P	
Family Batrachedridae					
Batrachedra praeangusta (Haworth, 1828)	p	AB	SK	MB	I?
Family Coleophoridae					
Coleophora multipulvella Chambers, 1878	p	AB	SK		
Coleophora tiliaefoliella Clemens, 1861	p			MB	
Coleophora elaeagnisella Kearfott, 1908	p	AB		MB	
Coleophora rosaefoliella Clemens, 1864	p	AB	SK	MB	
Coleophora asterophagella McDunnough, 1944	p	AB		MB	
Coleophora pruniella Clemens, 1861	p	AB	SK	MB	
Coleophora salicivorella McDunnough, 1945	G	AB	SK		
Coleophora cretaticostella Clemens, 1860	p	AB			
Coleophora kearfottella Barnes & Busck, 1920	p	AB	SK	MB	
Coleophora cornella Walsingham, 1882	p	AB		MB	
Coleophora rosacella Clemens, 1864	G	AB	SK	MB	
Coleophora rosaevorella McDunnough, 1946	p	AB			
Coleophora mcdunnoughiella Oudejans, 1971	p	AB	SK		
Coleophora sparsipuncta Heinrich, 1929	p	AB			
Coleophora seminella McDunnough, 1946	p	AB	SK		
Coleophora detractella McDunnough, 1961	G	AB			
Coleophora lineapulvella Chambers, 1874	p			MB	
Coleophora quadruplex McDunnough, 1940	p	AB		MB	
Coleophora sparsipulvella Chambers, 1875	G	AB	SK	MB	
Coleophora quadrilineella Chambers, 1878	p			MB	
Coleophora cervinella McDunnough, 1946	p	AB			
Coleophora benestrigatella McDunnough, 1941	p		SK	MB	
Coleophora brunneipennis Braun, 1921	G	AB	SK	MB	
Coleophora bidentella McDunnough, 1941	p	AB		MB	
Coleophora glissandella McDunnough, 1942	G	AB	SK		
Coleophora glaucicolella Wood, 1892	p	AB	SK	MB	
Coleophora bispinatella McDunnough, 1954	p			MB	
Coleophora maritella McDunnough, 1941	p	AB	SK	MB	
Coleophora mayrella (Hübner, [1813])	G	AB	SK	MB	I
Coleophora trifolii (Curtis, 1832)	p	AB	SK	MB	I
Coleophora deauratella Lienig & Zeller, 1846	p	AB			I

	Status	Occurrence			Introduced?
Family Momphidae					
Mompha albapalpella (Chambers, 1875)	p	AB	SK	MB	
Mompha claudiella Kearfott, 1907	p	AB	SK	MB	
Mompha definitella (Zeller, 1873)	G	AB	SK		
Mompha eloisella (Clemens, 1860)	G	AB	SK	MB	
Mompha raschkiella (Zeller, 1839)	p	AB			
Mompha stellella Busck, 1906	G	AB	SK	MB	
Mompha unifasciella (Chambers, 1876)	p	AB	SK	MB	
Mompha idaei (Zeller, 1839)	p	AB	SK	MB	
Family Scythrididae					
Scythris eboracensis (Zeller, 1855)	p	AB	SK	MB	
Scythris fuscicomella (Clemens, 1860)	p			MB	
Scythris noricella Zeller, 1843	p	AB	SK	MB	
Scythris mixaula Meyrick, 1916	G	AB			
Landryia impositella (Zeller, 1855)	p	AB	SK	MB	
Landryia matutella (Clemens, 1860)	p		SK		
Landryia scintillifera (Braun, 1927)	G	AB	SK	MB	
Family Cosmopterigidae					
Subfamily Chrysopeleiinae					
Walshia miscecolorella (Chambers, 1875)	G	AB	SK	MB	
Sorhagenia baucidis Hodges, 1969	p	P	SK		
Subfamily Cosmopteriginae					
Cosmopterix molybdina Hodges, 1962	p			MB	I?
Cosmopterix pulchrimella Chambers, 1875	p		SK	MB	I?
Cosmopterix gemmiferella Clemens, 1860	G	AB			
Cosmopterix fernaldella Walsingham, 1882	p	AB	SK		
Eteobalea intermediella (Riedl, 1966)	p	AB	SK		I
Eteobalea serratella (Treitschke, 1833)	p	AB	SK		I
Limnaecia phragmitella Stainton, 1851	p	AB	SK	MB	
Teladoma helianthi Busck, 1932 *	G			MB	
Family Gelechiidae					
Subfamily Gelechiinae					
Tribe Anomologini					
Metzneria lappella (Linnaeus, 1758)	G	AB	SK	MB	I
Isophrictis magnella (Busck, 1903) *	G	AB			
Isophrictis rudbeckiella Bottimer, 1926 *	G	P	SK		
Isophrictis similiella (Chambers, 1872) *	p			MB	
Chrysoesthia drurella (Fabricius, 1775)	p	AB	SK		I
Stereomita andropogonis Braun, 1922 *	G			MB	
Aristotelia devexella Braun, 1925	p	AB	SK	MB	
Aristotelia fungivorella (Clemens, 1864)	p	AB	SK	MB	
Aristotelia roseosuffusella (Clemens, 1860)	p	AB	SK	MB	
Aristotelia rubidella (Clemens, 1860)	p	AB		MB	
Deltophora sella (Chambers, 1874) *	G	AB			
Tribe Litini					
Agnippe prunifoliella (Chambers, 1873)	p	AB	SK		
Coleotechnites atrupictella (Dietz, 1900)	p	AB	SK	MB	
Coleotechnites biopes (Freeman, 1960) *	p	AB	SK		
Coleotechnites gibsonella (Kearfott, 1907)	p	AB		MB	
Coleotechnites piceaella (Kearfott, 1903)	p	AB	SK	MB	
Coleotechnites quercivorella (Chambers, 1872)	p			MB	
Arogalea cristifasciella (Chambers, 1878)	p			MB	
Neotelphusa praefixa (Braun, 1921)	p	AB	SK	MB	
Xenolechia ontariensis Keifer, 1933	p			MB	
Xenolechia velatella (Busck, 1907)	p	AB	SK	MB	
Carpatolechia belangerella (Chambers, 1875)	p	AB	SK	U	

	Status	Occurrence			Introduced?
Tribe Gelechiini					
Prolita variabilis (Busck, 1903)	G	AB	SK	MB	
Prolita barnesiella (Busck, 1903) *	G	AB			
Prolita rectistrigella (Barnes & Busck, 1920)	G	AB			
Rifseria fuscotaeniaella (Chambers, 1878)	G	AB		MB	
Bryotropha plantariella (Tengström, 1848)	G	AB	SK	MB	
Bryotropha gemella Rutten & Karsholt, 2004	p	AB			
Bryotropha similis (Stainton, 1854)	p	AB	SK	MB	
Bryotropha hodgesi Rutten & Karsholt, 2004	G	AB	U	MB	
Bryotropha altitudophila Rutten & Karsholt, 2004	G	AB	SK		
Gelechia albisparsella (Chambers, 1872)	G	AB			
Gelechia lynceella Zeller, 1873	p	AB	SK	MB	
Chionodes formosella (Murtfeldt, 1881)	p			MB	
Chionodes iridescens Clarke, 1947	p	P	SK	MB	
Chionodes abitus Hodges, 1999	G	P	SK		
Chionodes imber Hodges, 1999	p			MB	
Chionodes abella (Busck, 1903)	p	AB			
Chionodes kincaidella (Busck, 1907) *	G	AB	U		
Chionodes pinguicula (Meyrick, 1929)	G		SK		
Chionodes sistrella (Busck, 1903) *	G	AB			
Chionodes landryi Hodges, 1999 *	G	AB	SK		
Chionodes fructuaria (Braun, 1925) *	G	AB			
Chionodes thoraceochrella (Chambers, 1872)	p		SK	MB	
Chionodes obscurusella (Chambers, 1872)	p	AB	SK	MB	
Chionodes mediofuscella (Clemens, 1863)	p	AB	SK	MB	
Chionodes terminimaculella (Kearfott, 1908)	p	AB	SK	MB	
Chionodes baro Hodges, 1999	p			MB	
Chionodes adamas Hodges, 1999	p			MB	
Chionodes innox Hodges, 1999	G	AB	U	MB	
Chionodes fondella (Busck, 1906)	p	AB	SK	MB	
Chionodes petalumensis Clarke, 1947	p		SK		
Chionodes lugubrella (Fabricius, 1794)	p	AB	SK	MB	
Chionodes grandis Clarke, 1947	G	AB	SK	MB	
Chionodes praeclarella (Herrich-Schäffer, 1854)	G	AB	SK	MB	
Chionodes psiloptera (Barnes & Busck, 1920)	p	AB	SK	MB	
Chionodes agriodes (Meyrick, 1927)	G	AB			
Chionodes whitmanella Clarke, 1942	G	AB		MB	
Chionodes praeco Hodges, 1999	G	AB		MB	
Chionodes occlusa (Braun, 1925)	G	AB	SK		
Chionodes theurgis Hodges, 1999	p			MB	
Chionodes viduella (Fabricius, 1794)	p	AB	SK	MB	
Chionodes metallica (Braun, 1921)	G	AB			
Chionodes praecia Hodges, 1999	G	AB			
Chionodes praetor Hodges, 1999	p			MB	
Chionodes flavicorporella (Walsingham, 1882)	G	P		MB	
Filatima abactella (Clarke, 1932)	p	AB	SK	MB	
Filatima demissae (Keifer, 1931)	G	AB			
Filatima normifera (Meyrick, 1927)	G	AB			
Filatima striatella (Busck, 1903)	p	AB		MB	
Filatima vaccinii Clarke, 1947	p	AB		MB	
Tribe Gnorimoschemini					
Gnorimoschema alaskense Povolný, 1967	p	AB	SK	MB	
Gnorimoschema albangulatum Braun, 1926	p	AB		MB	
Gnorimoschema baccharisselloides Povolný & Powell, 2001	p	AB			
Gnorimoschema brachiatum Povolný, 1998	G	P	SK		
Gnorimoschema clavatum Povolný, 1998 *	G	AB	SK		

	Status	Occurrence			Introduced?
Gnorimoschema compsomorpha Meryrick, 1929	p	AB	SK		
Gnorimoschema dudiella Busck, 1903	p	AB			
Gnorimoschema gallaeasterella (Kellicott, 1878)	p	AB	SK	MB	
Gnorimoschema gallaesolidaginis (Riley, 1869)	p	AB	SK	MB	
Gnorimoschema gallaespeciosum Miller, 2000	p	AB			
Gnorimoschema gibsoniella Busck, 1915	p	AB		MB	
Gnorimoschema jocelynae Miller, 2000	G	AB			
Gnorimoschema nanulum Povolný, 1998	p	AB			
Gnorimoschema obscurior Povolný, 1998	G	AB	SK		
Gnorimoschema petiolatum Povolný, 1998 *	G	P	SK		
Gnorimoschema reichli Povolný, 1998	p	AB			
Gnorimoschema rotundatum Povolný, 1998	p	AB			
Gnorimoschema salinaris Busck, 1911	p	AB			
Gnorimoschema segregatum Povolný, 1998 *	G	P	SK		
Gnorimoschema septentrionella Fyles, 1911	p	AB	SK		
Gnorimoschema signatum Povolný, 2003	p	AB			
Gnorimoschema slabaughi Miller, 2000	G		SK		
Gnorimoschema spinosum Povolný, 1998 *	G	P	SK		
Gnorimoschema subterraneum Busck, 1911	p	AB			
Gnorimoschema tunicatum Povolný, 1998	G	AB	SK		
Gnorimoschema vastificum Braun, 1929	G	AB	SK	MB	
Scrobipalpulodes insularis (Povolný, 2001)	p	AB			
Scrobipalpula lutescella (Clarke, 1934)	p	AB		MB	
Scrobipalpula psilella (Herrich-Schäffer, 1853)	p	AB	SK	MB	
Scrobipalpa atriplicella (von Röslerstamm, 1839)	p	AB		MB	I
Scrobipalpa instabilella (Douglas, 1846)	G	P	SK		
Scrobipalpa macromaculata (Braun, 1925)	G	AB	SK	MB	
Scrobipalpa obsoletella (von Röslerstamm, 1841)	p			MB	I
Agonochaetia conspersa (Braun, 1921)	g	AB			
Caryocolum cassella (Walker, 1864)	p	AB	SK	MB	
Caryocolum pullatella (Tengström, 1848)	p	AB		MB	
Tribe Chelariini					
Anarsia lineatella Zeller, 1839	p	AB			I
Tribe Anacampsini					
Battaristis concinnusella (Chambers, 1875)	p	AB			
Anacampsis fragariella Busck, 1904	p	AB	P	MB	
Anacampsis innocuella (Zeller, 1873)	p	AB	SK	MB	
Anacampsis niveopulvella (Chambers, 1875)	p	AB	SK	MB	
Anacampsis paltodoriella Busck, 1903 *	G	AB			
Anacampsis tristrigella (Walsingham, 1882)	p			MB	
Subfamily Pexicopiinae					
Sitotroga cerealella (Olivier, 1789)	G	AB			I?
Subfamily Dichomeridinae					
Helcystogramma fernaldella (Busck, 1903)	p	AB	SK	MB	
Helcystogramma casca (Braun, 1925)	G	AB	SK		
Helcystogramma melanocarpa (Meyrick, 1929)	p			MB	
Dichomeris ligulella Hübner, 1818	p		SK	MB	I
Dichomeris flavocostella (Clemens, 1860)	p		SK	MB	
Dichomeris ventrella (Fitch, 1854)	p			MB	
Dichomeris setosella (Clemens, 1860)	p	AB		MB	
Dichomeris vindex Hodges, 1986 *	G			MB	
Dichomeris bilobella (Zeller, 1873)	p	AB	SK		
Dichomeris purpureofusca (Walsingham, 1882)	p	AB	SK	MB	
Dichomeris serrativittella (Zeller, 1873)	G			MB	
Dichomeris xanthoa Hodges, 1986	p			MB	
Dichomeris simpliciella (Busck, 1904)	G	AB	SK		
Dichomeris levisella (Fyles, 1904)	p	AB	SK	P	

	Status	Occurrence			Introduced?
Dichomeris leuconotella (Busck, 1904)	p	AB	P	MB	
Dichomeris costarufoella (Chambers, 1874)	p	AB		MB	
Superfamily Alucitoidea					
Family Alucitidae					
Alucita montana Barnes & Lindsey, 1921	p	AB	SK	MB	
Alucita adriendenisi Landry & Landry, 2004	p	AB	SK		
Alucita lalannei Landry & Landry, 2004	p	AB		MB	
Superfamily Pterophoroidea					
Family Pterophoridae					
Subfamily Pterophorinae					
Tribe Platyptiliini					
Platyptilia carduidactylus (Riley, 1869)	G	AB	SK	MB	
Platyptilia comstocki Lange, 1939	G	AB		MB	
Gillmeria pallidactyla (Haworth, 1811)	p	AB	SK	MB	
Stenoptilia coloradensis Fernald, 1898	G	AB	SK	MB	
Paraplatyptilia edwardsii (Fish, 1881)	G	AB		MB	
Paraplatyptilia albiciliatus (Walsingham, 1880)	p	AB	SK	MB	
Paraplatyptilia modesta (Walsingham, 1880)	G	AB	SK	MB	
Paraplatyptilia bowmani (McDunnough, 1923)	p	AB			
Amblyptilia pica (Walsingham, 1880)	G	AB	SK	MB	
Tribe Oxyptilini					
Geina tenuidactylus (Fitch, 1854)	G	AB	SK	MB	
Capperia evansi (McDunnough, 1923)	G	AB	SK	MB	
Oxyptilus delawaricus (Zeller, 1873)	p	AB		MB	
Dejongia lobidactylus (Fitch, 1854)	p	AB	SK	MB	
Tribe Oidaematophorini					
Hellinsia homodactylus (Walker, 1864)	p	AB	SK	MB	
Hellinsia elliottii (Fernald, 1893)	p	AB		MB	
Hellinsia pectodactylus (Staudinger, 1859)	G	AB	SK	MB	
Hellinsia lacteodactylus (Chambers, 1873)	p	AB	SK	MB	
Hellinsia subochraceus (Walsingham, 1880)	G	AB			
Hellinsia sulphureodactylus (Packard, 1873)	G	AB	SK	MB	
Hellinsia arion (Barnes & Lindsey, 1921)	p	AB			
Oidaematophorus mathewianus (Zeller, 1874)	p	AB	SK	MB	
Oidaematophorus phaceliae McDunnough, 1938	G	AB	SK	MB	
Oidaematophorus grisescens Walsingham, 1880	G	AB	U		
Oidaematophorus lindseyi McDunnough, 1923	p	AB	SK	MB	
Oidaematophorus brucei (Fernald, 1898)	G	AB	SK	MB	
Emmelina monodactyla (Linnaeus, 1758)	p	AB	SK	MB	
Adaina montanus (Walsingham, 1880)	p	AB		MB	
Superfamily Carposinoidea					
Family Carposinidae					
Carposina sasakii Matsumura, 1900	p	S	SK	MB	
Bondia comonana (Kearfott, 1907)	p	AB	SK	MB	
Bondia crescentella (Walsingham, 1882)	p	AB	SK		
Superfamily Schreckensteinioidea					
Family Schreckensteiniidae					
Schreckensteinia festaliella Hübner, [1819]	p	AB	P	MB	
Superfamily Epermenioidea					
Family Epermeniidae					
Epermenia imperialella Busck, 1906	p			MB	
Ochromolopis ramapoella (Kearfott, 1903)	G	AB	SK	MB	
Superfamily Choreutoidea					
Family Choreutidae					
Subfamily Choreutinae					
Prochoreutis pernivalis (Braun, 1921)	p	AB	SK		
Choreutis myllerana Fabricius, 1794	p	AB			

	Status	Occurrence			Introduced?
Superfamily Tortricoidea					
Family Tortricidae					
Subfamily Tortricinae					
Tribe Tortricini					
Acleris albicomana (Clemens, 1865)	p	AB	SK	MB	
Acleris curvalana (Kearfott, 1907)	p	AB	SK	MB	
Acleris nivisellana (Walsingham, 1879)	p	AB	SK	MB	
Acleris cervinana (Fernald, 1882)	p	AB	SK	MB	
Acleris fuscana (Barnes & Busck, 1920)	p	AB	SK	MB	
Acleris negundana (Busck, 1940)	p			MB	
Acleris fragariana Kearfott, 1904	p	AB	SK	MB	
Acleris robinsoniana (Forbes, 1923)	p	AB	SK	MB	
Acleris britannia Kearfott, 1904	p	AB	SK		
Acleris logiana (Clerck, 1759)	p	AB	SK	MB	
Acleris variana (Fernald, 1886)	p	AB	SK	MB	
Acleris maccana (Treitschke, 1835)	p	AB	SK	MB	
Acleris effractana (Hübner, 1822)	p	AB	SK	MB	
Tribe Cnephasiini					
Eana argentana (Clerck, 1759)	p	AB	SK	MB	
Decodes horariana (Walsingham, 1879)	p	AB	SK	U	
Tribe Cochylini					
Phtheochroa aureoalbida (Walsingham, 1895)	G	AB	SK		
Phtheochroa cartwrightana (Kearfott, 1907)	G	AB	SK	MB	
Phtheochroa fulviplicana (Walsingham, 1879)	p	AB	SK		
Phtheochroa vitellinana (Zeller, 1875)	p	AB	SK	MB	
Phtheochroa waracana (Kearfott, 1907)	G	AB	SK	MB	
Platphalonidia dangi Razowski, 1997	G	AB			
Platphalonidia felix (Walsingham, 1895)	p	AB	SK		
Platphalonidia lavana (Busck, 1907)	p	AB		MB	
Aethes biscana (Kearfott, 1907)	p	AB		MB	
Aethes promptana (Robinson, 1869)	p	AB	SK		
Aethes rutilana (Hübner, 1818)	G	AB	SK	MB	
Aethes smeathmanniana (Fabricius, 1781)	p	AB	SK	MB	
Aethes spartinana (Barnes & McDunnough, 1916)	p			MB	
Cochylis arthuri Dang, 1984	G	AB	SK	MB	
Cochylis bucera Razowski, 1997	p			MB	
Cochylis hospes (Walsingham, 1884)	G	AB	SK	MB	
Cochylis nana (Haworth, 1811)	p	AB	SK	P	
Eulia ministrana (Linnaeus, 1758)	p	AB	SK	MB	
Anopina ednana (Kearfott, 1907)	G	AB	SK		
Apotomops wellingtoniana (Kearfott, 1907)	p	AB	SK		
Tribe Archipini					
Pandemis limitata (Robinson, 1869)	p	AB	SK	MB	
Pandemis canadana Kearfott, 1905	p	AB	SK	MB	
Argyrotaenia velutinana (Walker, 1863)	p	AB	SK	MB	
Argyrotaenia repertana Freeman, 1944	p	AB	SK	MB	
Argyrotaenia tabulana Freeman, 1944	p	AB	SK	MB	
Argyrotaenia quadrifasciana (Fernald, 1882)	p	AB	SK	MB	
Argyrotaenia quercifoliana (Fitch, 1858)	p		SK	MB	
Argyrotaenia mariana (Fernald, 1882)	p	AB	SK	MB	
Choristoneura fractivittana (Clemens, 1865)	p	AB		U	
Choristoneura zapulata (Robinson, 1869)	G	AB	SK	MB	
Choristoneura rosaceana (Harris, 1841)	G	AB	SK	MB	
Choristoneura conflictana (Walker, 1863)	p	AB	SK	MB	
Choristoneura fumiferana (Clemens, 1865)	p	AB	SK	MB	
Archips packardiana (Fernald, 1886)	p	AB	SK	MB	

	Status	Occurrence	Introduced?
Archips striana Fernald, 1905	p	AB SK MB	
Archips argyrospila (Walker, 1863)	p	AB SK MB	
Archips mortuana Kearfott, 1907	p	AB SK MB	
Archips myricana (McDunnough, 1923)	p	U MB	
Archips semiferana (Walker, 1863)	p	MB	
Archips negundana (Dyar, 1902)	G	AB SK MB	
Archips cerasivorana (Fitch, 1856)	G	AB SK MB	
Archips fervidana (Clemens, 1860)	p	SK MB	
Archips purpurana (Clemens, 1865)	G	AB SK MB	
Syndemis afflictana (Walker, 1863)	p	AB SK MB	
Aphelia alleniana (Fernald, 1882)	G	AB SK MB	
Clepsis persicana (Fitch, 1856)	p	AB SK MB	
Clepsis clemensiana (Fernald, 1879)	G	AB SK MB	
Clepsis melaleucana (Walker, 1863)	p	AB SK MB	
Clepsis flavidana (McDunnough, 1923)	p	MB	
Clepsis peritana (Clemens, 1860)	p	AB SK MB	
Clepsis penetralis Razowski, 1979	G	AB	
Clepsis virescana (Clemens, 1865)	p	AB SK MB	
Adoxophyes negundana (McDunnough, 1923)	p	AB SK MB	
Xenotemna pallorana (Robinson, 1869)	G	AB SK MB	
Tribe Sparganothini			
Sparganothis flavibasana (Fernald, 1882)	p	AB SK MB	
Sparganothis sulfureana (Clemens, 1860)	p	AB SK MB	
Sparganothis unifasciana (Clemens, 1864)	G	AB SK MB	
Sparganothis violaceana (Robinson, 1869)	p	AB SK MB	
Sparganothis xanthoides (Walker, 1863)	p	AB SK MB	
Sparganothis vocaridorsana Kearfott, 1905	G	AB SK MB	
Cenopis pettitana (Robinson, 1869)	p	SK MB	
Cenopis reticulatana (Clemens, 1860)	p	AB SK MB	
Cenopis directana (Walker, 1863)	p	AB SK MB	
Platynota idaeusalis (Walker, 1859)	p	AB SK MB	
Subfamily Olethreutinae			
Tribe Olethreutini			
Endothenia montanana (Kearfott, 1907)	p	AB SK MB	
Endothenia heinrichi McDunnough, 1929	p	AB SK	
Endothenia hebesana (Walker, 1863)	p	AB SK MB	
Endothenia infuscata Heinrich, 1923	p	U MB	
Endothenia nubilana (Clemens, 1865)	G	AB SK MB	
Taniva albolineana (Kearfott, 1907)	p	AB SK MB	
Bactra furfurana (Haworth, 1811)	G	AB SK MB	
Bactra verutana Zeller, 1875	G	AB SK	
Episimus argutanus (Clemens, 1860)	p	MB	
Paralobesia aemulana (Heinrich, 1926)	p	AB	
Paralobesia blandula (Heinrich, 1926)	p	AB MB	
Lobesiodes euphorbiana (Freyer, 1842)	G	AB SK MB	I
Ahmosia galbinea Heinrich, 1926	G	AB SK	
Apotomis removana (Kearfott, 1907)	p	AB SK MB	
Apotomis capreana (Hübner, [1817])	p	AB SK MB	
Apotomis funerea (Meyrick, 1920)	p	AB SK MB	
Apotomis deceptana (Kearfott, 1905)	p	AB SK MB	
Pseudosciaphila duplex (Walsingham, 1905)	p	AB SK MB	
Orthotaenia undulana ([Denis & Schiffermüller], 1775)	p	AB SK MB	
Olethreutes rusticanum (McDunnough, 1922)	p	AB P MB	
Olethreutes atrodentana (Fernald, 1882)	p	MB	
Olethreutes punctanum (Walsingham, 1903)	p	AB SK	
Olethreutes inornatana (Clemens, 1860)	G	AB SK MB	

	Status	Occurrence			Introduced?
Olethreutes quadrifidum (Zeller, 1875)	p	AB	SK	MB	
Olethreutes tilianum (Heinrich, 1923)	p			MB	
Olethreutes valdanum (McDunnough, 1922)	p			MB	
Olethreutes permundana (Clemens, 1860)	p			MB	
Olethreutes appendiceum (Zeller, 1875)	p	AB	SK	MB	
Olethreutes galaxana Kearfott, 1907	G	AB	SK	MB	
Olethreutes astrologana (Zeller, 1875)	G	AB	SK	MB	
Olethreutes coruscana (Clemens, 1860)	p	U	SK	MB	
Olethreutes metallicana (Hübner, 1796)	p	AB	SK	MB	
Olethreutes nordeggana (McDunnough, 1922)	p	AB	P	MB	
Olethreutes deprecatorius Heinrich, 1926	p	AB		U	
Olethreutes carolana (McDunnough, 1922)	p	AB	SK	MB	
Olethreutes glaciana (Möschler, 1860)	G	AB	SK	MB	
Olethreutes bipartitana (Clemens, 1860)	G	AB	SK	MB	
Olethreutes trinitana (McDunnough, 1931)	p	AB	SK	MB	
Olethreutes schulziana (Fabricius, 1777)	p	AB	SK		
Olethreutes turfosana (Herrich-Schäffer, 1851)	p	AB	SK	MB	
Olethreutes costimaculana (Fernald, 1882)	G	AB		MB	
Celypha cespitana (Hübner, [1817])	p	AB	SK	MB	
Hedya separatana (Kearfott, 1907)	p	AB	SK	MB	
Hedya ochroleucana (Frölich, 1828)	G	AB	SK	MB	
Hedya nubiferana (Haworth, 1811)	G	AB			I
Hedya chionosema (Zeller, 1875)	p			MB	
Hedya cyanana (Murtfeldt, 1880)	p		SK	MB	
Evora hemidesma (Zeller, 1875)	p	P	SK	MB	
Tribe Enarmoniini					
Ancylis nubeculana (Clemens, 1860)	p	AB	SK	MB	
Ancylis subaequana (Zeller, 1875)	p	AB	SK	MB	
Ancylis discigerana (Walker, 1863)	p	U		MB	
Ancylis metamelana (Walker, 1863)	p	AB	SK	MB	
Ancylis tenebrica (Heinrich, 1929)	p	AB			
Ancylis laciniana (Zeller, 1875)	p	AB	SK	MB	
Ancylis burgessiana (Zeller, 1875)	p	AB		MB	
Ancylis mira Heinrich, 1929	p	AB		MB	
Ancylis comptana (Frölich, 1828)	G	AB	SK	MB	I?
Ancylis apicana (Walker, 1866)	p	AB	SK	MB	
Ancylis diminutana (Haworth, 1811)	p	AB	SK	MB	
Ancylis goodelliana (Fernald, 1882)	p	AB	SK	MB	
Ancylis unguicella (Linnaeus, 1758)	p	AB	SK	MB	
Ancylis mediofasciana (Clemens, 1864)	p	AB	SK	MB	
Ancylis tineana (Hübner, [1799])	p	AB	SK	MB	
Ancylis albacostana Kearfott, 1905	G	U		MB	
Hystrichophora paradisiae Heinrich, 1923	G	AB	SK		
Hystrichophora stygiana (Dyar, 1903)	G	AB	SK		
Hystrichophora asphodelana (Kearfott, 1907)	p	AB	P	MB	
Hystrichophora taleana (Grote, 1878)	G			MB	
Hystrichophora ochreicostana (Walsingham, 1884)	G	AB	SK	MB	
Hystrichophora vestaliana (Zeller, 1875)	G	AB	SK	MB	
Tribe Eucosmini					
Rhyacionia buoliana ([Denis & Schiffermüller], 1775)	p	AB	P	MB	I
Retinia albicapitana (Busck, 1914)	p	AB	SK	MB	
Retinia burkeana (Kearfott, 1907)	p	AB	SK	MB	
Eucosma albertana (McDunnough, 1925) *	G	AB			
Eucosma awemeana (Kearfott, 1907)	p	AB	SK	MB	
Eucosma indeterminana (McDunnough, 1925)	p	AB		MB	
Eucosma umbrastriana (Kearfott, 1907)	p	AB	SK	MB	

	Status	Occurrence			Introduced?
Eucosma citricolorana (McDunnough, 1942)	p	AB	SK		
Eucosma amphorana (Walsingham, 1879)	G	AB			
Eucosma verna (Miller, 1971)	p	AB		MB	
Eucosma ochroterminana (Kearfott, 1907)	p	AB	SK	MB	
Eucosma marmontana (Kearfott, 1907)	p	AB	SK	MB	
Eucosma parmatana (Clemens, 1860)	p	AB	SK	MB	
Eucosma convergana (McDunnough, 1925)	G	AB	SK	MB	
Eucosma influana (Heinrich, 1923)	G	AB	SK	MB	
Eucosma lapidana (Walsingham, 1879)	G	AB			
Eucosma ornatula (Heinrich, 1924)	G	AB	SK	MB	
Eucosma rupestrana (McDunnough, 1925)	G	AB			
Eucosma tarandana (Möschler, 1874)	G	AB	SK	MB	
Eucosma nepotinana (Heinrich, 1923)	G	AB		MB	
Eucosma spectana (McDunnough, 1938)	p	AB			
Eucosma misturana (Heinrich, 1923)	G	AB	SK	MB	
Eucosma fertoriana (Heinrich, 1923)	p	AB		U	
Eucosma crassana (McDunnough, 1938)	G	AB		MB	
Eucosma indagatricana (Heinrich, 1923)	G	AB	U	MB	
Eucosma labiata (Wright, 2010)	G	AB			
Eucosma argenticostana (Walsingham, 1879)	G			MB	
Eucosma dorsiatomana (Kearfott, 1905)	G	AB	SK	MB	
Eucosma striatana (Clemens, 1860)	p	AB	SK	MB	
Eucosma modicellana (Heinrich, 1923)	G	AB	SK	MB	
Eucosma pallidicostana (Walsingham, 1879)	G	AB	SK	MB	
Eucosma artemisiana (Walsingham, 1879)	p	AB			
Eucosma infimbriana (Dyar, 1904)	p	AB		MB	
Eucosma octopunctana (Walsingham, 1895)	p	AB	SK	MB	
Eucosma montanana (Walsingham, 1884)	G	AB	SK	MB	
Eucosma offectalis (Hulst, 1886)	p	AB	SK		
Eucosma glomerana (Walsingham, 1879)	G		SK	MB	
Eucosma bilineana Kearfott, 1907	G	AB	SK	MB	
Eucosma landana Kearfott, 1907	G	AB	SK	MB	
Eucosma simplex McDunnough, 1925	G	AB		MB	
Eucosma sombreana Kearfott, 1905	G			MB	
"Eucosma" delphinoides (Heinrich, 1923) *	G	AB			
Pelochrista fandana (Kearfott, 1907)	G	AB	SK	MB	
Pelochrista ridingsana (Robinson, 1869)	G	AB	SK	MB	
Pelochrista fernaldana (Grote, 1880)	G	AB	SK	MB	
Pelochrista caniceps (Walsingham, 1884)	G	AB			
Pelochrista ragonoti (Walsingham, 1895)	G	AB		MB	
Pelochrista serpentana (Walsingham, 1895)	G	AB	SK		
Pelochrista ophionana (McDunnough, 1925)	G	AB	SK		
Pelochrista heathiana (Kearfott, 1907)	G			MB	
Pelochrista morrisoni (Walsingham, 1884)	G	AB	SK	MB	
Pelochrista lathami (Forbes, 1937)	G	AB	SK		
Pelochrista agricolana (Walsingham, 1879)	G	AB	SK	MB	
Pelochrista smithiana (Walsingham, 1895)	G	AB	SK	MB	
Pelochrista comatulana (Zeller, 1875)	G			MB	
Pelochrista vagana (McDunnough, 1925)	p	AB	SK	MB	
Pelochrista galenapunctana (Kearfott, 1905) *	G	AB			
Pelochrista serapicana (Heinrich, 1923)	G	AB			
Pelochrista luridana (Walsingham, 1879)	G	AB			
Pelochrista subflavana (Walsingham, 1879)	G	AB			
Pelochrista invicta (Walsingham, 1895)	G	AB	SK		
Pelochrista heinrichi (McDunnough, 1925)	G	AB	SK	MB	
Pelochrista nandana (Kearfott, 1907)	p	AB	SK	MB	

	Status	Occurrence			Introduced?
Pelochrista dorsisignatana (Clemens, 1860)	p	AB	SK	MB	
Pelochrista similiana (Clemens, 1860)	p	AB	P	MB	
Pelochrista juncticiliana (Walsingham, 1879)	p	AB		MB	
Pelochrista nuntia (Heinrich, 1929)	G	AB	SK	MB	
Pelochrista lafontainei (Wright, 2012) *	G	AB			
Pelochrista seamansi (Wright, 2011)	G	AB	P	MB	
Pelochrista cataclystiana (Walker, 1863)	G	AB		MB	
Pelochrista conspiciendana (Heinrich, 1923)	G	AB			
Pelochrista corosana (Walsingham, 1884)	G	U	U	MB	
Pelochrista argenteana (Walsingham, 1895)	G	AB	SK		
Pelochrista gelattana Wright, 2007 *	G	AB			
Pelochrista scintillana (Clemens, 1865)	G	AB	SK	MB	
Pelochrista mediostriata (Walsingham, 1895)	G	AB	SK		
Pelochrista kingi Wright, 2008	G	AB	SK	U	
Pelochrista rorana (Kearfott, 1907)	G			MB	
Epiblema abruptana (Walsingham, 1879) *	G	AB			
Epiblema benignata McDunnough, 1925	G	AB	SK	MB	
Epiblema scudderiana (Clemens, 1860)	G		SK	MB	
Epiblema carolinana (Walsingham, 1895)	G			MB	
Epiblema walsinghami (Kearfott, 1907)	p	AB			
Epiblema brightonana (Kearfott, 1907)	G			MB	
Epiblema tandana (Kearfott, 1907)	G			MB	
Epiblema resumptana (Walker, 1863)	p	AB	SK	MB	
Notocelia purpurissatana (Heinrich, 1923)	p	AB	SK		
Notocelia illotana (Walsingham, 1879)	G	AB	SK	MB	
Notocelia culminana (Walsingham, 1879)	p	AB	SK	MB	
Suleima helianthana (Riley, 1881)	G		SK	MB	
Suleima baracana (Kearfott, 1907)	G	AB			
Gypsonoma fasciolana (Clemens, 1864)	p	AB	SK	MB	
Gypsonoma nebulosana (Packard, 1866)	p	U		MB	
Gypsonoma haimbachiana (Kearfott, 1907)	p	AB	SK	MB	
Gypsonoma substitutionis Heinrich, 1923	p	AB	SK	MB	
Gypsonoma salicicolana (Clemens, 1864)	p	AB	SK	MB	
Gypsonoma adjuncta Heinrich, 1924	p	AB	SK	MB	
Proteoteras aesculana Riley, 1881	G	AB	SK	MB	
Proteoteras willingana (Kearfott, 1904)	G	AB	SK	MB	
Proteoteras crescentana Kearfott, 1907	G	AB	SK	MB	
Zeiraphera canadensis Mutuura & Freeman, [1967]	p	AB	SK	MB	
Zeiraphera fortunana (Kearfott, 1907)	p	AB	SK	MB	
Pseudexentera oregonana (Walsingham, 1879)	G	AB	SK	MB	
Rhopobota naevana (Hübner, [1817])	p	AB			
Epinotia radicana (Heinrich, 1923)	p	AB	SK	MB	
Epinotia solandriana (Linnaeus, 1758)	p	AB	SK	MB	
Epinotia castaneana (Walsingham, 1895)	p	AB	SK	U	
Epinotia madderana (Kearfott, 1907)	p	AB	SK	MB	
Epinotia xandana (Kearfott, 1907)	p	AB			
Epinotia albicapitana (Kearfott, 1907)	G	AB			
Epinotia rectiplicana (Walsingham, 1879)	p	AB	SK	MB	
Epinotia corylana McDunnough, 1925	p	AB			
Epinotia solicitana (Walker, 1863)	p	AB		MB	
Epinotia nisella (Clerck, 1759)	p	AB	SK	MB	
Epinotia cinereana (Haworth, 1811)	p	AB	SK	MB	
Epinotia transmissana (Walker, 1863)	p	AB	SK	MB	
Epinotia momonana (Kearfott, 1907)	p	AB		MB	
Epinotia silvertoniensis Heinrich, 1923	p	AB	SK		
Epinotia nigralbana (Walsingham, 1879)	p	AB			

	Status	Occurrence			Introduced?
Epinotia columbia (Kearfott, 1904)	p	AB	SK	MB	
Epinotia lomonana (Kearfott, 1907)	p	AB	P	MB	
Epinotia medioplagata (Walsingham, 1895)	G	AB	SK	MB	
Epinotia lindana (Fernald, 1892)	p	AB	SK	MB	
Catastega timidella Clemens, 1861	p		U	MB	I?
Tribe Grapholitini					
Dichrorampha bittana (Busck, 1906)	p	AB	SK		
Dichrorampha sedatana (Busck, 1906)	p	AB	SK		
Pammene felicitana Heinrich, 1923	p	AB	SK		
Pammene perstructana (Walker, 1863)	p	AB		MB	
Sereda tautana (Clemens, 1865)	p		SK	MB	
Grapholita packardi (Zeller, 1875)	p	AB			
Grapholita prunivora (Walsh, 1868)	p	AB	SK	MB	
Grapholita lunatana (Walsingham, 1879)	p	AB	SK	MB	
Grapholita dyarana (Kearfott, 1907) *	G	AB			
Cydia youngana (Kearfott, 1907)	p	AB	SK	MB	
Cydia multilineana (Kearfott, 1907)	p	AB		MB	
Cydia ingrata (Heinrich, 1926)	p	AB	SK	MB	
Cydia populana (Busck, 1916)	p	AB	SK	MB	
Cydia flexiloqua (Heinrich, 1926)	p	AB	SK	MB	
Cydia nigricana (Fabricius, 1794)	G	AB		MB	I
Cydia lautiuscula (Heinrich, 1926)	p	AB	SK	MB	
Cydia pomonella (Linnaeus, 1758)	p	AB			I
Ecdytolopha insiticiana Zeller, 1875	p		SK	MB	
Superfamily Cossoidea					
Family Cossidae					
Subfamily Cossinae					
Acossus centerensis (Lintner, 1877)	p	AB	SK	MB	
Acossus populi (Walker, 1856)	p	AB	SK	MB	
Prionoxystus robiniae (Peck, 1818)	G	AB	SK	MB	
Family Sesiidae					
Subfamily Tinthiinae					
Tribe Tinthiini					
Zenodoxus canescens Edwards, 1881 *	G	AB			
Zenodoxus sidalceae Engelhardt, 1946	G	AB			
Tribe Pennisetiini					
Pennisetia marginatum (Harris, 1839)	p	AB	SK	MB	
Subfamily Sesiinae					
Tribe Paranthrenini					
Paranthrene robiniae (Edwards, 1880)	p	AB	SK		
Paranthrene tabaniformis (Rottemburg, 1775)	p	AB	SK	MB	
Albuna pyramidalis (Walker, 1856)	G	AB	SK	MB	
Euhagena nebraskae Edwards, 1881	G	AB	SK		
Tribe Sesiini					
Sesia tibiale (Harris, 1839)	p	AB	SK	MB	
Sesia spartani Eichlin & Taft, 1988	p	AB			
Tribe Synanthedonini					
Synanthedon pictipes (Grote & Robinson, 1868)	p	AB	SK	MB	
Synanthedon tipuliformis (Clerck, 1759)	G	AB	P	MB	I?
Synanthedon fatifera Hodges, 1962	p	AB	P	MB	
Synanthedon bolteri (Edwards, 1883)	p	AB	SK	MB	
Synanthedon culiciformis (Linnaeus, 1758)	p	AB			
Synanthedon helenis (Engelhardt, 1946)	p	AB	SK	MB	
Synanthedon albicornis (Edwards, 1881)	p	AB	U	U	
Synanthedon proxima (Edwards, 1881)	p	AB	SK	MB	
Synanthedon polygoni (Edwards, 1881)	p	AB			

	Status	Occurrence			Introduced?
Synanthedon exitiosa (Say, 1823)	p			MB	
Podosesia syringae (Harris, 1839)	G	AB	SK	MB	
Carmenta anthracipennis (Boisduval, 1875)	G		SK	MB	
Carmenta giliae (Edwards, 1881)	G	AB			
Carmenta verecunda (Edwards, 1881)	G	P		MB	
Superfamily Zygaenoidea					
Family Limacodidae					
Subfamily Limacodinae					
Tortricidia testacea Packard, 1864	p	AB	SK	MB	
Tortricidia flexuosa (Grote, 1880)	p			MB	
Family Zygaenidae					
Subfamily Procridinae					
Tribe Procridini					
Pyromorpha dimidiata Herrich-Schäffer, 1854	p			MB	
Harrisina americana (Guérin-Méneville, 1829)	p			MB	
Superfamily Thyridoidea					
Family Thyrididae					
Subfamily Thyridinae					
Thyris maculata Harris, 1839	G	AB	SK	MB	
Pseudothyris sepulchralis (Guérin-Méneville, 1832)	p		SK	MB	
Superfamily Papilionoidea					
Family Papilionidae					
Subfamily Parnassiinae					
Tribe Parnassiini					
Parnassius smintheus Doubleday, 1847	p	AB	SK		
Subfamily Papilioninae					
Tribe Troidini					
Subtribe Troidina					
Battus philenor (Linnaeus, 1771)	p		SK	MB	
Tribe Papilionini					
Papilio machaon Linnaeus, 1758	G	AB	SK	MB	
Papilio polyxenes Fabricius, 1775	G		SK	MB	
Papilio zelicaon Lucas, 1852	G	AB	SK		
Papilio cresphontes Cramer, 1777	p			MB	
Papilio canadensis Rothschild & Jordan, 1906	G	AB	SK	MB	
Papilio eurymedon Lucas, 1852	p	AB			
Papilio multicaudata Kirby, 1884	G	AB	SK		
Family Hesperiidae					
Subfamily Eudaminae					
Epargyreus clarus (Cramer, 1775)	G	AB	SK	MB	
Thorybes bathyllus (Smith, 1797)	p			MB	
Thorybes pylades (Scudder, 1870)	G	AB	SK	MB	
Subfamily Pyrginae					
Tribe Carcharodini					
Pholisora catullus (Fabricius, 1793)	G	AB	SK	MB	
Tribe Erynnini					
Erynnis icelus (Scudder & Burgess, 1870)	G	AB	SK	MB	
Erynnis brizo (Boisduval & Le Conte, [1837])	p		SK	MB	
Erynnis juvenalis (Fabricius, 1793)	p		SK	MB	
Erynnis martialis (Scudder, [1870])	p		P	MB	
Erynnis lucilius (Scudder & Burgess, 1870)	p			MB	
Erynnis afranius (Lintner, 1878)	G	AB	SK	MB	
Erynnis persius (Scudder, 1863)	G	AB	SK	MB	
Tribe Pyrgini					
Pyrgus scriptura (Boisduval, 1852)	G	AB	SK		
Pyrgus communis (Grote, 1872)	G	AB	SK	MB	

	Status	Occurrence			Introduced?
Subfamily Heteropterinae					
Carterocephalus palaemon (Pallas, 1771)	p	AB	SK	MB	
Carterocephalus mandan (Edwards, 1863)	p	AB	SK	MB	
Subfamily Hesperiinae					
Tribe Megathymini					
Megathymus streckeri (Skinner, 1895) *	G	AB			
Tribe Thymelicini					
Ancyloxypha numitor (Fabricius, 1793)	G	S	SK	MB	
Oarisma poweshiek (Parker, 1870) *	G			MB	
Oarisma garita (Reakirt, 1866)	G	AB	SK	MB	
Thymelicus lineola (Ochsenheimer, 1808)	p	AB	SK	MB	I
Amblyscirtes oslari (Skinner, 1899) *	G	AB	SK		
Amblyscirtes hegon (Scudder, 1863)	p		SK	MB	
Amblyscirtes vialis (Edwards, 1862)	G	AB	SK	MB	
Tribe Hesperiini					
Hesperia uncas Edwards, 1863 *	G	AB	SK	MB	
Hesperia assiniboia (Lyman, 1892)	G	AB	SK	MB	
Hesperia colorado (Scudder, 1874)	G	P	SK		
Hesperia ottoe Edwards, 1866 *	G		P	MB	
Hesperia leonardus Harris, 1862	G	P	SK	MB	
Hesperia pahaska (Leussler, 1938) *	G	P	SK	MB	
Hesperia dacotae (Skinner, 1911) *	G		SK	MB	
Hesperia sassacus Harris, 1862	p			MB	
Hesperia nevada (Scudder, 1874)	G	AB	SK	MB	
Polites rhesus (Edwards, 1878) *	G	AB	SK		
Polites peckius (Kirby, 1837)	G	AB	SK	MB	
Polites draco (Edwards, 1871)	p	AB	SK		
Polites themistocles (Latreille, [1824])	G	AB	SK	MB	
Polites mystic (Edwards, 1863)	G	AB	SK	MB	
Wallengrenia egeremet (Scudder, 1863)	G			MB	
Atalopedes campestris (Boisduval, 1852)	p			S	
Poanes hobomok (Harris, 1862)	G	AB	SK	MB	
Ochlodes sylvanoides (Boisduval, 1852)	G	AB	SK		
Anatrytone logan (Edwards, 1863)	G	AB	SK	MB	
Notamblyscirtes simius (Edwards, 1881) *	G	P	SK		
Euphyes vestris (Boisduval, 1852)	G	AB	SK	MB	
Atrytonopsis hianna (Scudder, 1868)	G		SK	MB	
Family Pieridae					
Subfamily Coliadinae					
Nathalis iole Boisduval, 1836	p		SK	MB	
Eurema mexicana (Boisduval, 1836)	p		SK	MB	
Pyrisitia lisa (Boisduval & Le Conte, [1830])	p			MB	
Colias philodice Godart, 1819	G	AB	SK	MB	
Colias eurytheme Boisduval, 1852	G	M	M	M	
Colias christina Edwards, 1863	G	AB	SK	MB	
Colias alexandra Edwards, 1863	G	AB	SK	MB	
Colias gigantea Strecker, 1900	p	AB	SK	MB	
Colias interior Scudder, 1862	p	AB	SK	MB	
Zerene cesonia (Stoll, [1790])	G	S		S	
Subfamily Anthocharinae					
Anthocharis stella Edwards, 1879	p	AB			
Euchloe ausonides (Lucas, 1852)	G	AB	SK	MB	
Euchloe olympia (Edwards, 1871)	G	AB	SK	MB	

	Status	Occurrence			Introduced?
Subfamily Pierinae					
Tribe Pierini					
Subtribe Pierina					
Pieris marginalis Scudder, 1861	p	AB	SK		
Pieris oleracea Harris, 1829	p	AB	SK	MB	
Pieris rapae (Linnaeus, 1758)	G	AB	SK	MB	I
Pontia protodice (Boisduval & Le Conte, [1830])	G	M	M	M	
Pontia occidentalis (Reakirt, 1866)	G	AB	SK	MB	
Family Riodinidae					
Subfamily Riodininae					
Tribe Emesiini					
Apodemia mormo (Felder & Felder, 1859)	G		SK		
Family Lycaenidae					
Subfamily Miletinae					
Tribe Miletini					
Subtribe Spalgina					
Feniseca tarquinius (Fabricius, 1793)	p		SK	MB	
Subfamily Lycaeninae					
Tribe Lycaenini					
Lycaena phlaeas (Linnaeus, 1761)	p	AB	SK	MB	
Lycaena dione (Scudder, 1868)	G	AB	SK	MB	
Lycaena editha (Mead, 1878)	p	S			
Lycaena rubidus (Behr, 1866) *	G	AB	SK		
Lycaena hyllus (Cramer, 1775)	G	AB	SK	MB	
Lycaena dorcas Kirby, 1837	p	AB	SK	MB	
Lycaena helloides (Boisduval, 1852)	G	AB	SK	MB	
Lycaena mariposa (Reakirt, 1866)	p	AB	SK		
Subfamily Theclinae					
Tribe Eumaeini					
Subtribe Eumaeina					
Satyrium acadica (Edwards, 1862)	G	AB	SK	MB	
Satyrium titus (Fabricius, 1793)	G	AB	SK	MB	
Satyrium edwardsii (Grote & Robinson, 1869)	p		SK	MB	
Satyrium calanus (Hübner, [1809])	p		SK	MB	
Satyrium liparops (Le Conte, 1833)	G	AB	SK	MB	
Callophrys gryneus (Hübner, [1819])	G	P	SK		
Callophrys augustinus (Westwood, 1852)	p	AB	SK	MB	
Callophrys polios (Cook & Watson, 1907)	p	AB	SK	MB	
Callophrys henrici (Grote & Robinson, 1867)	p			MB	
Callophrys niphon (Hübner, [1819])	p	AB	SK	MB	
Callophrys eryphon (Boisduval, 1852)	p	AB	SK	MB	
Calycopis cecrops (Fabricius, 1793)	p		SK		
Strymon melinus Hübner, 1818	G	AB	SK	MB	
Subfamily Polyommatinae					
Tribe Polyommatini					
Leptotes marina (Reakirt, 1868)	p		SK		
Cupido comyntas (Godart, [1824])	p		SK	MB	
Cupido amyntula (Boisduval, 1852)	G	AB	SK	MB	
Celastrina lucia (Kirby, 1837)	p	AB	SK	MB	
Celastrina neglecta (Edwards, 1862)	G	AB	SK	MB	
Euphilotes ancilla (Barnes & McDunnough, 1918) *	G	AB	SK		
Glaucopsyche piasus (Boisduval, 1852)	G	AB	SK		
Glaucopsyche lygdamus (Doubleday, 1842)	G	AB	SK	MB	
Echinargus isola (Reakirt, 1866)	p		SK	MB	
Plebejus idas (Linnaeus, 1761)	p	AB	SK	MB	
Plebejus melissa (Edwards, 1873)	G	AB	SK	MB	

	Status	Occurrence			Introduced?
Plebejus saepiolus (Boisduval, 1852)	G	AB	SK	MB	
Plebejus icarioides (Boisduval, 1852)	G	AB	SK		
Plebejus shasta (Edwards, 1862) *	G	AB	SK		
Plebejus lupini (Boisduval, 1869)	G	AB	SK		
Plebejus glandon (de Prunner, 1798)	G	AB	SK	MB	
Family Nymphalidae					
Subfamily Danainae					
Tribe Danaini					
Subtribe Danaina					
Danaus plexippus (Linnaeus, 1758)	G	M	M	M	
Subfamily Limenitidinae					
Tribe Limenitidini					
Subtribe Limenitidina					
Limenitis arthemis (Drury, 1773)	G	AB	SK	MB	
Limenitis weidemeyerii Edwards, 1861 *	G	AB	P		
Limenitis lorquini Boisduval, 1852	p	AB	SK		
Limenitis archippus (Cramer, 1776)	G	AB	SK	MB	
Subfamily Heliconiinae					
Tribe Heliconiini					
Subtribe Heliconiina					
Agraulis vanillae (Linnaeus, 1758)	p			S	
Tribe Argynnini					
Subtribe Euptoietina					
Euptoieta claudia (Cramer, 1776)	G	M	M	M	
Subtribe Boloriina					
Boloria eunomia (Esper, 1800)	p	AB	SK	MB	
Boloria myrina (Cramer, 1777)	G	AB	SK	MB	
Boloria bellona (Fabricius, 1775)	G	AB	SK	MB	
Boloria frigga (Thunberg, 1791)	p	AB	SK	MB	
Boloria freija (Thunberg, 1791)	p	AB	SK	MB	
Boloria chariclea (Schneider, 1794)	p	AB	SK	MB	
Subtribe Argynnina					
Speyeria cybele (Fabricius, 1775)	G	AB	SK	MB	
Speyeria leto (Behr, 1862)	G	AB			
Speyeria aphrodite (Fabricius, 1787)	G	AB	SK	MB	
Speyeria idalia (Drury, 1773)	G		SK	MB	
Speyeria edwardsii (Reakirt, 1866) *	G	AB	SK	MB	
Speyeria zerene (Boisduval, 1852)	G	AB	SK		
Speyeria callippe (Boisduval, 1852)	G	AB	SK	MB	
Speyeria egleis (Behr, 1862) *	G	AB	P		
Speyeria atlantis (Edwards, 1862)	p	AB	SK	MB	
Speyeria hesperis (Edwards, 1864)	G	AB	SK	MB	
Speyeria hydaspe (Boisduval, 1869)	p	AB	SK		
Speyeria mormonia (Boisduval, 1869)	G	AB	SK	MB	
Subfamily Apaturinae					
Asterocampa celtis (Boisduval & Le Conte, [1837])	p			MB	
Subfamily Nymphalinae					
Tribe Nymphalini					
Vanessa virginiensis (Drury, 1773)	G	S	S	S	
Vanessa cardui (Linnaeus, 1758)	G	M	M	M	
Vanessa annabella (Field, 1971)	p	M	M	P	
Vanessa atalanta (Linnaeus, 1758)	G	AB	SK	MB	
Aglais milberti (Godart, 1819)	G	AB	SK	MB	
Nymphalis j-album (Boisduval & Le Conte, 1833)	p	AB	SK	MB	
Nymphalis californica (Boisduval, 1852)	p	AB	SK	MB	
Nymphalis antiopa (Linnaeus, 1758)	G	AB	SK	MB	

	Status	Occurrence			Introduced?
Polygonia interrogationis (Fabricius, 1798)	G	S	S	S	
Polygonia comma (Harris, 1842)	G		SK	MB	
Polygonia satyrus (Edwards, 1869)	p	AB	SK	MB	
Polygonia progne (Cramer, 1776)	G	AB	SK	MB	
Polygonia gracilis (Grote & Robinson, 1867)	p	AB	SK	MB	
Polygonia faunus (Edwards, 1862)	p	AB	SK	MB	
Tribe Junoniini					
Junonia coenia Hübner, [1822]	p			S	
Tribe Melitaeini					
Subtribe Euphydryina					
Euphydryas editha (Boisduval, 1852)	G	AB	SK		
Euphydryas anicia (Doubleday, [1847])	G	AB	SK		
Euphydryas bernadetta Leussler, 1920 *	G	AB			
Subtribe Melitaeini					
Chlosyne nycteis (Doubleday, 1847)	p		SK	MB	
Chlosyne gorgone (Hübner, 1810)	G	AB	SK	MB	
Chlosyne harrisii (Scudder, 1862)	p		SK	MB	
Chlosyne acastus (Edwards, 1874) *	G	AB	SK		
Subtribe Phyciodina					
Phyciodes tharos (Drury, 1773)	G	AB	SK	MB	
Phyciodes cocyta (Cramer, [1777])	G	AB	SK	MB	
Phyciodes batesii (Reakirt, 1865)	G	AB	SK	MB	
Subfamily Satyrinae					
Tribe Elymniini					
Subtribe Lethina					
Lethe anthedon (Clark, 1936)	p	AB	SK	MB	
Lethe eurydice (Linnaeus, 1763)	p	AB	SK	MB	
Tribe Satyrini					
Subtribe Coenonymphina					
Coenonympha tullia (Müller, 1764)	G	AB	SK	MB	
Subtribe Euptychiina					
Megisto cymela (Cramer, 1777)	p	P	SK	MB	
Subtribe Maniolina					
Cercyonis pegala (Fabricius, 1775)	G	AB	SK	MB	
Cercyonis oetus (Boisduval, 1869)	G	AB	SK		
Subtribe Erebiina					
Erebia mancinus Doubleday & Hewitson, 1849	p	AB	SK	MB	
Erebia epipsodea Butler, 1868	G	AB	SK	MB	
Erebia discoidalis (Kirby, 1837)	p	AB	SK	MB	
Neominois ridingsii (Edwards, 1865) *	G	AB	SK	MB	
Oeneis jutta (Hübner, [1806])	p	AB	SK	MB	
Oeneis chryxus (Doubleday & Hewitson, 1849)	p	AB	SK	MB	
Oeneis alberta Elwes, 1893	G	AB	SK	MB	
Oeneis macounii (Edwards, 1885)	p	AB	SK	MB	
Oeneis uhleri (Reakirt, 1866)	G	AB	SK	MB	
Superfamily Pyraloidea					
Family Pyralidae					
Subfamily Chrysauginae					
Acallis gripalis (Hulst, 1886)	G	AB			
Galasa nigrinodis (Zeller, 1873)	p			MB	
Subfamily Galleriinae					
Tribe Galleriini					
Galleria mellonella (Linnaeus, 1758)	p	H		H	I
Subfamily Pyralinae					
Tribe Pyralini					
Pyralis farinalis Linnaeus, 1758	G	AB	SK	MB	I

	Status	Occurrence			Introduced?
Aglossa pinguinalis (Linnaeus, 1758)	p	H			I
Aglossa caprealis (Hübner, [1809])	p	AB			I
Aglossa cuprina Zeller, 1872	G	AB			
Hypsopygia costalis (Fabricius, 1775)	p	S	SK		
Dolichomia olinalis (Guenée, 1854)	p	AB	SK	MB	
Dolichomia thymetusalis (Walker, 1859)	p	AB	SK	MB	
Subfamily Epipaschiinae					
Toripalpus trabalis Grote, 1881	G	AB	SK		
Oneida lunulalis (Hulst, 1887)	p			MB	
Pococera aplastella (Hulst, 1888)	p	AB	SK	MB	
Pococera asperatella (Clemens, 1860)	p	AB	SK	MB	
Pococera expandens (Walker, 1863)	p			MB	
Pococera baptisiella (Fernald, 1887)	G	AB	SK	U	
Subfamily Phycitinae					
Tribe Phycitini					
Acrobasis indigenella (Zeller, 1848)	G	AB	U	MB	
Acrobasis tricolorella Grote, 1878	p	AB	SK	MB	
Acrobasis betulella Hulst, 1890	p	AB	SK	MB	
Myelopsis minutularia (Hulst, 1887)	G	AB	SK	MB	
Myelopsis subtetricella (Ragonot, 1889)	G	AB	SK	MB	
Apomyelois bistriatella (Hulst, 1887)	p	AB	SK	MB	
Eulogia ochrifrontella (Zeller, 1876)	p	AB	SK	MB	
Ephestiodes gilvescentella Ragonot, 1887	G	AB			
Moodna ostrinella (Clemens, 1860)	p	AB	SK	MB	
Caudellia nigrella (Hulst, 1890)	p	AB			
Vitula edmandsii (Packard, 1864)	p			MB	
Vitula serratilineella Ragonot, 1887	G	AB	SK		
Vitula broweri (Heinrich, 1956)	p	AB	SK	MB	
Sosipatra rileyella (Ragonot, 1887) *	G	AB			
Plodia interpunctella (Hübner, [1813])	p	AB	SK	MB	
Ephestia elutella (Hübner, 1796)	p	H	P	H	I
Ephestia kuehniella Zeller, 1879	p	H	H	H	
Ephestia columbiella Neunzig, 1990	p	U	SK	MB	
Bandera binotella (Zeller, 1872)	G	AB			
Bandera virginella Dyar, 1908	G	AB			
Bandera cupidinella Hulst, 1888 *	G	AB			
Eurythmia angulella Ely, 1910	p			MB	
Pima fosterella Hulst, 1888	G	AB	SK		
Pima boisduvaliella (Guenée, 1845)	G	AB	SK	MB	
Pima fulvirugella (Ragonot, 1887)	G	AB	SK	MB	
Pima albocostalialis (Hulst, 1886)	G	AB			
Interjectio columbiella (McDunnough, 1935)	G	AB			
Interjectio denticulella (Ragonot, 1887)	p		SK		
Interjectio niviella (Hulst, 1888)	G	AB	SK	MB	
Ambesa laetella Grote, 1880	G	AB	SK	MB	
Catastia incorruscella (Hulst, 1895)	p	AB			
Catastia actualis (Hulst, 1886)	G	AB	SK	MB	
Oreana unicolorella (Hulst, 1887)	p			MB	
Salebriaria tenebrosella (Hulst, 1887)	p		SK	MB	
Ortholepis pasadamia (Dyar, 1917)	p	AB	SK	MB	
Meroptera pravella (Grote, 1878)	p	AB	SK	MB	
Meroptera abditiva Heinrich, 1956	p	P	SK		
Sciota basilaris (Zeller, 1872)	p	AB	SK	MB	
Sciota levigatella (Hulst, 1892)	p	AB		MB	
Sciota fernaldi (Ragonot, 1887)	G	AB	SK	MB	
Sciota rubescentella (Hulst, 1900)	G	AB	SK		

	Status	Occurrence			Introduced?
Sciota carneella (Hulst, 1887)	p			MB	
Tulsa finitella (Walker, 1863)	p		SK	MB	
Telethusia ovalis (Packard, 1873)	p	AB	SK	MB	
Pyla impostor Heinrich, 1956	G	AB			
Pyla arenaeola Balogh & Wilterding, 1998	p			MB	
Pyla aenigmatica Heinrich, 1956	G	AB			
Pyla fusca (Haworth, 1828)	p	AB	SK	MB	
Pyla hanhamella Dyar, 1904	G	AB	SK	MB	
Pyla aeneoviridella Ragonot, 1887	p	AB			
Pyla metalicella Hulst, 1895	G			MB	
Dioryctria abietivorella (Grote, 1878)	p	AB	SK	MB	
Dioryctria reniculelloides Mutuura & Munroe, 1973	p	AB	SK	MB	
Dioryctria auranticella (Grote, 1883)	p	AB	SK		
Dioryctria rossi Munroe, 1959	p	AB			
Dioryctria zimmermani (Grote, 1877)	p	AB	SK	MB	
Sarata nigrifasciella Ragonot, 1887	p			MB	
Sarata caudellella (Dyar, 1904)	G	AB	SK	MB	
Sarata edwardsialis (Hulst, 1886)	G	AB			
Sarata punctella (Dyar, 1915)	G	AB	SK		
Sarata alpha Heinrich, 1956	G		SK	MB	
Lipographis fenestrella (Packard, 1873)	G	AB		MB	
Etiella zinckenella (Treitschke, 1832)	G	P	SK	MB	I
Staudingeria albipenella (Hulst, 1887)	G	AB			
Hulstia undulatella (Clemens, 1860)	G	AB	SK	MB	
Rostrolaetilia placidissima Blanchard & Ferguson, 1975 *	G	AB			
Zophodia grossulariella (Hübner, [1809])	p	AB	SK	MB	
Melitara dentata (Grote, 1876) *	G	AB	SK		
Melitara subumbrella (Dyar, 1925) *	G	AB	SK		
Homoeosoma electella (Hulst, 1887)	G	AB	SK	MB	
Homoeosoma stypticellum Grote, 1878	p	AB	SK	MB	
Homoeosoma illuviellum Ragonot, 1888	G	AB			
Homoeosoma impressale Hulst, 1886	G	AB		MB	
Homoeosoma ardaloniphas Goodson & Neunzig, 1993	G	AB	SK	MB	
Phycitodes mucidella (Ragonot, 1887)	G	AB	SK	MB	
Tribe Anerastiini					
Ragonotia dotalis (Hulst, 1886)	G	AB			
Anerastia lotella (Hübner, [1813])	G	AB	SK	MB	
Coenochroa californiella Ragonot, 1887	G	AB			
Coenochroa illibella (Hulst, 1887)	G	AB			
Tribe Peoriini					
Peoria approximella (Walker, 1866)	G	AB	SK	MB	
Family Crambidae					
Subfamily Scopariinae					
Gesneria centuriella ([Denis & Schiffermüller], 1775)	G	AB	SK	MB	
Scoparia penumbralis Dyar, 1906	p			MB	
Scoparia biplagialis Walker, 1866	p	AB	SK	MB	
Scoparia basalis Walker, 1866	p	U	SK	MB	
Eudonia alpina (Curtis, 1850)	p	AB	SK	MB	
Subfamily Crambinae					
Tribe Ancylolomiini					
Pseudoschoenobius opalescalis (Hulst, 1886)	G	AB			
Tribe Argyriini					
Urola nivalis (Drury, 1773)	p			MB	
Tribe Haimbachiini					
Occidentalia comptulatalis (Hulst, 1886)	p	AB	SK	MB	

	Status	Occurrence			Introduced?
Tribe Crambini					
Euchromius californicalis (Packard, 1873)	G	AB	SK		
Platytes vobisne Dyar, 1920	G	AB			
Catoptria latiradiellus (Walker, 1863)	p	AB	SK	MB	
Chrysoteuchia topiarius (Zeller, 1866)	G	AB	SK	MB	
Crambus pascuella (Linnaeus, 1758)	G	AB	SK	MB	
Crambus perlella (Scopoli, 1763)	p	AB	SK	MB	
Crambus unistriatellus Packard, 1867	p	AB	SK	MB	
Crambus whitmerellus Klots, 1942	p	AB	SK	MB	
Crambus awemellus McDunnough, 1921	p	AB	SK	MB	
Crambus trichusalis Hulst, 1886	G	AB	SK		
Crambus ainsliellus Klots, 1942	G	AB	SK	MB	
Crambus praefectellus (Zincken, 1821)	p	AB		MB	
Crambus leachellus (Zincken, 1818)	p	AB	SK	MB	
Crambus occidentalis Grote, 1880	G	AB			
Crambus albellus Clemens, 1860	p		U	MB	
Crambus agitatellus Clemens, 1960	p			MB	
Crambus girardellus Clemens, 1860	p	AB	SK	MB	
Agriphila ruricolellus (Zeller, 1863)	p	AB	SK	MB	
Agriphila vulgivagellus (Clemens, 1860)	G	AB	SK	MB	
Agriphila attenuatus (Grote, 1880)	G	AB			
Neodactria luteolellus (Clemens, 1860)	p	AB	SK	MB	
Neodactria zeellus (Fernald, 1885)	G	AB	SK	MB	
Neodactria caliginosellus (Clemens, 1860)	G	AB	SK	MB	
Neodactria murellus (Dyar, 1904)	G	AB		MB	
Pediasia aridella (Thunberg, 1788)	G	AB	SK	MB	
Pediasia truncatellus (Zetterstedt, 1840)	p	AB	SK	MB	
Pediasia browerellus (Klots, 1942)	G			MB	
Pediasia trisecta (Walker, 1856)	G	AB	SK	MB	
Pediasia laciniellus (Grote, 1880)	G	AB	SK		
Pediasia ericellus (Barnes & McDunnough, 1918)	p	AB	SK		
Pediasia abnaki (Klots, 1942)	p	AB		MB	
Pediasia dorsipunctellus (Kearfott, 1908)	p	AB	SK	MB	
Fissicrambus mutabilis (Clemens, 1860)	p		SK	MB	
Loxocrambus awemensis McDunnough, 1929	G	AB	SK	MB	
Tehama bonifatella (Hulst, 1887)	G	AB		MB	
Thaumatopsis pexellus (Zeller, 1863)	G	AB	SK	MB	
Thaumatopsis fernaldella Kearfott, 1905	G	AB	SK	MB	
Microcrambus minor (Forbes, 1920)	p			MB	
Subfamily Schoenobiinae					
Donacaula melinellus (Clemens, 1860)	p	AB	SK	MB	
Subfamily Acentropinae					
Tribe Acentropiini					
Acentria ephemerella ([Denis & Schiffermüller], 1775)	p	AB			I
Tribe Nymphulini					
Elophila icciusalis (Walker, 1859)	p	AB	SK	MB	
Elophila obliteralis (Walker, 1859)	p	AB	SK	MB	
Parapoynx maculalis (Clemens, 1860)	p	AB	SK	MB	
Tribe Argyractini					
Petrophila kearfottalis (Barnes & McDunnough, 1917)	G	AB			
Petrophila jaliscalis (Schaus, 1906)	G	AB			
Petrophila confusalis (Walker, 1866)	G	AB			
Subfamily Odontiinae					
Tribe Odontiini					
Frechinia criddlealis (Munroe, 1951)	p			MB	

	Status	Occurrence			Introduced?
Tribe Eurrhypini					
Mimoschinia rufofascialis (Stephens, 1834)	G	AB	SK		
Subfamily Evergestinae					
Evergestis pallidata (Hufnagel, 1767)	p	AB	SK	MB	I?
Evergestis vinctalis Barnes & McDunnough, 1914	G	AB			
Prorasea simalis Grote, 1878	G	AB			
Prorasea praeia (Dyar, 1917)	G	AB	SK		
Cylindrifrons succandidalis (Hulst, 1886)	G	AB	SK		
Subfamily Pyraustinae					
Tribe Pyraustini					
Saucrobotys fumoferalis (Hulst, 1886)	p	AB	SK	MB	
Saucrobotys futilalis (Lederer, 1863)	p	AB	SK	MB	
Ostrinia penitalis (Grote, 1876)	G	AB	SK	MB	
Ostrinia obumbratalis (Lederer, 1863)	G		SK	MB	
Ostrinia marginalis (Walker, 1866)	p	AB	SK	MB	
Ostrinia nubilalis (Hübner, 1796)	G	AB	SK	MB	I
Fumibotys fumalis (Guenée, 1854)	p	AB	SK	MB	
Perispasta caeculalis Zeller, 1875	p	AB	SK	MB	
Anania tertialis (Guenée, 1854)	p	AB	SK	MB	
Anania mysippusalis (Walker, 1859)	p	AB	SK	MB	
Anania funebris (Ström, 1768)	p	AB	SK	MB	
Achyra bifidalis (Fabricius, 1794)	G	S			
Sitochroa chortalis (Grote, 1873)	G	AB	SK	MB	
Loxostege lepidalis (Hulst, 1886)	G	AB	SK		
Loxostege indentalis (Grote, 1883)	G	AB			
Loxostege sticticalis (Linnaeus, 1761)	G	M	M	M	I?
Loxostege anartalis (Grote, 1877)	G	AB	SK	MB	
Loxostege cereralis (Zeller, 1872)	G	M	M	M	
Pyrausta nicalis (Grote, 1878)	p	AB	SK	MB	
Pyrausta signatalis (Walker, 1866)	G	AB	SK	MB	
Pyrausta pythialis Barnes & McDunnough, 1918	G		SK	MB	
Pyrausta generosa (Grote & Robinson, 1867)	p	AB	SK	MB	
Pyrausta orphisalis Walker, 1859	p	AB	SK	MB	
Pyrausta subsequalis (Guenée, 1854)	G	AB	SK	MB	
Pyrausta scurralis (Hulst, 1886)	G	AB	SK	MB	
Pyrausta unifascialis (Packard, 1873)	p	AB	SK	MB	
Pyrausta fodinalis (Lederer, 1863)	p	AB	SK	MB	
Pyrausta socialis (Grote, 1877)	G	AB	SK	MB	
Tribe Spilomelini					
Diastictis ventralis (Grote & Robinson, 1867)	G	AB	SK	MB	
Framinghamia helvalis (Walker, 1859)	p		SK	MB	
Herpetogramma thestealis (Walker, 1859)	G	AB	SK	MB	
Choristostigma plumbosignalis (Fernald, 1888)	p	AB	SK	MB	
Udea rubigalis (Guenée, 1854)	p	AB	SK	MB	
Udea itysalis (Walker, 1859)	p	AB	SK	MB	
Udea radiosalis (Möschler, 1883)	p	AB	SK	MB	
Desmia funeralis (Hübner, 1796)	p	AB	SK	MB	
Desmia maculalis Westwood, 1831	G			MB	
Loxostegopsis polle Dyar, 1917 *	G	AB			
Loxostegopsis merrickalis (Barnes & McDunnough, 1918)	p			MB	
Palpita magniferalis (Walker, 1861)	p	AB	SK	MB	
Diacme adipaloides (Grote & Robinson, 1867)	p	AB	SK	MB	
Mecyna submedialis (Grote, 1876)	G	AB	SK	MB	
Mecyna mustelinalis (Packard, 1873)	p	AB	SK		
Nomophila nearctica Munroe, 1973	G	AB	SK	MB	

	Status	Occurrence			Introduced?
Superfamily Drepanoidea					
Family Drepanidae					
Subfamily Thyatirinae					
Tribe Habrosynini					
Habrosyne scripta (Gosse, 1840)	p	AB	SK	MB	
Pseudothyatira cymatophoroides (Guenée, 1852)	p	AB	SK	MB	
Tribe Macrothyatirini					
Euthyatira pudens (Guenée, 1852)	p	AB	SK	MB	
Tribe Ceranemotini					
Ceranemota albertae Clarke, 1938	G	AB	SK		
Subfamily Drepaninae					
Tribe Drepanini					
Drepana arcuata Walker, 1855	p	AB	SK	MB	
Drepana bilineata (Packard, 1864)	p	AB	SK	MB	
Eudeilinia herminiata (Guenée, [1858])	p	AB	SK	MB	
Tribe Oretini					
Oreta rosea (Walker, 1855)	p	AB	SK	MB	
Superfamily Lasiocampoidea					
Family Lasiocampidae					
Subfamily Lasiocampinae					
Tribe Gastropachini					
Phyllodesma americana (Harris, 1841)	p	AB	SK	MB	
Tribe Lasiocampini					
Malacosoma disstria Hübner, 1820	p	AB	SK	MB	
Malacosoma americana (Fabricius, 1793)	p		SK	MB	
Malacosoma californica (Packard, 1864)	G	AB	SK	MB	
Subfamily Macromphaliinae					
Tolype laricis (Fitch, 1856)	p	U	SK	MB	
Superfamily Bombycoidea					
Family Saturniidae					
Subfamily Ceratocampinae					
Anisota manitobensis McDunnough, 1921 *	p		P	MB	
Anisota virginiensis (Drury, 1773)	p		P	MB	
Subfamily Hemileucinae					
Tribe Hemileucini					
Hemileuca nevadensis Stretch, 1872 *	p	AB	SK	MB	
Hemileuca hera (Harris, 1841) *	G	AB	SK		
Automeris io (Fabricius, 1775)	p			MB	
Subfamily Saturniinae					
Tribe Saturniini					
Antheraea polyphemus (Cramer, 1776)	p	AB	SK	MB	
Actias luna (Linnaeus, 1758)	p	AB	SK	MB	
Tribe Attacini					
Callosamia promethea (Drury, 1773)	p			MB	
Hyalophora cecropia (Linnaeus, 1758)	G	AB	SK	MB	
Hyalophora columbia (Smith, 1865)	G			MB	
Hyalophora gloveri (Strecker, 1872)	G	AB	SK	MB	
Family Sphingidae					
Subfamily Sphinginae					
Tribe Sphingini					
Manduca quinquemaculata (Haworth, 1803)	p	P	SK	MB	
Ceratomia amyntor (Geyer, 1835)	G	AB	SK	MB	
Ceratomia undulosa (Walker, 1856)	p	AB	SK	MB	
Sphinx chersis (Hübner, 1823)	G	AB	SK	MB	
Sphinx vashti Strecker, 1878	G	AB	SK	MB	
Sphinx kalmiae Smith, 1797	p		SK	MB	

	Status	Occurrence			Introduced?
Sphinx gordius Cramer, 1780	G	P	SK	MB	
Sphinx luscitiosa Clemens, 1859	p	AB	SK	MB	
Sphinx drupiferarum Smith, 1797	p	AB	SK	MB	
Lapara bombycoides Walker, 1856	p	AB	SK	MB	
Subfamily Smerinthinae					
Tribe Smerinthini					
Smerinthus jamaicensis (Drury, 1773)	p	AB	SK	MB	
Smerinthus cerisyi Kirby, 1837	p	AB	SK	MB	
Smerinthus ophthalmica Boisduval, 1855	G	AB			
Paonias excaecata (Smith, 1797)	p	AB	SK	MB	
Paonias myops (Smith, 1797)	p	AB	SK	MB	
Amorpha juglandis (Smith, 1797)	p			MB	
Pachysphinx modesta (Harris, 1839)	p	AB	SK	MB	
Pachysphinx occidentalis (Edwards, 1875)	G	AB	SK	MB	
Subfamily Macroglossinae					
Tribe Dilophonotini					
Hemaris thysbe (Fabricius, 1775)	p	AB	SK	MB	
Hemaris gracilis (Grote & Robinson, 1865)	p	AB	SK	MB	
Hemaris diffinis (Boisduval, 1836)	G	AB	SK	MB	
Tribe Philampelini					
Eumorpha achemon (Drury, 1773)	p			MB	
Eumorpha labruscae (Linnaeus, 1758)	p		S	S	
Tribe Macroglossini					
Amphion floridensis Clark, 1920	p	S		S	
Proserpinus juanita (Strecker, 1877) *	G	AB	SK	MB	
Proserpinus clarkiae (Boisduval, 1852)	G	U			
Proserpinus flavofasciata (Walker, 1856)	p	AB	SK	MB	
Darapsa myron (Cramer, 1780)	p			MB	
Hyles euphorbiae (Linnaeus, 1758)	G	AB	SK	MB	I
Hyles gallii (Rottemburg, 1775)	p	AB	SK	MB	
Hyles lineata (Fabricius, 1775)	p	M	M	M	
Superfamily Geometroidea					
Family Uraniidae					
Subfamily Epipleminae					
Callizzia amorata Packard, 1876	p	AB	SK	MB	
Family Geometridae					
Subfamily Larentiinae					
Tribe Cidariini					
Dysstroma citrata (Linnaeus, 1761)	p	AB	SK	MB	
Dysstroma truncata (Hufnagel, 1767)	p	AB	SK	MB	
Dysstroma walkerata (Pearsall, 1909)	p	AB	SK	MB	
Dysstroma hersiliata (Guenée, [1858])	p	AB	SK	MB	
Dysstroma rutlandia McDunnough, 1943 *	p	AB	SK		
Dysstroma formosa (Hulst, 1896)	p	AB	SK	U	
Dysstroma brunneata (Packard, 1867)	p	AB	SK	P	
Eulithis gracilineata (Guenée, [1858])	p	AB	SK	MB	
Eulithis propulsata (Walker, 1862)	p	AB	SK	MB	
Eulithis testata (Linnaeus, 1761)	p	AB	SK	MB	
Eulithis destinata (Möschler, 1860)	p	AB	SK	MB	
Eulithis flavibrunneata (McDunnough, 1943)	p	AB	SK	MB	
Eulithis explanata (Walker, 1862)	p	AB	SK	MB	
Eulithis xylina (Hulst, 1896)	p	AB	SK	MB	
Eulithis serrataria (Barnes & McDunnough, 1917)	p			MB	
Antepirrhoe semiatrata (Hulst, 1881)	p	AB	SK	MB	
Ecliptopera silaceata ([Denis & Schiffermüller], 1775)	p	AB	SK	MB	
Plemyria georgii Hulst, 1896	p	AB	SK	MB	

	Status	Occurrence			Introduced?
Thera juniperata (Linnaeus, 1758)	p	AB	SK		I
Thera contractata (Packard, 1873)	p			MB	
Thera otisi (Dyar, 1904)	p	AB			
Tribe Hydriomenini					
Hydriomena perfracta Swett, 1910	p	AB	SK	MB	
Hydriomena divisaria (Walker, 1860)	p	AB	SK	MB	
Hydriomena renunciata (Walker, 1862)	p	AB	SK	MB	
Hydriomena transfigurata Swett, 1912	p			MB	
Hydriomena ruberata (Freyer, [1831])	p	AB	SK	MB	
Hydriomena furcata (Thunberg, 1784)	p	AB	SK	MB	
Hydriomena morosata Barnes & McDunnough, 1917 *	p	AB			
Triphosa haesitata (Guenée, [1858])	p	AB	SK	MB	
Rheumaptera undulata (Linnaeus, 1758)	p	AB	SK	MB	
Rheumaptera hastata (Linnaeus, 1758)	p	AB	SK	MB	
Rheumaptera subhastata (Nolcken, 1870)	p	AB	SK	MB	
Mesoleuca ruficillata (Guenée, [1858])	p	AB	SK	MB	
Mesoleuca gratulata (Walker, 1862)	p	AB			
Spargania magnoliata Guenée, [1858]	p	AB	SK	MB	
Spargania luctuata ([Denis & Schiffermüller], 1775)	p	AB	SK	MB	
Perizoma basaliata (Walker, 1862)	p	AB	SK	MB	
Perizoma custodiata (Guenée, [1858])	G	AB	SK		
Anticlea vasiliata Guenée, [1858]	p	AB	SK	MB	
Anticlea multiferata (Walker, 1863)	p	AB	SK	MB	
Tribe Stamnodini					
Stamnodes topazata (Strecker, 1899)	p	AB	SK	MB	
Tribe Xanthorhoini					
Xanthorhoe labradorensis (Packard, 1867)	p	AB	SK	MB	
Xanthorhoe packardata McDunnough, 1945	p	AB	SK	MB	
Xanthorhoe abrasaria (Herrich-Schäffer, [1855])	p	AB	SK	MB	
Xanthorhoe iduata (Guenée, [1858])	p	AB	SK	MB	
Xanthorhoe ramaria Swett & Cassino, 1920	p	AB	SK		
Xanthorhoe decoloraria (Esper, [1806])	p	AB	SK	MB	
Xanthorhoe ferrugata (Clerck, 1759)	p	AB	SK	MB	
Xanthorhoe lacustrata (Guenée, [1858])	p	AB	SK	MB	
Epirrhoe alternata (Müller, 1764)	p	AB	SK	MB	
Epirrhoe plebeculata (Guenée, [1858])	p	AB	SK		
Epirrhoe sperryi Herbulot, 1951	p	AB	SK	MB	
Euphyia intermediata (Guenée, [1858])	p	AB	SK	MB	
Zenophleps alpinata Cassino, 1927	p	AB	SK	MB	
Orthonama obstipata (Fabricius, 1794)	p	M	M	M	
Orthonama evansi McDunnough, 1920	G	AB		MB	
Costaconvexa centrostrigaria (Wollaston, 1858)	p	P	SK	MB	
Tribe Asthenini					
Hydrelia condensata (Walker, 1862)	p			MB	
Hydrelia albifera (Walker, 1866)	p	AB	SK	MB	
Venusia cambrica Curtis, 1839	p	AB	SK	U	
Venusia comptaria (Walker, 1860)	p	AB	SK	MB	
Venusia pearsalli (Dyar, 1906)	p	AB	SK	MB	
Trichodezia albovittata (Guenée, [1858])	p	AB	SK	MB	
Minoa murinata (Scopoli, 1763)	G	AB			
Tribe Operophterini					
Epirrita autumnata (Borkhausen, 1794)	p	AB	SK	MB	
Operophtera bruceata (Hulst, 1886)	p	AB	SK	MB	
Tribe Eudulini					
Eubaphe mendica (Walker, 1854)	p	AB	SK	MB	

	Status	Occurrence			Introduced?
Tribe Eupitheciini					
Horisme intestinata (Guenée, [1858])	p	AB	SK	MB	
Horisme incana Swett, 1918	G	AB	SK	MB	
Eupithecia palpata Packard, 1873	p	AB	SK	MB	
Eupithecia columbiata (Dyar, 1904)	p	AB	SK	MB	
Eupithecia interruptofasciata Packard, 1873	p	AB	SK	MB	
Eupithecia misturata (Hulst, 1896)	p	AB	SK	MB	
Eupithecia pygmaeata (Hübner, [1799])	p	AB	SK	MB	
Eupithecia coloradensis (Hulst, 1896)	G	AB			
Eupithecia regina Taylor, 1906	G	AB	SK	MB	
Eupithecia borealis (Hulst, 1898)	p	AB	SK	MB	
Eupithecia subfuscata (Haworth, 1809)	G	AB	SK	MB	
Eupithecia tripunctaria Herrich-Schäffer, 1852	p	AB	SK		
Eupithecia fletcherata Taylor, 1907	p			MB	
Eupithecia casloata (Dyar, 1904)	p	AB	SK		
Eupithecia sheppardata McDunnough, 1938	p	AB	SK		
Eupithecia satyrata (Hübner, [1813])	p	AB	SK	MB	
Eupithecia nimbicolor (Hulst, 1896)	p	AB	SK	MB	
Eupithecia cimicifugata Pearsall, 1908	p	AB	SK	MB	
Eupithecia russeliata Swett, 1908	p	AB	SK	U	
Eupithecia ammonata McDunnough, 1929 *	G	AB	SK	MB	
Eupithecia cretaceata (Packard, 1874)	p	AB	SK	MB	
Eupithecia behrensata Packard, 1876	G	AB	SK		
Eupithecia gelidata Möschler, 1860	p	AB	SK	MB	
Eupithecia multistrigata (Hulst, 1896)	p	AB	SK		
Eupithecia perfusca (Hulst, 1898)	p	AB	SK	MB	
Eupithecia annulata (Hulst, 1896)	p	AB	SK	MB	
Eupithecia lachrymosa (Hulst, 1900)	G	AB	SK		
Eupithecia lafontaineata Bolte, 1990	p	AB	P		
Eupithecia lariciata (Freyer, 1841)	p	AB	SK	MB	
Eupithecia niphadophilata (Dyar, 1904)	p	AB			
Eupithecia assimilata Doubleday, 1856	p	AB	SK	MB	
Eupithecia stellata (Hulst, 1896) *	G	AB	SK	MB	
Eupithecia albicapitata Packard, 1876	p	AB	SK	MB	
Eupithecia mutata Pearsall, 1908	p	AB	SK		
Eupithecia absinthiata (Clerck, 1759)	p	AB	SK	MB	
Eupithecia anticaria Walker, 1862	p	AB	SK	MB	
Eupithecia ravocostaliata Packard, 1876	p	AB	SK	MB	
Tribe Lobophorini					
Carsia sororiata (Hübner, [1813])	p	AB	SK	MB	
Acasis viridata (Packard, 1873)	p	AB		MB	
Cladara limitaria (Walker, 1860)	p	AB	SK	MB	
Cladara atroliturata (Walker, [1863])	p	AB	SK	U	
Lobophora nivigerata Walker, 1862	p	AB	SK	MB	
Lobophora magnoliatoidata (Dyar, 1904)	p	AB			
Subfamily Sterrhinae					
Tribe Sterrhini					
Idaea occidentaria (Packard, 1874) *	G	AB			
Idaea rotundopennata (Packard, 1876)	p	AB	SK	MB	
Tribe Cosymbiini					
Cyclophora pendulinaria (Guenée, [1858])	p	AB	SK	MB	
Tribe Timandrini					
Haematopis grataria (Fabricius, 1798)	G	AB	SK	MB	
Tribe Scopulini					
Scopula cacuminaria (Morrison, 1874)	p	AB	SK	MB	
Scopula limboundata (Haworth, 1809)	p	AB	SK	MB	

	Status	Occurrence			Introduced?
Scopula ancellata (Hulst, 1887)	p	AB	SK	MB	
Scopula fuscata (Hulst, 1887)	p	AB	U		
Scopula junctaria (Walker, 1861)	G	AB	SK	MB	
Scopula quinquelinearia (Packard, 1871)	p	AB			
Scopula frigidaria (Möschler, 1860)	p	AB	SK	MB	
Scopula inductata (Guenée, [1858])	G	AB	SK	MB	
Scopula luteolata (Hulst, 1880)	p	AB			
Scopula sentinaria (Geyer, 1837)	G	AB	SK	MB	
Leptostales ferruminaria (Zeller, 1872)	G	AB	SK	MB	
Subfamily Geometrinae					
Tribe Nemoriini					
Nemoria unitaria (Packard, 1873)	G	AB	SK		
Nemoria mimosaria (Guenée, [1858])	G	AB	SK	MB	
Dichorda rectaria (Grote, 1877) *	G	AB	P		
Tribe Synchlorini					
Synchlora aerata (Fabricius, 1798)	G	AB	SK	MB	
Synchlora bistriaria (Packard, 1876)	G	AB	SK	U	
Tribe Hemitheini					
Chlorochlamys chloroleucaria (Guenée, [1858])	p		SK	MB	
Hethemia pistasciaria (Guenée, [1858])	p			MB	
Mesothea incertata (Walker, [1863])	p	AB	SK	MB	
Subfamily Archiearinae					
Archiearis infans (Möschler, 1862)	p	AB	SK	MB	
Leucobrephos brephoides (Walker, 1857)	p	AB	SK	MB	
Subfamily Ennominae					
Tribe Alsophilini					
Alsophila pometaria (Harris, 1841)	G	AB	SK	MB	
Tribe Cassymini					
Nematocampa resistaria (Herrich-Schäffer, [1856])	p	AB	SK	MB	
Protitame virginalis (Hulst, 1900)	p	AB	SK	MB	
Protitame subalbaria (Packard, 1873)	p	AB			
Tribe Macariini					
Eumacaria madopata (Guenée, [1858])	G	AB	SK	MB	
Speranza brunneata (Thunberg, 1784)	p	AB	SK	MB	
Speranza sulphurea (Packard, 1873)	p			MB	
Speranza amboflava (Ferguson, 1953)	p	AB	SK	MB	
Speranza exauspicata (Walker, 1861)	p	AB	SK	MB	
Speranza coortaria (Hulst, 1887)	p	AB	SK	MB	
Speranza hesperata Ferguson, 2008	G	AB			
Speranza bitactata (Walker, 1862)	p	AB	SK	MB	
Speranza decorata (Hulst, 1896)	p	AB	U		
Speranza occiduaria (Packard, 1874)	p	AB	SK	MB	
Speranza helena (Cassino, 1928) *	G	AB			
Speranza ribearia (Fitch, 1848)	G	AB	SK	MB	
Speranza loricaria (Eversmann, 1837)	p	AB	SK	MB	
Speranza pustularia (Guenée, [1858])	p		SK	MB	
Speranza quadrilinearia (Packard, 1873)	G	AB		U	
Epelis truncataria (Walker, 1862)	p	AB	SK	MB	
Macaria notata (Linnaeus, 1758)	p	AB	SK	MB	
Macaria aemulataria Walker, 1861	p	AB	SK	MB	
Macaria sexmaculata Packard, 1867	p	AB	SK	MB	
Macaria signaria (Hübner, [1809])	p	AB	SK	MB	
Macaria oweni (Swett, 1907)	p	AB	SK	MB	
Digrammia californiaria (Packard, 1871)	G	AB	SK		
Digrammia ubiquitata Ferguson, 2008	p			MB	
Digrammia denticulata (Grote, 1883)	G	AB	SK	MB	

	Status	Occurrence			Introduced?
Digrammia curvata (Grote, 1880)	G	AB	SK		
Digrammia sublacteolata (Hulst, 1887) *	G			MB	
Digrammia eremiata (Guenée, [1858]) *	G			MB	
Digrammia equivocata Ferguson, 2008 *	G			MB	
Digrammia rippertaria (Duponchel, 1830)	p	AB	SK	MB	
Digrammia decorata (Grossbeck, 1907)	G	AB	SK	MB	
Digrammia mellistrigata (Grote, 1873)	p	AB	SK	MB	
Digrammia subminiata (Packard, 1873)	G	AB	SK	MB	
Digrammia neptaria (Guenée, [1858])	p	AB	SK	MB	
Digrammia irrorata (Packard, 1876)	G	AB	SK		
Fernaldella fimetaria (Grote & Robinson, 1870)	G	AB	SK		
Tribe Boarmiini					
Hesperumia sulphuraria Packard, 1873	p	AB	SK	MB	
Ematurga amitaria (Guenée, [1858])	p	AB	SK	MB	
Stenoporpia polygrammaria (Packard, 1876)	p		SK	MB	
Aethalura intertexta (Walker, 1860)	p	AB	SK	MB	
Iridopsis vellivolata (Hulst, 1881)	p	P	SK	MB	
Iridopsis ephyraria (Walker, 1860)	G	AB	SK	MB	
Iridopsis humaria (Guenée, [1858])	p	AB	SK	MB	
Iridopsis larvaria (Guenée, [1858])	p	AB	SK	MB	
Anavitrinella pampinaria (Guenée, [1858])	p	AB	SK	MB	
Cleora projecta (Walker, 1860)	p			MB	
Ectropis crepuscularia ([Denis & Schiffermüller], 1775)	p	AB	SK	MB	
Protoboarmia porcelaria (Guenée, [1858])	p	AB	SK	MB	
Tribe Melanolophiini					
Melanolophia canadaria (Guenée, [1858])	p		SK	MB	
Melanolophia signataria (Walker, 1860)	p	P	SK	MB	
Eufidonia convergaria (Walker, 1860)	p	AB	SK	MB	
Eufidonia notataria (Walker, 1860)	p		SK	MB	
Eufidonia discospilata (Walker, 1862)	p	AB	SK	MB	
Tribe Bistonini					
Biston betularia (Linnaeus, 1758)	p	AB	SK	MB	
Lycia ursaria (Walker, 1860)	p	AB	SK	MB	
Lycia rachelae (Hulst, 1896)	p	AB	SK	MB	
Hypagyrtis unipunctata (Haworth, 1809)	p	AB	SK	MB	
Hypagyrtis piniata (Packard, 1870)	p	AB	SK	MB	
Phigalia titea (Cramer, [1780])	G	AB	SK	MB	
Paleacrita vernata (Peck, 1795)	G	AB	SK	MB	
Erannis tiliaria (Harris, 1841)	p	AB	SK	MB	
Tribe Baptini					
Lomographa semiclarata (Walker, 1866)	p	AB	SK	MB	
Lomographa vestaliata (Guenée, [1858])	p	AB	SK	MB	
Lomographa glomeraria (Grote, 1881)	p			MB	
Tribe Caberini					
Cabera exanthemata (Scopoli, 1763)	p	AB	SK	U	
Cabera erythemaria Guenée, [1858]	p	AB	SK	MB	
Cabera variolaria Guenée, [1858]	p	AB	SK	MB	
Cabera borealis (Hulst, 1896)	p	AB	SK	MB	
Drepanulatrix unicalcararia (Guenée, [1858])	p	AB			
Erastria cruentaria (Hübner, [1799])	p			MB	
Tribe Angeronini					
Aspitates aberrata (Edwards, 1884) *	G	AB	SK	MB	
Euchlaena obtusaria (Hübner, [1813])	G	AB	SK	MB	
Euchlaena effecta (Walker, 1860)	p		SK	MB	
Euchlaena johnsonaria (Fitch, 1869)	p	AB	SK	MB	

	Status	Occurrence			Introduced?
Euchlaena madusaria (Walker, 1860)	p	AB	SK	MB	
Euchlaena marginaria (Minot, 1869)	p	AB	SK	MB	
Euchlaena tigrinaria (Guenée, [1858])	p	AB	SK	MB	
Euchlaena irraria (Barnes & McDunnough, 1917)	G	P	SK	MB	
Xanthotype urticaria Swett, 1918	p	AB	SK	MB	
Xanthotype sospeta (Drury, 1773)	p	AB	SK	MB	
Tribe Azelinini					
Pero honestaria (Walker, 1860)	p	AB	SK	MB	
Pero morrisonaria (Edwards, 1881)	p	AB	SK	MB	
Tribe Nacophorini					
Phaeoura quernaria (Smith, 1797)	p	AB	SK	MB	
Animomyia hardwicki Rindge, 1974 *	G	P	SK		
Tribe Campaeini					
Campaea perlata (Guenée, [1858])	p	AB	SK	MB	
Tribe Ennomini					
Ennomos magnaria Guenée, [1858]	p	AB	SK	MB	
Ennomos subsignaria (Hübner, [1823])	G	AB	SK	MB	
Tribe Epirranthini					
Spodolepis substriataria Hulst, 1896	p	AB	SK	U	
Tribe Lithinini					
Tacparia detersata (Guenée, [1858])	p	U	SK	MB	
Homochlodes fritillaria (Guenée, [1858])	p		SK	MB	
Homochlodes disconventa (Walker, 1860)	p			MB	
Tribe Anagogini					
Selenia alciphearia Walker, 1860	p	AB	SK	MB	
Selenia kentaria (Grote & Robinson, 1867)	p	AB	SK	MB	
Metanema inatomaria Guenée, [1858]	p	AB	SK	MB	
Metanema determinata Walker, 1866	p	AB	SK	MB	
Metarranthis duaria (Guenée, [1858])	p	AB	SK	MB	
Metarranthis indeclinata (Walker, 1861)	p			MB	
Metarranthis refractaria (Guenée, [1858])	p			MB	
Metarranthis warneri (Harvey, 1874)	p	AB	SK	MB	
Cepphis decoloraria (Hulst, 1886)	p			MB	
Cepphis armataria (Herrich-Schäffer, [1855])	p			MB	
Probole alienaria Herrich-Schäffer, [1855]	p	AB	SK	MB	
Probole amicaria (Herrich-Schäffer, [1855])	p	AB	SK	MB	
Plagodis serinaria Herrich-Schäffer, [1855]	p	P	SK	MB	
Plagodis phlogosaria (Guenée, [1858])	p	AB	SK	MB	
Plagodis pulveraria (Linnaeus, 1758)	p	AB	SK	MB	
Plagodis alcoolaria (Guenée, [1858])	p	AB	SK	MB	
Tribe Ourapterygini					
Neoterpes trianguliferata (Packard, 1871)	p	AB	SK		
Caripeta divisata Walker, [1863]	p	AB	SK	MB	
Caripeta piniata (Packard, 1870)	p		SK	MB	
Caripeta angustiorata Walker, [1863]	p	AB	SK	MB	
Meris patula Rindge, 1981 *	G	AB			
Besma quercivoraria (Guenée, [1858])	p	AB	SK	MB	
Lambdina fiscellaria (Guenée, [1858])	p	AB	SK	MB	
Lambdina fervidaria (Hübner, [1831])	p		SK	MB	
Cingilia catenaria (Drury, 1773)	p	AB	SK	MB	
Nepytia canosaria (Walker, [1863])	p	AB	SK	MB	
Sicya macularia (Harris, 1850)	p	AB	SK	MB	
Plataea trilinearia (Packard, 1873)	G	AB	SK		
Tetracis crocallata Guenée, [1858]	p	AB	SK	MB	
Tetracis cachexiata Guenée, [1858]	p	AB	SK	MB	

	Status	Occurrence			Introduced?
Tetracis jubararia Hulst, 1886	p	AB	SK	U	
Tetracis formosa (Hulst, 1896)	G	AB			
Eugonobapta nivosaria (Guenée, [1858])	p			MB	
Eutrapela clemataria (Smith, 1797)	p	P	SK	MB	
Prochoerodes lineola (Goeze, 1781)	p	AB	SK	MB	
Antepione thisoaria (Guenée, [1858])	p		SK	MB	
Superfamily Noctuoidea					
Family Notodontidae					
Subfamily Pygaerinae					
Clostera albosigma Fitch, 1856	p	AB	SK	MB	
Clostera strigosa (Grote, 1882)	p	AB	SK	MB	
Clostera brucei (Edwards, 1885)	p	AB	SK	MB	
Clostera apicalis (Walker, 1855)	p	AB	SK	MB	
Subfamily Notodontinae					
Tribe Notodontini					
Hyperaeschra georgica (Herrich-Schäffer, 1855)	p		P	MB	
Pheosia rimosa Packard, 1864	p	AB	SK	MB	
Odontosia elegans (Strecker, 1885)	p	AB	SK	MB	
Notodonta scitipennis Walker, 1862	p	AB	SK	MB	
Notodonta torva (Hübner, 1803)	p	AB	SK	MB	
Nerice bidentata Walker, 1855	p		SK	MB	
Tribe Dicranurini					
Gluphisia septentrionis Walker, 1855	p	AB	SK	MB	
Gluphisia avimacula Hudson, 1891	p	AB	SK	MB	
Gluphisia lintneri (Grote, 1877)	p	AB	SK	MB	
Furcula cinerea (Walker, 1865)	p	AB	SK	MB	
Furcula occidentalis (Lintner, 1878)	p	AB	SK	MB	
Furcula scolopendrina (Boisduval, 1869)	p	AB	SK	MB	
Furcula modesta (Hudson, 1891)	p	AB	SK	MB	
Cerura scitiscripta Walker, 1865	p	AB	SK	MB	
Subfamily Phalerinae					
Datana ministra (Drury, 1773)	p	P	SK	MB	
Nadata gibbosa (Smith, 1797)	p	AB	SK	MB	
Peridea angulosa (Smith, 1797)	p		SK	MB	
Peridea ferruginea (Packard, 1864)	p		SK	MB	
Subfamily Heterocampinae					
Macrurocampa marthesia (Cramer, [1780])	p			MB	
Heterocampa obliqua Packard, 1864	p			MB	
Heterocampa umbrata Walker, 1855	p		SK	MB	
Heterocampa guttivitta (Walker, 1855)	p	P	SK	MB	
Heterocampa biundata Walker, 1855	p			MB	
Lochmaeus manteo Doubleday, 1841	p			MB	
Lochmaeus bilineata (Packard, 1864)	p		SK	MB	
Schizura ipomoeae Doubleday, 1841	p	AB	SK	MB	
Schizura badia (Packard, 1864)	p		SK	MB	
Schizura unicornis (Smith, 1797)	p	AB	SK	MB	
Schizura concinna (Smith, 1797)	p	P	SK	MB	
Schizura leptinoides (Grote, 1864)	p	AB	SK	MB	
Oligocentria semirufescens (Walker, 1865)	p	AB	SK	MB	
Oligocentria lignicolor (Walker, 1855)	p		SK	MB	
Subfamily Nystaleinae					
Symmerista canicosta Franclemont, 1946	p		SK	MB	
Dasylophia anguina (Smith, 1797)	G	AB	SK	MB	

	Status	Occurrence			Introduced?
Family Erebidae					
Subfamily Lymantriinae					
Tribe Orgyiini					
Subtribe Orgyiina					
Dasychira dorsipennata (Barnes & McDunnough, 1919)	p	U	SK	MB	
Dasychira vagans (Barnes & McDunnough, 1913)	p	AB	SK	MB	
Dasychira plagiata (Walker, 1865)	p			MB	
Dasychira grisefacta (Dyar, 1911)	p	AB			
Orgyia antiqua (Linnaeus, 1758)	p	AB	SK	MB	
Orgyia leucostigma (Smith, 1797)	p	U	SK	MB	
Tribe Leucomini					
Subtribe Leucomina					
Leucoma salicis (Linnaeus, 1758)	p	AB			I
Subfamily Arctiinae					
Tribe Lithosiini					
Subtribe Cisthenina					
Lycomorpha pholus (Drury, 1773)	G	AB	SK	MB	
Hypoprepia miniata (Kirby, 1837)	p	AB	SK	MB	
Hypoprepia fucosa Hübner, [1831]	G	AB	SK	MB	
Clemensia albata Packard, 1864	p	AB	SK	MB	
Subtribe Lithosiina					
Eilema bicolor (Grote, 1864)	p	AB	SK	MB	
Crambidia pallida Packard, 1864	p			MB	
Crambidia casta (Packard, 1869)	G	AB	SK	MB	
Crambidia cephalica (Grote & Robinson, 1870) *	G	AB			
Tribe Arctiini					
Subtribe Arctiina					
Holarctia obliterata (Stretch, 1885)	G	AB	SK	MB	
Grammia doris (Boisduval, 1869)	p	AB	SK	MB	
Grammia phyllira (Drury, 1773)	p	AB	SK	MB	
Grammia virgo (Linnaeus, 1758)	p	AB	SK	MB	
Grammia parthenice (Kirby, 1837)	p	AB	SK	MB	
Grammia virguncula (Kirby, 1837)	p	AB	SK	MB	
Grammia margo Schmidt, 2009 *	p	AB	SK	MB	
Grammia williamsii (Dodge, 1871)	G	AB	SK	MB	
Grammia elongata (Stretch, 1885)	p	AB			
Grammia blakei (Grote, 1865) *	G	AB	SK	MB	
Parasemia plantaginis (Linnaeus, 1758)	p	AB	SK	MB	
Platarctia parthenos (Harris, 1850)	p	AB	SK	MB	
Arctia caja (Linnaeus, 1758)	p	AB	SK	MB	
Virbia laeta (Guérin-Méneville, [1832])	p	P	SK	MB	
Virbia aurantiaca (Hübner, [1831])	p	AB	SK	MB	
Virbia ferruginosa (Walker, 1854)	p	AB	SK	MB	
Subtribe Spilosomina					
Spilosoma congrua Walker, 1855	p	AB	SK	MB	
Spilosoma dubia (Walker, 1855)	p	AB	SK	MB	
Spilosoma vagans (Boisduval, 1852)	p	AB			
Spilosoma pteridis Edwards, 1874	G	P	SK	MB	
Spilosoma virginica (Fabricius, 1798)	p	AB	SK	MB	
Estigmene acrea (Drury, 1773)	G	AB	SK	MB	
Hyphantria cunea (Drury, 1773)	G	AB	SK	MB	
Hypercompe permaculata (Packard, 1872)	G	AB	SK		
Phragmatobia fuliginosa (Linnaeus, 1758)	G	AB	SK	MB	
Phragmatobia lineata Newman & Donahue, 1966	G	AB	SK	MB	
Phragmatobia assimilans Walker, 1855	p	AB	SK	MB	
Pyrrharctia isabella (Smith, 1797)	G	AB	SK	MB	

	Status	Occurrence	Introduced?
Subtribe Callimorphina			
Dodia tarandus Schmidt & Macaulay, 2009	p	AB SK MB	
Haploa lecontei (Guérin-Méneville, 1832)	p	AB SK MB	
Haploa confusa (Lyman, 1887)	p	P SK MB	
Subtribe Pericopina			
Gnophaela vermiculata (Grote, 1864)	G	AB SK MB	
Subtribe Phaegopterina			
Halysidota tessellaris (Smith, 1797)	p	P SK MB	
Lophocampa maculata Harris, 1841	p	AB SK MB	
Cycnia tenera Hübner, 1818	G	AB SK MB	
Cycnia oregonensis (Stretch, [1874])	G	AB SK MB	
Pygarctia spraguei (Grote, 1875) *	G	MB	
Subtribe Ctenuchina			
Ctenucha virginica (Esper, 1794)	p	AB SK MB	
Cisseps fulvicollis (Hübner, [1818])	p	AB SK MB	
Subfamily Herminiinae			
Idia americalis (Guenée, 1854)	p	AB SK MB	
Idia aemula Hübner, 1814	p	AB SK MB	
Idia concisa of authors, not Walker, 1860	p	AB SK MB	
Idia rotundalis (Walker, 1866)	p	SK MB	
Idia julia (Barnes & McDunnough, 1918)	p	P MB	
Idia lubricalis (Geyer, 1832)	p	AB SK MB	
Idia occidentalis (Smith, 1884)	G	AB U U	
Idia immaculalis (Hulst, 1886) *	G	AB SK	
Phalaenophana pyramusalis (Walker, 1859)	p	AB SK MB	
Zanclognatha theralis (Walker, 1859)	p	MB	
Zanclognatha laevigata (Grote, 1872)	p	MB	
Zanclognatha pedipilalis (Guenée, 1854)	G	AB P	
Zanclognatha jacchusalis (Walker, 1859)	p	AB SK MB	
Chytolita morbidalis (Guenée, 1854)	p	AB SK MB	
Macrochilo louisiana (Forbes, 1922)	p	AB SK P	
Macrochilo bivittata (Grote, 1877)	p	AB SK U	
Macrochilo absorptalis (Walker, 1859)	G	P SK MB	
Macrochilo orciferalis (Walker, 1859)	p	SK MB	
Phalaenostola metonalis (Walker, 1859)	p	AB SK MB	
Phalaenostola hanhami (Smith, 1899)	p	AB SK MB	
Bleptina caradrinalis Guenée, 1854	G	AB SK MB	
Renia flavipunctalis (Geyer, 1832)	G	P SK MB	
Palthis angulalis (Hübner, 1796)	p	AB SK MB	
Subfamily Pangraptinae			
Pangrapta decoralis Hübner, 1818	p	AB SK MB	
Subfamily Hypeninae			
Hypena bijugalis Walker, 1859	p	AB SK MB	
Hypena palparia Walker, 1861	p	AB SK MB	
Hypena abalienalis Walker, 1859	p	SK MB	
Hypena deceptalis Walker, 1859	p	AB SK U	
Hypena sordidula Grote, 1872	p	P MB	
Hypena atomaria (Smith, 1903)	p	AB SK MB	
Hypena edictalis Walker, 1859	p	AB SK MB	
Hypena humuli Harris, 1841	p	AB SK MB	
Hypena californica Behr, 1870	p	AB SK	
Hypena scabra (Fabricius, 1798)	p	AB SK MB	
Hypena eductalis Walker, [1859]	p	AB SK MB	
Subfamily Rivulinae			
Rivula propinqualis Guenée, 1854	p	AB SK MB	

	Status	Occurrence			Introduced?
Subfamily Scoliopteryginae					
Tribe Scoliopterygini					
Scoliopteryx libatrix (Linnaeus, 1758)	G	AB	SK	MB	
Tribe Anomini					
Alabama argillacea (Hübner, 1823)	p			MB	
Subfamily Calpinae					
Tribe Calpini					
Calyptra canadensis (Bethune, 1865)	p		SK	MB	
Subfamily Hypenodinae					
Hypenodes fractilinea (Smith, 1908)	p	AB	SK		
Hypenodes sombrus Ferguson, 1954	p	AB	P	MB	
Subfamily Boletobinae					
Tribe Boletobiini					
Mycterophora inexplicata (Walker, [1863])	p	AB	SK	MB	
Metalectra quadrisignata (Walker, [1858])	p			MB	
Tribe Phytometrini					
Spargaloma sexpunctata Grote, 1873	p	AB	SK	MB	
Subfamily Toxocampinae					
Tathorhynchus exsiccata (Lederer, 1855) *	G	AB	SK	MB	
Subfamily Erebinae					
Tribe Thermesiini					
Thysania zenobia (Cramer, [1777])	p		S	S	
Ascalapha odorata (Linnaeus, 1758)	p	S	S	S	
Tribe Catocalini					
Catocala antinympha (Hübner, 1823)	p		SK		
Catocala ilia (Cramer, [1775])	p		SK	MB	
Catocala cerogama Guenée, 1852	p		SK	MB	
Catocala relicta Walker, [1858]	G	AB	SK	MB	
Catocala unijuga Walker, [1858]	p	AB	SK	MB	
Catocala parta Guenée, 1852	G	AB	SK	MB	
Catocala luciana Strecker, 1874 *	G	AB	SK	MB	
Catocala hermia Edwards, 1880 *	G	AB	SK	U	
Catocala briseis Edwards, 1864	G	AB	SK	MB	
Catocala semirelicta Grote, 1874	G	AB	SK	MB	
Catocala meskei Grote, 1873	G	AB	SK	MB	
Catocala junctura Walker, [1858]	G	AB	U	U	
Catocala concumbens Walker, [1858]	G	AB	SK	MB	
Catocala whitneyi Dodge, 1874 *	p			MB	
Catocala sordida Grote, 1877	p	P	SK	MB	
Catocala coccinata Grote, 1872	p		SK	MB	
Catocala ultronia (Hübner, 1823)	G	AB	SK	MB	
Catocala mira Grote, 1876	p			MB	
Catocala praeclara Grote & Robinson, 1866	G	AB	SK	MB	
Catocala blandula Hulst, 1884	G	AB	SK	MB	
Catocala clintonii Grote, 1864	p		P	MB	
Catocala micronympha Guenée, 1852	p		P	MB	
Tribe Melipotini					
Melipotis perpendicularis (Guenée, 1852)	p			MB	
Melipotis jucunda Hübner, 1818	G	AB	SK	MB	
Bulia deducta (Morrison, 1875)	p	AB	SK	MB	
Drasteria pallescens (Grote & Robinson, 1866) *	G	AB	SK		
Drasteria petricola (Walker, 1858)	G	AB	SK	MB	
Drasteria hudsonica (Grote & Robinson, 1865)	G	AB	SK	MB	
Drasteria perplexa (Edwards, 1884) *	G	AB	SK		
Drasteria adumbrata (Behr, 1870)	p	AB	SK	MB	
Drasteria howlandii (Grote, 1865)	G	AB	SK		

	Status	Occurrence			Introduced?
Tribe Euclidiini					
Caenurgina annexa (Edwards, 1890)	G	AB			
Caenurgina crassiuscula (Haworth, 1809)	G	AB	SK	MB	
Caenurgina erechtea (Cramer, [1780])	G	AB	SK	MB	
Euclidia cuspidea (Hübner, 1818)	G	AB	SK	MB	
Tribe Poaphilini					
Argyrostrotis anilis (Drury, 1773)	G		SK	MB	
Tribe Omopterini					
Zale lunata (Drury, 1773)	G	P	P	MB	
Zale galbanata (Morrison, 1876)	G	AB	SK	MB	
Zale minerea (Guenée, 1852)	G	AB	SK	MB	
Zale submediana Strand, 1917	p		SK	MB	
Zale duplicata (Bethune, 1865)	p	AB	SK	MB	
Zale helata (Smith, 1908)	p			MB	
Zale metatoides McDunnough, 1943	p		SK	MB	
Zale unilineata (Grote, 1876)	p			MB	
Zale horrida Hübner, 1819	p			MB	
Family Euteliidae					
Subfamily Euteliinae					
Marathyssa inficita (Walker, 1865)	G	AB	U	MB	
Paectes oculatrix (Guenée, 1852)	p		SK	MB	
Family Nolidae					
Subfamily Nolinae					
Meganola minuscula (Zeller, 1872)	p		SK	MB	
Nola cilicoides (Grote, 1873)	p	AB	SK	MB	
Subfamily Chloephorinae					
Tribe Sarrothripini					
Nycteola frigidana (Walker, 1863)	p	AB	SK	MB	
Nycteola cinereana Neumögen & Dyar, 1893	p	AB	SK	MB	
Subfamily Risobinae					
Baileya doubledayi (Guenée, 1852)	p	P	SK	MB	
Baileya ophthalmica (Guenée, 1852)	p	AB	SK	U	
Family Noctuidae					
Subfamily Plusiinae					
Tribe Abrostolini					
Abrostola urentis Guenée, 1852	G	AB	SK	MB	
Tribe Argyrogrammatini					
Trichoplusia ni (Hübner, [1803])	G	M	M	M	
Tribe Plusiini					
Subtribe Autoplusiina					
Rachiplusia ou (Guenée, 1852)	p		P	MB	
Subtribe Euchalciina					
Diachrysia aereoides (Grote, 1864)	G	AB	SK	MB	
Diachrysia balluca (Geyer, 1832)	p	AB	SK	MB	
Polychrysia esmeralda (Oberthür, 1880)	G	AB	SK	MB	
Pseudeva purpurigera (Walker, 1858)	p	AB	SK	MB	
Pseudeva palligera (Grote, 1881)	p	AB			
Chrysanympha formosa (Grote, 1865)	p	AB	SK	MB	
Eosphoropteryx thyatyroides (Guenée, 1852)	p	AB	SK	MB	
Exyra fax (Grote, 1873)	p		P	MB	
Subtribe Plusiina					
Autographa precationis (Guenée, 1852)	p		SK	MB	
Autographa californica (Speyer, 1875)	G	AB	SK	MB	
Autographa mappa (Grote & Robinson, 1868)	p	AB	SK	MB	
Autographa pseudogamma (Grote, 1875)	p	AB	SK	MB	
Autographa bimaculata (Stephens, 1830)	p	AB	SK	MB	

	Status	Occurrence			Introduced?
Autographa ampla (Walker, [1858])	p	AB	SK	MB	
Autographa rubidus Ottolengui, 1902	p	AB	SK	MB	
Autographa sansoni Dod, 1910	p	AB			
Autographa flagellum (Walker, [1858])	p	AB	SK	MB	
Megalographa biloba (Stephens, 1830)	G	M	M	M	
Syngrapha octoscripta (Grote, 1874)	G	AB	SK	MB	
Syngrapha viridisigma (Grote, 1874)	p	AB	SK	MB	
Syngrapha epigaea (Grote, 1875)	p	AB	SK	MB	
Syngrapha ignea (Grote, 1863)	p	AB	SK		
Syngrapha abstrusa Eichlin & Cunningham, 1978	p	AB	P	MB	
Syngrapha alias (Ottolengui, 1902)	p	AB	SK	MB	
Syngrapha rectangula (Kirby, 1837)	p	AB	SK	MB	
Syngrapha microgamma (Hübner, 1823)	p	AB	SK	MB	
Syngrapha montana (Packard, 1869)	p	P	SK	P	
Anagrapha falcifera (Kirby, 1837)	G	AB	SK	MB	
Plusia venusta Walker, 1865	G	AB	SK	MB	
Plusia putnami Grote, 1873	p	AB	SK	MB	
Plusia contexta Grote, 1873	p	P	SK	MB	
Subfamily Bagisarinae					
Bagisara rectifascia (Grote, 1874) *	p			MB	
Subfamily Eustrotiinae					
Deltote bellicula (Hübner, 1818)	p	AB	SK	MB	
Protodeltote albidula (Guenée, 1852)	p	AB	SK	MB	
Maliattha synochitis (Grote & Robinson, 1868)	G	P	SK	MB	
Capis curvata Grote, 1882	p		SK	MB	
Subfamily Acontiinae					
Tribe Acontiini					
Ponometia semiflava (Guenée, 1852)	G	AB	SK	MB	
Ponometia virginalis (Grote, 1881) *	G		SK	U	
Ponometia binocula (Grote, 1875) *	G	AB	SK	MB	
Ponometia candefacta (Hübner, [1831])	p		SK	MB	
Ponometia erastrioides (Guenée, 1852)	p		SK	U	
Ponometia tortricina (Zeller, 1872)	G	AB	SK	MB	
Ponometia fasciatella (Grote, 1875) *	G		P	MB	
Ponometia elegantula (Harvey, 1876) *	G	AB	SK		
Ponometia sutrix (Grote, 1880) *	G	AB	SK		
Tarache augustipennis Grote, 1875	G	AB	SK	MB	
Spragueia leo (Guenée, 1852)	p		P	MB	
Subfamily Pantheinae					
Panthea acronyctoides (Walker, 1861)	p	AB	SK	MB	
Panthea virginarius (Grote, 1880)	p	AB	SK	U	
Colocasia flavicornis (Smith, 1884)	p	P	SK	MB	
Colocasia propinquilinea (Grote, 1873)	p	AB	SK	MB	
Charadra deridens (Guenée, 1852)	p		SK	MB	
Subfamily Raphinae					
Raphia frater Grote, 1864	G	AB	SK	MB	
Subfamily Balsinae					
Balsa labecula (Grote, 1880)	p		U	MB	
Subfamily Acronictinae					
Acronicta americana (Harris, 1841)	G	AB	SK	MB	
Acronicta dactylina (Grote, 1874)	G	AB	SK	MB	
Acronicta lepusculina (Guenée, 1852)	G	AB	SK	MB	
Acronicta vulpina (Grote, 1883)	G	AB	SK	MB	
Acronicta innotata (Guenée, 1852)	p	AB	SK	MB	
Acronicta radcliffei (Harvey, 1875)	p	AB	SK	MB	
Acronicta grisea (Walker, 1856)	p	AB	SK	MB	

	Status	**Occurrence**			**Introduced?**
Acronicta falcula (Grote, 1877) *	p			MB	
Acronicta mansueta (Smith, 1897)	p	AB			
Acronicta funeralis (Grote & Robinson, 1866)	G	P	SK	MB	
Acronicta quadrata (Grote, 1874)	G	AB	SK	MB	
Acronicta superans (Guenée, 1852)	p	AB	SK	MB	
Acronicta hasta (Guenée, 1852)	p	AB	SK	MB	
Acronicta spinigera (Guenée, 1852)	p		SK	MB	
Acronicta morula (Grote & Robinson, 1868)	p		SK	MB	
Acronicta interrupta (Guenée, 1852)	G	AB	SK	MB	
Acronicta lobeliae (Guenée, 1852)	p		SK	U	
Acronicta fragilis (Guenée, 1852)	p	AB	SK	MB	
Acronicta albarufa (Grote, 1874)	p			MB	
Acronicta ovata (Grote, 1873)	p			MB	
Acronicta exilis (Grote, 1874)	p			MB	
Acronicta increta (Morrison, 1874)	p		SK	MB	
Acronicta retardata (Walker, 1861)	p		SK	U	
Acronicta impleta (Walker, 1856)	G	AB	SK	MB	
Acronicta sperata (Grote, 1873)	G	AB	SK	MB	
Acronicta noctivaga (Grote, 1864)	p		P	MB	
Acronicta impressa (Walker, 1856)	G	AB	SK	MB	
Acronicta longa (Guenée, 1852)	G	AB	SK	U	
Acronicta oblinita (Smith, 1797)	p	AB	SK	MB	
Acronicta lanceolaria (Grote, 1875)	G	AB	SK	MB	
Simyra insularis (Herrich-Schäffer, 1868)	G	AB	SK	MB	
Agriopodes geminata (Smith, 1903)	p		SK	MB	
Harrisimemna trisignata (Walker, 1856)	p	AB	SK	U	
Subfamily Cuculliinae					
Cucullia asteroides Guenée, 1852	G	P	SK	MB	
Cucullia montanae Grote, 1882	G	AB	SK	MB	
Cucullia similaris Smith, 1892	G	AB	P		
Cucullia omissa Dod, 1916	G	AB	SK	MB	
Cucullia florea Guenée, 1852	G	AB	SK	MB	
Cucullia postera Guenée, 1852	G	AB	SK	MB	
Cucullia convexipennis Grote & Robinson, 1868	G	P	SK	MB	
Cucullia intermedia Speyer, 1870	G	AB	SK	MB	
Cucullia speyeri Lintner, 1874	G	AB	SK	MB	
Cucullia dorsalis Smith, 1892	G	AB	U		
Cucullia antipoda Strecker, 1878	G	AB	SK	U	
Cucullia luna Morrison, 1875 *	G	AB	SK	MB	
Cucullia strigata (Smith, 1892)	G	AB			
Cucullia albida Smith, 1894 *	G	AB	SK	MB	
Cucullia pulla (Grote, 1881)	G		SK		
Subfamily Amphipyrinae					
Tribe Amphipyrini					
Amphipyra pyramidoides Guenée, 1852	p	AB	SK	MB	
Amphipyra tragopoginis (Clerck, 1759)	p	AB		U	I
Amphipyra glabella (Morrison, 1874)	p	AB	SK	MB	
Tribe Psaphidini					
Subtribe Psaphidina					
Copivaleria grotei (Morrison, 1874)	p	P	SK	MB	
Brachionycha borealis (Smith, 1899)	p	AB	SK	MB	
Subtribe Feraliina					
Feralia jocosa (Guenée, 1852)	p	AB	SK	MB	
Feralia major Smith, 1890	p	AB		MB	
Feralia comstocki Grote, 1874	p	AB	SK	MB	

	Status	Occurrence			Introduced?
Subtribe Triocnemidina					
Acopa perpallida Grote, 1878	G	AB	SK		
Tribe Stiriini					
Subtribe Stiriina					
Plagiomimicus heitzmani Poole, 1995 *	G			MB	
Plagiomimicus spumosum (Grote, 1874)	G	AB	P		
Plagiomimicus expallidus Grote, 1883 *	G	AB	SK	U	
Stiria rugifrons Grote, 1874 *	G	AB	SK	U	
Subfamily Oncocnemidinae					
Catabena lineolata Walker, 1865	G	AB	P	U	
Calophasia lunula (Hufnagel, 1766)	G	AB			I
Pseudacontia crustaria (Morrison, 1875) *	G	AB	SK	MB	
Pleromelloida conserta (Grote, 1881)	G	AB	SK		
Pleromelloida bonuscula (Smith, 1898)	G	AB			
Sympistis albifasciata (Hampson, 1906)	G	AB	SK		
Sympistis saundersiana (Grote, 1876)	G	AB	P	MB	
Sympistis occata (Grote, 1875)	G	AB	SK		
Sympistis balteata (Smith, 1902) *	G	P	SK	MB	
Sympistis viriditincta (Smith, 1894)	G	AB	SK	MB	
Sympistis stabilis (Smith, 1895)	G	AB	SK	MB	
Sympistis badistriga (Grote, 1872)	p	AB	SK	MB	
Sympistis dinalda (Smith, 1908)	G	AB	SK	MB	
Sympistis iricolor (Smith, 1888) *	G		P	MB	
Sympistis lepipoloides (McDunnough, 1922) *	G	AB	SK		
Sympistis levis (Grote, 1880)	G	AB	SK		
Sympistis insanina Troubridge, 2008 *	G	AB	SK	MB	
Sympistis poliochroa (Hampson, 1906)	G	AB	SK	MB	
Sympistis mackiei (Barnes & Benjamin, 1924) *	G	AB	SK		
Sympistis cibalis (Grote, 1880)	G	AB	SK	MB	
Sympistis regina (Smith, 1902) *	G	AB	SK		
Sympistis augustus (Harvey, 1875)	G	AB	SK		
Sympistis pudorata (Smith, 1893)	G	AB			
Sympistis riparia (Morrison, 1875)	G	AB	SK	MB	
Sympistis chons Troubridge, 2008	G	AB			
Sympistis chionanthi (Smith, 1797)	G	AB	SK	MB	
Sympistis barnesii (Smith, 1899)	G	AB		U	
Sympistis piffardi (Walker, 1862)	p	AB	SK	MB	
Sympistis dentata (Grote, 1875)	p	AB	SK	MB	
Sympistis pallidior (Barnes, 1928)	G	AB	SK		
Subfamily Agaristinae					
Alypia octomaculata (Fabricius, 1775)	p		SK	U	
Alypia langtoni Couper, 1865	p	AB	SK	MB	
Androloma maccullochii (Kirby, 1837)	p	AB	SK	MB	
Subfamily Condicinae					
Tribe Condicini					
Condica videns (Guenée, 1852)	p	AB	SK	MB	
Condica discistriga (Smith, 1894)	G	AB	SK		
Tribe Leuconyctini					
Leuconycta diphteroides (Guenée, 1852)	p		SK	MB	
Leuconycta lepidula (Grote, 1874)	G	AB	SK	MB	
Crambodes talidiformis Guenée, 1852	G	AB	P	MB	
Subfamily Heliothinae					
Eutricopis nexilis Morrison, 1875	G	AB	SK	MB	
Pyrrhia cilisca (Guenée, 1852)	G		SK	MB	
Pyrrhia exprimens (Walker, 1857)	G	AB	SK	MB	
Helicoverpa zea (Boddie, 1850)	G	M	M	M	

	Status	Occurrence			Introduced?
Heliothis phloxiphaga Grote & Robinson, 1867	G	AB	SK	MB	
Heliothis acesias Felder & Rogenhofer, 1875	G	AB	SK	MB	
Heliothis ononis (Fabricius, 1787)	G	AB	SK	MB	
Heliothis oregonica (Edwards, 1875)	G	AB	SK	U	
Heliothis borealis (Hampson, 1903)	G	AB	SK	MB	
Protoschinia nuchalis (Grote, 1878)	G	AB	SK	U	
Schinia bimatris (Harvey, 1875) *	G		P	MB	
Schinia jaguarina (Guenée, 1852) *	G	AB	SK	MB	
Schinia suetus (Grote, 1873)	G	AB	P		
Schinia lucens (Morrison, 1875) *	G			MB	
Schinia meadi (Grote, 1873)	G	AB	SK	U	
Schinia florida (Guenée, 1852)	G	AB	SK	MB	
Schinia gaurae (Smith, 1797) *	G	AB	SK	U	
Schinia thoreaui (Grote & Robinson, 1870)	G		P	MB	
Schinia verna Hardwick, 1983 *	G	AB	SK	MB	
Schinia villosa (Grote, 1864)	G	AB	SK	MB	
Schinia sexata (Smith, 1906) *	G		U	MB	
Schinia persimilis (Grote, 1873) *	G	AB	SK	MB	
Schinia arcigera (Guenée, 1852)	G		SK	MB	
Schinia sanguinea (Geyer, 1832)	G		SK		
Schinia roseitincta (Harvey, 1875)	G	AB	P	MB	
Schinia bina (Guenée, 1852) *	G		SK	MB	
Schinia acutilinea (Grote, 1878)	G	AB	SK		
Schinia cumatilis (Grote, 1865)	G	AB	SK	MB	
Schinia avemensis (Dyar, 1904) *	G	AB	SK	MB	
Melaporphyria immortua Grote, 1874 *	p	AB	SK	MB	
Subfamily Eriopinae					
Callopistria cordata (Ljungh, 1825)	p			MB	
Subfamily Bryophilinae					
“Cryphia” cuerva (Barnes, 1907)	p	AB			
Subfamily Noctuinae					
Tribe Pseudeustrotiini					
Pseudeustrotia carneola (Guenée, 1852)	G	AB	SK	MB	
Anterastria teratophora (Herrich-Schäffer, [1854])	p	AB	SK	MB	
Tribe Phosphilini					
Phosphila miselioides (Guenée, 1852)	p		SK	MB	
Tribe Prodeniini					
Spodoptera frugiperda (Smith, 1797)	G		M	M	
Spodoptera praefica (Grote, 1875)	G	AB			
Tribe Elaphriini					
Elaphria versicolor (Grote, 1875)	p			MB	
Elaphria alapallida Pogue & Sullivan, 2003	p	AB	SK	MB	
Galgula partita Guenée, 1852	p			MB	
Chytonix palliatricula (Guenée, 1852)	p	AB	SK	MB	
Tribe Caradrinini					
Subtribe Caradrinina					
Protoperigea anotha (Dyar, 1904)	G	AB			
Protoperigea posticata (Harvey, 1875)	G	AB	P		
Caradrina morpheus (Hufnagel, 1766)	G	AB			I
Caradrina meralis Morrison, 1875	G	AB	SK	MB	
Caradrina montana Bremer, 1861	G	AB	SK	MB	
Caradrina multifera Walker, [1857]	p			MB	
Subtribe Athetiina					
Proxenus miranda (Grote, 1873)	G	AB	SK	MB	
Proxenus mendosa McDunnough, 1927	G	AB	SK	MB	

	Status	Occurrence			Introduced?
Tribe Drypterygiini					
Dypterygia rozmani Berio, 1974	p		U	MB	
Trachea delicata (Grote, 1874)	G	AB	SK	U	
Magusa divaricata (Grote, 1874)	p			S	
Tribe Phlogophorini					
Euplexia benesimilis McDunnough, 1922	p	AB	SK	MB	
Phlogophora iris Guenée, 1852	p		SK	MB	
Phlogophora periculosa Guenée, 1852	p	AB	SK	MB	
Tribe Apameini					
Apamea verbascoides (Guenée, 1852)	p	P	SK	MB	
Apamea cariosa (Guenée, 1852)	G	AB	SK	U	
Apamea apamiformis (Guenée, 1852)	p		P	MB	
Apamea vultuosa (Grote, 1875)	p	AB	SK	MB	
Apamea plutonia (Grote, 1883)	p	AB	SK	MB	
Apamea alia (Guenée, 1852)	p	AB	SK	MB	
Apamea indocilis (Walker, 1856)	p	AB	SK	MB	
Apamea impulsa (Guenée, 1852)	p	AB	SK	MB	
Apamea unita (Smith, 1904) *	p	AB			
Apamea sordens (Hufnagel, 1766)	G	AB	SK	MB	
Apamea inordinata (Morrison, 1875)	G	AB	SK	MB	
Apamea spaldingi (Smith, 1909)	G	AB	SK		
Apamea lignicolora (Guenée, 1852)	G	AB	SK	MB	
Apamea helva (Grote, 1875)	p		SK	MB	
Apamea sora (Smith, 1903)	p	AB	SK		
Apamea commoda (Walker, 1857)	G	AB	SK	MB	
Apamea occidens (Grote, 1878)	G	AB		U	
Apamea amputatrix (Fitch, 1857)	G	AB	SK	MB	
Apamea burgessi (Morrison, 1874) *	G	AB	P		
Apamea longula (Grote, 1879)	G	AB	SK		
Apamea scoparia Mikkola, Mustelin & Lafontaine, 2000	G	AB	SK	MB	
Apamea dubitans (Walker, 1856)	p			MB	
Apamea cogitata (Smith, 1891)	G	AB	SK	MB	
Apamea inficita (Walker, 1857)	G	AB	SK	MB	
Apamea lutosa (Andrews, 1877)	G	P	SK	MB	
Apamea devastator (Brace, 1819)	G	AB	SK	MB	
Apamea contradicta (Smith, 1895)	p	AB	SK		
Apamea niveivenosa (Grote, 1879)	G	AB	SK	MB	
Loscopia velata (Walker, 1865)	p		SK	MB	
Lateroligia ophiogramma (Esper, 1793)	p	AB	SK	MB	I
Resapamea passer (Guenée, 1852)	G	AB	SK	MB	
“Resapamea” stipata (Morrison, 1875)	p		SK	MB	
Mesapamea fractilinea (Grote, 1874)	G	AB	SK	MB	
Eremobina claudens (Walker, 1857)	p	AB	SK	MB	
Eremobina leucoscelis (Grote, 1874)	p	AB	P	U	
“Oligia” modica (Guenée, 1852)	p	AB	SK	MB	
“Oligia” egens (Walker, [1857])	G	AB	SK	MB	
“Oligia” minuscula (Morrison, 1875)	p		SK	MB	
“Oligia” obtusa (Smith, 1902)	G	P	SK	MB	
Neoligia subjuncta (Smith, 1898)	G	AB	SK	MB	
Neoligia tonsa (Grote, 1880)	G	AB	U	U	
Xylomoia chagnoni Barnes & McDunnough, 1917	p	P	SK	MB	
Photedes inops (Grote, 1881) *	G	AB	SK	MB	
Photedes includens (Walker, [1858])	G	AB	SK	U	
Photedes panatela (Smith, 1904)	p	AB	SK	MB	
Photedes didonea (Smith, 1894) *	G	AB		U	
Photedes defecta (Grote, 1874)	G	AB	SK	MB	

	Status	Occurrence			Introduced?
Hypocoena inquinata (Guenée, 1852)	p	AB	SK	MB	
Hypocoena basistriga (McDunnough, 1933)	p	AB	SK	U	
Hypocoena rufostrigata (Packard, 1867)	G	AB	SK	MB	
Capsula oblonga (Grote, 1882)	G	AB	SK	MB	
Capsula subflava (Grote, 1882)	G	AB	SK	MB	
Helotropha reniformis (Grote, 1874)	G	AB	SK	MB	
Amphipoea interoceanica (Smith, 1899)	G	AB	SK	MB	
Amphipoea americana (Speyer, 1875)	p	AB	SK	MB	
Hydraecia pallescens (Smith, 1899)	G	AB	SK		
Hydraecia immanis (Guenée, 1852)	p			MB	
Hydraecia perobliqua (Hampson, 1910)	G	AB	SK	MB	
Hydraecia intermedia (Barnes & Benjamin, 1924) *	G	AB			
Papaipema unimoda (Smith, 1894)	p	AB	SK	MB	
Papaipema cerina (Grote, 1874)	G		SK	U	
Papaipema furcata (Smith, 1899)	p		P	MB	
Papaipema circumlucens (Smith, 1899) *	G		SK	MB	
Papaipema birdi (Dyar, 1908)	p	AB	SK	MB	
Papaipema harrisii (Grote, 1881)	G	AB	SK	MB	
Papaipema leucostigma (Harris, 1841)	p		SK	MB	
Papaipema cataphracta (Grote, 1864)	p		SK	MB	
Papaipema nebris (Guenée, 1852)	p			MB	
Papaipema rigida (Grote, 1877)	p		P	MB	
Papaipema nelita (Strecker, 1898)	p		P	MB	
Papaipema aweme (Lyman, 1908)	p		P	MB	
Papaipema maritima Bird, 1909 *	G	AB			
Tribe Arzamini					
Bellura gortynoides Walker, 1865	p	AB	SK		
Bellura obliqua (Walker, 1865)	p	AB	SK	MB	
Tribe Xylenini					
Subtribe Xylenina					
Xylena nupera (Lintner, 1874)	G	AB	SK	MB	
Xylena curvimacula (Morrison, 1874)	p	AB	SK	MB	
Xylena thoracica (Putnam-Cramer, 1886)	p	AB	SK	U	
Xylena cineritia (Grote, 1875)	p	AB	SK	MB	
Lithomoia germana (Morrison, 1875)	p	AB	SK	MB	
Homoglaea hircina Morrison, 1876	p	AB	SK	MB	
Homoglaea carbonaria (Harvey, 1876)	p	AB	SK	U	
Litholomia napaea (Morrison, 1874)	p	AB	SK	MB	
Lithophane bethunei (Grote & Robinson, 1868)	p	P	SK	MB	
Lithophane innominata (Smith, 1893)	p	AB	SK	MB	
Lithophane petulca Grote, 1874	p	AB	SK	MB	
Lithophane disposita Morrison, 1874	p	AB	SK	MB	
Lithophane amanda (Smith, 1900)	p	AB	SK	MB	
Lithophane pexata Grote, 1874	p	AB	SK	MB	
Lithophane thaxteri Grote, 1874	p	AB	SK	MB	
Lithophane fagina Morrison, 1874	p	AB	SK	MB	
Lithophane baileyi Grote, 1877	p			MB	
Lithophane tepida Grote, 1874	p	AB	SK	MB	
Lithophane georgii Grote, 1875	p	AB	SK	MB	
Lithophane antennata (Walker, 1858)	p			MB	
Lithophane laticinerea Grote, 1874	G	P	SK	MB	
Lithophane unimoda (Lintner, 1878)	p	AB	SK	MB	
Eupsilia vinulenta (Grote, 1864)	G	AB	SK	MB	
Eupsilia sidus (Guenée, 1852)	p		SK	MB	
Eupsilia tristigmata (Grote, 1877)	G	AB	SK	MB	
Eupsilia devia (Grote, 1875)	p	AB	SK	MB	

	Status	Occurrence			Introduced?
Metaxaglaea inulta (Grote, 1874)	p		P	MB	
Epiglaea decliva (Grote, 1874)	G	AB	SK	MB	
Chaetaglaea cerata Franclemont, 1943	p			MB	
Eucirroedia pampina (Guenée, 1852)	G	AB	SK	MB	
Sunira bicolorago (Guenée, 1852)	G	AB	SK	MB	
Sunira verberata (Smith, 1904)	p	AB	SK	MB	
Anathix puta (Grote & Robinson, 1868)	G	AB	SK	MB	
Anathix aggressa (Smith, 1907)	G	AB	SK	U	
Xanthia tatago Lafontaine & Mikkola, 2003	p	AB	SK	MB	
Hillia maida (Dyar, 1904)	p	AB			
Hillia iris (Zetterstedt, 1839)	p	AB	SK	MB	
Parastichtis suspecta (Hübner, [1817])	p	AB	SK	MB	
Aseptis characta (Grote, 1880)	G	AB	SK	MB	
Epidemas obscurus Smith, 1903	G	AB	U	U	
Brachylomia populi (Strecker, 1898)	p	AB	SK	MB	
Brachylomia algens (Grote, 1878)	p	AB	SK	MB	
Brachylomia discinigra (Walker, 1856)	p	AB	SK	MB	
Hyppa contrasta McDunnough, 1946	p	AB	SK	MB	
Subtribe Cosmiina					
Cosmia calami (Harvey, 1876)	p		SK	MB	
Enargia infumata (Grote, 1874)	p	AB	SK	MB	
Enargia decolor (Walker, 1858)	p	AB	SK	MB	
Ipimorpha pleonectusa Grote, 1873	p	AB	SK	MB	
Subtribe Antitypina					
Andropolia contacta (Walker, 1856)	p	AB	SK	MB	
Andropolia aedon (Grote, 1880)	p	AB	SK		
Rhizagrotis cloanthoides (Grote, 1881) *	G	AB			
Rhizagrotis albalis (Grote, 1878) *	G	AB	P		
Rhizagrotis stylata (Smith, 1893) *	G	AB	P		
Fishia discors (Grote, 1881)	p	AB	SK	MB	
Fishia yosemitae (Grote, 1873)	G	AB	SK	MB	
Fishia illocata (Walker, 1857)	p	AB	SK	MB	
Platypolia anceps (Stephens, 1850)	p	AB	SK	MB	
Platypolia contadina (Smith, 1894)	p	AB			
Platypolia loda (Strecker, 1898)	p	AB			
"Platypolia" mactata (Guenée, 1852)	p	AB	SK	MB	
Xylotype arcadia Barnes & Benjamin, 1922	p	AB	SK	U	
Mniotype ducta (Grote, 1878)	G	AB	SK	MB	
Mniotype tenera (Smith, 1900)	G	AB	SK	MB	
Sutyna privata (Walker, 1857)	p	AB	SK	MB	
Subtribe Ufeina					
Ufeus satyricus Grote, 1873	p	AB	SK	MB	
Ufeus hulstii Smith, 1908	p	AB	U		
Subtribe Xylenini-unplaced					
Pseudanarta crocea (Edwards, 1875)	G	AB	SK		
Tribe Orthosiini					
Stretchia plusiaeformis Edwards, 1874	p	AB	SK		
Stretchia muricina (Grote, 1876)	G	AB	P		
Orthosia revicta (Morrison, 1876)	G	AB	SK	MB	
Orthosia segregata (Smith, 1893)	G	AB	SK	MB	
Orthosia hibisci (Guenée, 1852)	p	AB	SK	MB	
Crocigrapha normani (Grote, 1874)	G	AB	SK	MB	
Egira curialis (Grote, 1873)	G	P	SK		
Egira dolosa (Grote, 1880)	p	AB	SK	MB	
Egira rubrica (Harvey, 1878)	G	AB	SK	U	
Achatia distincta Hübner, 1813	p		P	MB	

	Status	Occurrence			Introduced?
Morrisonia evicta (Grote, 1873)	G	AB	SK	MB	
Morrisonia latex (Guenée, 1852)	p			MB	
Tribe Tholerini					
Tholera americana (Smith, 1894)	G	AB	SK		
Nephelodes minians Guenée, 1852	G	AB	SK	MB	
Tribe Hadenini					
Escaria homogena McDunnough, 1922 *	G	AB	SK		
Afotella cylindrica (Grote, 1880) *	G	AB	SK		
Hadenella pergentilis Grote, 1883	G	AB	SK		
Anarta trifolii (Hufnagel, 1766)	G	AB	SK	MB	
Anarta mutata (Dod, 1913)	G	AB	SK	MB	
Anarta inconcinna (Smith, [1888]) *	G	AB	SK		
Anarta hamata (McDunnough, 1930)	p	P	SK		
Anarta alta (Barnes & Benjamin, 1924) *	p	AB			
Anarta obesula (Smith, 1904) *	G	AB	SK	U	
Anarta farnhami (Grote, 1873)	G	AB	SK	MB	
Anarta crotchii (Grote, 1880)	G	AB	SK	MB	
Anarta antica (Smith, 1891) *	G	AB	P		
Anarta decepta (Grote, 1883) *	G	AB	SK		
Scotogramma submarina (Grote, 1883) *	G	AB	SK		
Scotogramma fervida Barnes & McDunnough, 1912 *	G	AB	SK		
Coranarta luteola (Grote & Robinson, 1865)	p	AB	SK	MB	
Coranarta macrostigma (Laf. & Mik., 1987)	p	AB			
Polia discalis (Grote, 1877)	G	AB	SK		
Polia piniae Buckett & Bauer, 1967	p	AB			
Polia nimbosa (Guenée, 1852)	p	AB	SK	MB	
Polia imbrifera (Guenée, 1852)	p	AB	SK	MB	
Polia rogenhoferi (Möschler, 1870)	p	AB	SK	MB	
Polia purpurissata (Grote, 1864)	G	AB	SK	MB	
Polia nugatis (Smith, 1898)	G	AB	SK		
Melanchra adjuncta (Guenée, 1852)	G	AB	SK	MB	
Melanchra picta (Harris, 1841)	G	AB	SK	MB	
Melanchra pulverulenta (Smith, 1888)	p	AB	SK	MB	
Melanchra assimilis (Morrison, 1874)	p	AB	SK	MB	
Lacanobia nevadae (Grote, 1876)	p	AB	SK	MB	
Lacanobia atlantica (Grote, 1874)	G	AB	SK	MB	
Lacanobia radix (Walker, [1857])	G	AB	SK	MB	
Lacanobia subjuncta (Grote & Robinson, 1868)	G	AB	SK	MB	
Lacanobia grandis (Guenée, 1852)	G	AB	SK	MB	
Spiramater lutra (Guenée, 1852)	G	AB	SK	MB	
Trichordestra tacoma (Strecker, 1900)	p	AB	SK	MB	
Trichordestra legitima (Grote, 1864)	p	AB	SK	U	
Trichordestra dodii (Smith, 1904)	p	AB	SK	U	
Trichordestra lilacina (Harvey, 1874)	G	AB	SK	MB	
Trichordestra liquida (Grote, 1881)	G	AB	SK		
Papestra quadrata (Smith, 1891)	p	AB	SK	MB	
Papestra biren (Goeze, 1781)	p	AB	SK	MB	
Papestra cristifera (Walker, 1858)	p	AB	SK	MB	
Hada sutrina (Grote, 1881)	p	AB	SK	MB	
Mamestra configurata Walker, 1856	G	AB	SK	MB	
Mamestra curialis (Smith, 1888)	G	AB	SK	U	
Sideridis fuscolutea (Smith, 1892)	G	AB			
Sideridis uscripta (Smith, 1891)	G	AB	SK	U	
Sideridis artesta (Smith, 1903)	G	AB	SK	U	
Sideridis rosea (Harvey, 1874)	G	AB	SK	MB	
Sideridis maryx (Guenée, 1852)	p	AB	SK	MB	

	Status	Occurrence			Introduced?
Hadena capsularis (Guenée, 1852)	p		SK	MB	
Hadena circumvadis (Smith, 1902) *	G	AB	SK	MB	
Dargida procinctus (Grote, 1873)	G	AB	SK	MB	
Dargida diffusa (Walker, 1856)	G	AB	SK	MB	
Tribe Leucaniini					
Mythimna oxygala (Grote, 1881)	G	AB	SK	MB	
Mythimna unipuncta (Haworth, 1809)	G	AB	SK	MB	
Leucania linita Guenée, 1852	p		U	MB	
Leucania anteroclara Smith, 1902	G	AB	SK		
Leucania phragmitidicola Guenée, 1852	p		SK	MB	
Leucania multilinea Walker, 1856	G	AB	SK	MB	
Leucania commoides Guenée, 1852	G	AB	SK	MB	
Leucania insueta Guenée, 1852	G	AB	SK	MB	
Leucania dia (Grote, 1879)	p	AB	P	U	
Leucania inermis (Forbes, 1936)	p			MB	
Tribe Eriopygini					
Lasionycta secedens (Walker, [1858])	p	AB	SK	MB	
Lacinipolia meditata (Grote, 1873)	G	AB	SK	MB	
Lacinipolia lustralis (Grote, 1875)	G	AB	SK	MB	
Lacinipolia anguina (Grote, 1881)	G	AB	SK	MB	
Lacinipolia longiclava (Smith, 1891) *	G	AB	SK		
Lacinipolia naevia (Smith, 1898) *	G	AB			
Lacinipolia vicina (Grote, 1874)	G	AB	SK	MB	
Lacinipolia pensilis (Grote, 1874)	G	AB		MB	
Lacinipolia renigera (Stephens, 1829)	G	AB	SK	MB	
Lacinipolia stricta (Walker, 1865)	G	AB	U		
Lacinipolia lorea (Guenée, 1852)	G	AB	SK	MB	
Lacinipolia olivacea (Morrison, 1874)	G	AB	SK	MB	
Lacinipolia strigicollis (Wallengren, 1860)	G	AB			
Anhimella contrahens (Walker, 1860)	G	AB	SK	MB	
Homorthodes furfurata (Grote, 1875)	G	AB	SK	MB	
Protorthodes curtica (Smith, 1890)	G	AB	P		
Protorthodes eureka (Barnes & Benjamin, 1927) *	G	AB			
Protorthodes incincta (Morrison, 1874)	G	AB	SK	MB	
Protorthodes oviduca (Guenée, 1852)	G	AB	SK	MB	
Ulolonche disticha (Morrison, 1875) *	G	AB			
Ulolonche orbiculata (Smith, 1891) *	G	AB	SK	MB	
Pseudorthodes vecors (Guenée, 1852)	p		P	MB	
Orthodes majuscula Herrich-Schäffer, 1868	G	AB	SK	MB	
Orthodes cynica Guenée, 1852	p	P	SK	MB	
"Orthodes" goodelli (Grote, 1875)	G	AB	SK	MB	
"Orthodes" obscura (Smith, 1888)	p	AB	SK	MB	
"Orthodes" detracta (Walker, 1857)	G	AB	SK	MB	
Neleucania praegracilis (Grote, 1877) *	G	AB			
Tricholita signata (Walker, 1860)	p		P	MB	
Tribe Noctuini					
Subtribe Agrotina					
Peridroma saucia (Hübner, [1808])	G	M	M	M	
Anicla tenuescens (Smith, 1890) *	G			MB	
Anicla exuberans (Smith, 1898)	G	AB	SK	MB	
Anicla tepperi (Smith, 1888)	G	AB	SK	MB	
Actebia fennica (Tauscher, 1806)	p	AB	SK	MB	
Actebia balanitis (Grote, 1873)	G	AB	SK	U	
Dichagyris variabilis (Grote, 1874)	p	AB	SK		
Dichagyris reliqua Lafontaine & Schweitzer, 2004	G			MB	
Copablepharon longipenne Grote, 1882 *	G	AB	SK	MB	

	Status	Occurrence			Introduced?
Copablepharon grandis (Strecker, 1878) *	G	AB	SK	MB	
Copablepharon viridisparsa Dod, 1916	G	AB	SK	MB	
Protogygia enalaga McDunnough, 1932 *	G	AB	SK		
Protogygia postera Fauske & Lafontaine, 2004	G	AB	SK		
Protogygia querula (Dod, 1915) *	G	AB	SK		
Protogygia alberta Troubridge & Lafontaine, 2004 *	G	AB			
Protogygia pallida Fauske & Lafontaine, 2004 *	G	AB			
Euxoa bochus (Morrison, 1874)	G	AB	SK	U	
Euxoa adumbrata (Eversmann, 1842) *	G	AB	SK	MB	
Euxoa auxiliaris (Grote, 1873)	G	AB	SK	MB	
Euxoa mimallonis (Grote, 1873)	G	AB	SK	MB	
Euxoa septentrionalis (Walker, 1865)	G	AB		U	
Euxoa olivia (Morrison, 1876)	G	AB	SK	MB	
Euxoa messoria (Harris, 1841)	G	AB	SK	U	
Euxoa divergens (Walker, [1857])	G	AB	SK	MB	
Euxoa sinelinea Hardwick, 1965	p	AB		MB	
Euxoa edictalis (Smith, 1893)	G	AB			
Euxoa quebecensis (Smith, 1900)	p	AB	P		
Euxoa scandens (Riley, 1869)	G	AB	SK	MB	
Euxoa aurulenta (Smith, 1888)	G	AB	SK	MB	
Euxoa tristicula (Morrison, 1876)	G	AB	SK	MB	
Euxoa atomaris (Smith, 1890)	p	AB			
Euxoa pleuritica (Grote, 1876)	G	AB	SK	MB	
Euxoa pestula Smith, 1904	G	AB	SK	MB	
Euxoa simona McDunnough, 1932	G	AB	SK		
Euxoa medialis (Smith, 1888) *	G	AB	SK	MB	
Euxoa intrita (Morrison, 1874)	G	AB	SK	MB	
Euxoa setonia McDunnough, 1927	G	AB			
Euxoa declarata (Walker, 1865)	G	AB	SK	MB	
Euxoa campestris (Grote, 1875)	p	AB	SK	MB	
Euxoa silens (Grote, 1875)	G	AB		U	
Euxoa spumata McDunnough, 1940 *	G	AB	SK		
Euxoa pallipennis (Smith, 1888)	G	AB	SK		
Euxoa tessellata (Harris, 1841)	G	AB	SK	MB	
Euxoa plagigera (Morrison, 1874)	G	AB	SK		
Euxoa albipennis (Grote, 1876)	G	AB	SK	MB	
Euxoa catenula (Grote, 1879)	G	AB	SK	MB	
Euxoa comosa (Morrison, 1876)	G	AB	SK	MB	
Euxoa velleripennis (Grote, 1874)	p		P	MB	
Euxoa infausta (Walker, 1865)	G	AB	SK		
Euxoa satis (Harvey, 1876)	p	AB			
Euxoa ochrogaster (Guenée, 1852)	G	AB	SK	MB	
Euxoa nostra (Smith, 1890)	G	AB	P		
Euxoa siccata (Smith, 1893) *	G	AB			
Euxoa choris (Harvey, 1876)	G	AB	U		
Euxoa obeliscoides (Guenée, 1852)	G	AB	SK	MB	
Euxoa oberfoelli Hardwick, 1973 *	G	P	SK		
Euxoa basalis (Grote, 1879) *	G	AB	SK	U	
Euxoa castanea Lafontaine, 1981	G	AB	SK	MB	
Euxoa idahoensis (Grote, 1878)	G	AB	SK	U	
Euxoa furtivus (Smith, 1890)	G	AB	SK		
Euxoa clausa McDunnough, 1923 *	G	AB	SK		
Euxoa brevipennis (Smith, 1888)	G	AB	SK		
Euxoa servitus (Smith, 1895)	G	AB	SK	MB	
Euxoa redimicula (Morrison, 1874)	G		SK	MB	
Euxoa auripennis Lafontaine, 1974	G	AB	SK	MB	

	Status	Occurrence			Introduced?
Euxoa olivalis (Grote, 1879)	G	AB	SK		
Euxoa oblongistigma (Smith, 1888)	G	AB	SK		
Euxoa citricolor (Grote, 1880) *	G	AB	P		
Euxoa tronellus (Smith, 1903) *	G	AB	SK		
Euxoa teleboa (Smith, 1890) *	G	AB	SK		
Euxoa difformis (Smith, 1900)	G	AB	SK		
Euxoa moerens (Grote, 1883) *	G	AB	SK		
Euxoa murdocki (Smith, 1890)	G	AB			
Euxoa dodi McDunnough, 1923 *	G	AB	SK		
Euxoa infracta (Morrison, 1875)	G	AB	SK	MB	
Euxoa laetificans (Smith, 1894)	G	AB	SK		
Euxoa quadridentata (Grote & Robinson, 1865)	G	AB	SK	MB	
Euxoa unica McDunnough, 1940 *	G	P	SK		
Euxoa niveilinea (Grote, 1882) *	G	AB	SK	MB	
Euxoa dargo (Strecker, 1898)	G	AB	SK	MB	
Euxoa detersa (Walker, 1856)	G	AB	SK	MB	
Euxoa cicatricosa (Grote & Robinson, 1865)	G	AB	SK		
Euxoa aequalis (Harvey, 1876)	G	AB	SK	MB	
Euxoa munis (Grote, 1879)	G	AB	SK	MB	
Euxoa misturata (Smith, 1890) *	G	AB	SK		
Euxoa nevada (Smith, 1900)	G	AB	SK		
Euxoa cinereopallidus (Smith, 1903)	G	AB	SK		
Euxoa mitis (Smith, 1894)	G	AB	SK		
Euxoa aberrans McDunnough, 1932	G	AB	SK	MB	
Euxoa manitobana McDunnough, 1925	G	AB	SK	MB	
Euxoa perolivalis (Smith, 1905)	G	AB	SK	MB	
Euxoa perpolita (Morrison, 1876)	G	AB	SK	MB	
Euxoa taura Smith, 1905 *	G	AB	SK		
Euxoa flavicollis (Smith, 1888)	G	AB	SK	MB	
Euxoa maimes (Smith, 1903)	G	AB	SK	MB	
Euxoa ridingsiana (Grote, 1875)	G	AB	SK	MB	
Feltia mollis (Walker, [1857])	p	AB	SK	MB	
Feltia geniculata (Grote & Robinson, 1868)	p			MB	
Feltia jaculifera (Guenée, 1852)	G	AB	SK	MB	
Feltia subgothica (Haworth, 1809)	G	P	SK	MB	
Feltia tricosa (Lintner, 1874)	G	P	P	MB	
Feltia herilis (Grote, 1873)	G	AB	SK	MB	
Agrotis vetusta (Walker, 1856)	G	AB	SK	MB	
Agrotis daedalus (Smith, 1890) *	G	AB	SK		
Agrotis rileyana Morrison, 1874 *	G	AB	SK		
Agrotis orthogonia Morrison, 1876 *	G	AB	SK	MB	
Agrotis kingi McDunnough, 1932 *	G	P	SK		
Agrotis robustior (Smith, 1899) *	G	AB	SK	MB	
Agrotis venerabilis Walker, [1857]	G	AB	SK	MB	
Agrotis vancouverensis Grote, 1873	G	AB	SK		
Agrotis stigmosa Morrison, 1874	G	AB	SK	MB	
Agrotis volubilis Harvey, 1874	G	AB	SK	MB	
Agrotis obliqua (Smith, 1903)	G	AB	SK	MB	
Agrotis ipsilon (Hufnagel, 1766)	G	M	M	M	
Subtribe Noctuina					
Ochropleura implecta Lafontaine, 1998	p	AB	SK	MB	
Diarsia calgary (Smith, 1898)	p	AB	SK		
Diarsia rubifera (Grote, 1875)	p	AB	SK	MB	
Diarsia rosaria (Grote, 1878)	p	AB	SK	MB	
Cerastis salicarum (Walker, 1857)	p	AB	SK	MB	
Paradiarsia littoralis (Packard, 1867)	G	AB	SK	MB	

	Status	Occurrence			Introduced?
Hemipachnobia monochromatea (Morrison, 1874)	p	AB	SK	MB	
Lycophotia phyllophora (Grote, 1874)	p	AB	SK	MB	
Rhyacia clemens (Smith, 1890)	G	AB	SK		
Chersotis juncta (Grote, 1878)	G	AB	SK	MB	
Noctua pronuba (Linnaeus, 1758)	G	AB	SK	MB	I
Cryptocala acadiensis (Bethune, 1870)	G	AB	SK	MB	
Spaelotis clandestina (Harris, 1841)	G	AB	SK	MB	
Spaelotis bicava Lafontaine, 1998	G	AB	SK	U	
Eurois occulta (Linnaeus, 1758)	p	AB	SK	MB	
Eurois astricta Morrison, 1874	G	AB	SK	MB	
Eurois nigra (Smith, 1892)	p	AB	SK		
Graphiphora augur (Fabricius, 1775)	p	AB	SK	MB	
Anaplectoides prasina ([Denis & Schiffermüller], 1775)	p	AB	SK	MB	
Anaplectoides pressus (Grote, 1874)	p	AB	SK	MB	
Aplectoides condita (Guenée, 1852)	p	AB	SK	MB	
Eueretagrotis sigmoides (Guenée, 1852)	G	U	SK	MB	
Eueretagrotis perattentus (Grote, 1876)	p	AB	SK	MB	
Eueretagrotis attentus (Grote, 1874)	p		SK	MB	
Xestia smithii (Snellen, 1896)	G	AB	SK	MB	
Xestia normanianus (Grote, 1874)	p	AB	SK	MB	
Xestia oblata (Morrison, 1875)	p	AB	SK	MB	
Xestia plebeia (Smith, 1898)	p	AB			
Xestia vernilis (Grote, 1879)	p	AB			
Xestia praevia Lafontaine, 1998	p	AB	SK	MB	
Xestia c-nigrum (Linnaeus, 1758)	G	AB	SK	MB	
Xestia dolosa Franclemont, 1980	p			MB	
Xestia speciosa (Hübner, [1813])	p	AB		MB	
Xestia perquiritata (Morrison, 1874)	p	AB	SK	MB	
Coenophila opacifrons (Grote, 1878)	p	AB	SK	MB	
Prognorisma substrigata (Smith, 1895)	G	AB	SK	U	
Agnorisma bugrai (Kocak, 1983)	G	AB	SK	MB	
Pseudohermonassa bicarnea (Guenée, 1852)	G	AB	SK	MB	
Pseudohermonassa tenuicula (Morrison, 1874)	G	AB	SK	MB	
Setagrotis radiola (Hampson, 1903) *	G	AB			
Parabagrotis exsertistigma (Morrison, 1874)	G	AB	SK	MB	
Protolampra rufipectus (Morrison, 1875)	G	AB	SK	MB	
Protolampra brunneicollis (Grote, 1865)	G	AB	SK	U	
Abagrotis erratica (Smith, 1890)	G	AB			
Abagrotis trigona (Smith, 1893)	G	AB	SK	MB	
Abagrotis vittifrons (Grote, 1864)	G	AB	SK	U	
Abagrotis nefascia (Smith, 1908)	G	AB			
Abagrotis reedi Buckett, 1969	G	AB	SK	MB	
Abagrotis duanca (Smith, 1908)	G	AB	SK		
Abagrotis nanalis (Grote, 1881)	G	AB	SK	U	
Abagrotis discoidalis (Grote, 1876) *	G	AB			
Abagrotis hermina Lafontaine, 1998	G	AB	SK	MB	
Abagrotis dickeli Lafontaine, 1998	G		SK	MB	
Abagrotis placida (Grote, 1876)	G	AB	SK	MB	
Abagrotis orbis (Grote, 1876)	G	AB	SK	U	
Abagrotis variata (Grote, 1876)	G	AB	U		
Abagrotis scopeops (Dyar, 1904)	G	AB			
Abagrotis alternata (Grote, 1864)	G	AB	SK	MB	
Abagrotis brunneipennis (Grote, 1875)	G	AB	SK	MB	
Abagrotis cupida (Grote, 1865)	G	AB	SK	MB	
Abagrotis anchocelioides (Guenée, 1852)	G			MB	
Pronoctua peabodyae (Dyar, 1903)	G	AB			

Conclusions

The Prairies Ecozone supports a diverse fauna of butterflies and moths, with 2,232 species recorded, about 43% of the entire Lepidoptera fauna of Canada. The high diversity of butterflies and moths in the Prairies Ecozone results in part from the large number of forest-associated species that are mainly in the Boreal Plains and Montane Cordillera ecozones but occur in the Prairies Ecozone in wooded areas. Our knowledge of the Lepidoptera fauna of the ecozone in terms of distribution, abundance, habitat requirements, and life history varies greatly from group to group. These data are well-known only for a few groups such as the butterflies and some families of large moths (e.g., giant silk moths (Saturniidae) and sphinx moths (Sphingidae)). Other groups, such as owlet moths (Noctuidae and Erebidae), inchworm moths (Geometridae), and prominent moths (Notodontidae), are moderately well-known, at least in terms of general distribution and abundance. Most of the 42 families of microlepidoptera are poorly known in the ecozone.

There are three main terrestrial habitat types within the ecozone: (1) deciduous woodlands, which form a transition zone between the open grasslands to the south and the forests of the Boreal Plains Ecozone to the north, the Boreal Shield Ecozone to the east, and the Montane Cordillera Ecozone to the west; (2) prairie thickets, which are formed from a variety of flowering, low-growing shrubs, which offer food, shelter, and nesting sites to species in the ecozone; and (3) open aridlands, which include grasslands, badlands, and dune habitats.

Compared with other ecozones, the Prairies Ecozone harbours a large number of Lepidoptera species at risk. The most serious threats are related to conversion of native prairie into agricultural lands. The most threatened habitats within the ecozone are the tallgrass prairie of southern Manitoba and dune habitats.

References

Acorn, J.H. 2011. Sand hill arthropods in Canadian Grasslands. *In* Arthropods of Canadian Grasslands, Vol. 2: Inhabitants of a Changing Landscape. *Edited by* K.D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 25–43.

Alberta Environment and Sustainable Resource Development. 2012. Species Assessed by Alberta's Endangered Species Conservation Committee: Short List [online]. Available from http://srd.alberta.ca/FishWildlife/SpeciesAtRisk/documents/SpeciesAssessed-EndangeredSpeciesConservationCommittee-ShortList-Nov06-2012.pdf [accessed 5 July 2013].

Alberta Lepidopterists' Guild. 2014. Faunal Inventory Projects [online]. Available from http://www.biology.ualberta.ca/uasm/alg/projects/inventory_faunal.html [accessed 31 March 2014].

Bird, C.D., Hilchie, G.J., Kondla, N.G., Pike, E.M., and Sperling, F.A.H. 1995. Alberta Butterflies. The Provincial Museum of Alberta, Edmonton, Alberta.

Bird, R.D. 1961. Ecology of the Aspen Parkland in Western Canada. Canada Department of Agriculture, Research Branch, Publication 1066, Ottawa, Ontario.

Bolte, K.B. 1990. Guide to the Geometridae of Canada (Lepidoptera). VI. Subfamily Larentiinae. 1. Revision of the genus *Eupithecia.* Memoirs of the Entomological Society of Canada, **151**: 1–253.

Brodie, H.J. 1929. A preliminary list of the Lepidoptera of Manitoba. Transactions of the Royal Canadian Institute, **17**: 81–101.

Brown, J.W. 2005. World Catalog of Insects. Vol. 5: Tortricidae (Lepidoptera). Apollo Books, Stenstrup, Denmark.

Canadian Endangered Species Conservation Council (CESCC). 2011. Wild Species 2010: The General Status of Species in Canada. National General Status Working Group, Gatineau, Quebec.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2003. COSEWIC Assessment and Status Report on the Dakota Skipper *Hesperia dacotae* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2005. COSEWIC Assessment and Status Report on the Ottoe Skipper *Hesperia ottoe* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario.
Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2011. Canadian Wildlife Species at Risk. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario.
Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2012. COSEWIC Assessment and Status Report on the Weidemeyer's Admiral *Limenitis weidemeyerii* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario.
Coupland, R.T. 1961. Reconsideration of grassland in the northern Great Plains of North America. Journal of Ecology, **49**: 135–167.
Dosdall, L.M. 1994. Evidence for successful overwintering of Diamondback Moth, *Plutella xylostella* (L.) (Lepidoptera: Plutellidae) in Alberta. The Canadian Entomologist, **126**: 183–185.
Ecological Stratification Working Group. 1996. A National Ecological Framework for Canada. Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resource Research, and Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch, Ottawa, Ontario.
Guppy, C.S., and Shepard, J.H. 2001. Butterflies of British Columbia. University of British Columbia Press, Vancouver.
Hall, P.W., Catling, P.M., and Lafontaine, J.D. 2011. Insects at risk in the prairie region. *In* Arthropods of Canadian Grasslands, Vol. 2: Inhabitants of a Changing Landscape. *Edited by* K.D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 323–349.
Heikkilä, M., Kaila, L., Mutanen, M., Peña, C., and Wahlberg, N. 2012. Cretaceous origin and repeated tertiary diversification of the redefined butterflies. Proceedings of the Royal Society B: Biological Sciences, **279**: 1093–1099.
Hooper, R.R. 1973. The Butterflies of Saskatchewan: A Field Guide. Saskatchewan Museum of Natural History, Regina, Saskatchewan.
Hooper, R.R. 1986. Revised checklist of Saskatchewan butterflies. Blue Jay, **44**: 154–163.
Hooper, R.R. 1987. A check-list of the moths of Saskatchewan. Part 1: Tent Caterpillars, Silk Moths, and Sphinx Moths. Blue Jay, **45**: 146–152.
Hooper, R.R. 1988*a*. A check-list of the moths of Saskatchewan. Part 2: Prominent Moths (Notodontidae). Blue Jay, **46**: 7–8.
Hooper, R.R. 1988*b*. A check-list of the moths of Saskatchewan. Part 3: Tiger Moths (Arctiidae) and Tussock Moths (Lymantriidae). Blue Jay, **46**: 127–132.
Hooper, R.R. 1988*c*. A checklist of the moths of Saskatchewan. Part 4: Snout Moths (Herminiinae, Rivulinae, Hypenodinae, and Hypeninae). Blue Jay, **46**: 178–180.
Hooper, R.R. 1990*a*. Check-list of the moths of Saskatchewan. Part 5: Arches Moths, Similar-wings, Grass Moths and Underwings (Catocalinae). Blue Jay, **48**: 79–83.
Hooper, R.R. 1990*b*. Check-list of Saskatchewan moths. Part 6: Looper Moths (Plusiinae). Blue Jay, **48**: 136–138.
Hooper, R.R. 1990*c*. Check-list of Saskatchewan moths. Part 7: Sumach Moths (Euteliinae), Sarrothripin Moths (Sarrothripinae), Nolin Moths (Nolinae), Midgets (Acontiinae), and Panthein Moths (Pantheinae). Blue Jay, **48**: 200–203.
Hooper, R.R. 1991*a*. Check-list of the moths of Saskatchewan. Part 8: Dagger-Moths (Acronictinae) and Foresters (Agaristinae). Blue Jay, **49**: 62–65.
Hooper, R.R. 1991*b*. Check-list of Saskatchewan moths part 9: Quakers and Borers. Blue Jay, **49**: 118–122.
Hooper, R.R. 1992. Check-list of Saskatchewan moths. Part 10: Falconers, Pinions, Sallows, and Swordgrass Moths. Blue Jay, **50**: 205–210.
Hooper, R.R. 1993. Check-list of Saskatchewan moths. Part 11: Penmans, Arches, Armyworms, and Stylus Moths. Blue Jay, **51**: 79–84.
Hooper, R.R. 1994. Check-list of Saskatchewan moths. Part 12: Dart Moths. Blue Jay, **52**: 91–96.
Hooper, R.R. 1996*a*. Check-list of Saskatchewan moths. Part 13: Dart Moths. Blue Jay, **54**: 40–43.
Hooper, R.R. 1996*b*. Check-list of Saskatchewan moths. Part 14: Flower Moths. Blue Jay, **54**: 44–46.
Hooper, R.R. 2006*a*. Checklist of Saskatchewan moths: Part 15 - Lute Strings, Hook-tips, Uraniids and Geometrids (1). Blue Jay, **64**: 97–102.
Hooper, R.R. 2006*b*. Checklist of the Saskatchewan moths: Part 16 - Geometrids (2), Ennominae (2). Blue Jay, **64**: 160–167.
Hooper, R.R. 2006*c*. Checklist of Saskatchewan moths: Part 17 - Geometridae (3), Alsophilinae, Geometrinae and Sterrhinae. Blue Jay, **64**: 212–215.
Hooper, R.R. 2007. Checklist of Saskatchewan moths: Part 18 - Geometridae (4), Larentiinae. Blue Jay **65**: 148–157.

Klassen, P., Westwood, A.R., Preston, W.B., and McKillop, W.B. 1989. The Butterflies of Manitoba. Manitoba Museum of Man and Nature, Winnipeg, Manitoba.

Lafontaine, J.D. 1998. Noctuoidea, Noctuidae (part), Noctuinae (Part –Noctuini). Fascicle 27.3. *In* The Moths of America North of Mexico. *Edited by* R.B. Dominick, D.C. Ferguson, J.G. Franclemont, R.W. Hodges, and E.G. Munroe. The Wedge Entomological Research Foundation, Washington, D.C.

Lafontaine, J.D. 2004. Noctuoidea, Noctuidae (part), Noctuinae (Part - Agrotini). Fascicle 27.1. *In* The Moths of America North of Mexico. *Edited by* R.B. Dominick, D.C. Ferguson, J.G. Franclemont, R.W. Hodges, and E.G. Munroe. The Wedge Entomological Research Foundation, Washington, D.C.

Lafontaine, J.D., and Poole, R.W. 1991. Noctuoidea, Noctuidae (part) Plusiinae. Fascicle 25.1. *In* The Moths of America North of Mexico. *Edited by* R.B. Dominick, D.C. Ferguson, J.G. Franclemont, R.W. Hodges, and E.G. Munroe. The Wedge Entomological Research Foundation, Washington, D.C.

Lafontaine, J.D., and Schmidt, B.C. 2010. An annotated check list of the Noctuoidea (Insecta, Lepidoptera) of North America north of Mexico. ZooKeys, **40**: 1–239.

Lafontaine, J.D., and Schmidt, B.C. 2011. Additions and corrections to the check list of the Noctuoidea (Insecta, Lepidoptera) of North America north of Mexico. ZooKeys, **149**: 145–161.

Lafontaine J.D., and Schmidt, B.C. 2013. Additions and corrections to the check list of the Noctuoidea (Insecta, Lepidoptera) of North America north of Mexico. ZooKeys, **264**: 227–236.

Layberry, R.A., Hall, P.W., and Lafontaine, J.D. 1998. The Butterflies of Canada. University of Toronto Press, Toronto, Ontario.

Lee, S., Hodges, R.W., and Brown, R.L. 2009. Checklist of Gelechiidae (Lepidoptera) in America north of Mexico. Zootaxa, **2231**: 1–39.

Manitoba Wildlife Branch. 2012. Species Listed Under the *Manitoba Endangered Species Act* [online]. Available from http://www.gov.mb.ca/conservation/wildlife/sar/sarlist.html [accessed 28 August, 2012].

McGuffin, W.C. 1967. Guide to the Geometridae of Canada (Lepidoptera). I. Subfamily Sterrhinae. Memoirs of the Entomological Society of Canada, **50**: 1–67.

McGuffin, W.C. 1972. Guide to the Geometridae of Canada (Lepidoptera). II. Subfamily Ennominae. 1. Memoirs of the Entomological Society of Canada, **86**: 1–159.

McGuffin, W.C. 1977. Guide to the Geometridae of Canada (Lepidoptera). III. Subfamily Ennominae. 2. Memoirs of the Entomological Society of Canada, **101**: 1–191.

McGuffin, W.C. 1981. Guide to the Geometridae of Canada (Lepidoptera). IV. Subfamily Ennominae. 3. Memoirs of the Entomological Society of Canada, **117**: 1–153.

McGuffin, W.C. 1987. Guide to the Geometridae of Canada (Lepidoptera). V. Subfamily Ennominae. 4. Memoirs of the Entomological Society of Canada, **138**: 1–182.

McGugan, B.M. (*Compiler*). 1958. Forest Lepidoptera of Canada. Vol. 1: Papilionidae to Arctiidae. Canada Department of Agriculture, Forest Biology Division Publication, **1034**: 1-76.

Metzler, E.H., Shuey, J.A., Ferge, L.A., Henderson, R.A., and Goldstein, P.Z. 2005. Contributions to the understanding of tallgrass prairie-dependent butterflies and moths (Lepidoptera) and their biogeography in the United States. Bulletin of the Ohio Biological Survey (New Series), **15**: 1–143.

Mikkola, K., Lafontaine, J.D., and Gill, J. 2009. Noctuiodea: Noctuidae (part): Xyleninae (part) Apameini (part – *Apamea* group of genera). Fascicle 26.9. *In* The Moths of America North of Mexico. *Edited by* R. W. Hodges, R. L. Brown, D. R. Davis, J. D. Lafontaine, J. A. Powell, and M. A. Solis. The Wedge Entomological Research Foundation, Washington, DC.

Mutanen, M., Wahlberg, N., and Kaila, L. 2010. Comprehensive gene and taxon coverage elucidates radiation patterns in moths and butterflies. Proceedings of the Royal Society, Series B, **277**: 2839–2848.

Pelham, J.P. 2008. A catalogue of the butterflies of the United States and Canada with a complete bibliography of the descriptive and systematic literature. Journal of Research on the Lepidoptera, **40**: 1–652.

Pohl, G.R., Anweiler, G.G., Bird, C.D., Landry, J.-F., Macaulay, D.A., Maton, I., Nazari, V., and Scott, J. 2013. 2013 update to the checklist of the Lepidoptera of Alberta. Alberta Lepidopterists' Guild Newsletter, **2013(2)**: 15-24.

Pohl, G.R., Anweiler, G.G., Schmidt, B.C., and Kondla, N.G. 2010. Annotated list of the Lepidoptera of Alberta, Canada. Zookeys, **38**: 1–549.

Pohl, G.R., Bird, C.D., Nazari, V., and Landry, J.-F. 2012. 2012 update to the checklist of the Lepidoptera of Alberta. Alberta Lepidopterists' Guild Newsletter, **2012(1)**: 7–13.

Pohl, G.R., Cannings, R.A., Landry, J.-F., Holden, D.G., and Scudder, G.G.E. (in press). Checklist of the Lepidoptera of British Columbia, Canada. Entomological Society of British Columbia, Occasional Paper 3. (in press).

Pohl, G.R., Dombroskie, J.J., Landry, J.-F., Bird, C.D., and Nazari, V. 2011. Errata and first update to the 2010 checklist of the Lepidoptera of Alberta. Alberta Lepidopterists' Guild Newsletter, **2011(1)**: 10–17.

Pohl G.R., Langor, D.W., Landry, J.-F., and Spence, J.R. 2004. Lepidoptera of the boreal mixedwood forest near Lac La Biche, Alberta, including new provincial records. Canadian Field-Naturalist, **118**: 530–549.

Poole, R.W. 1995. Noctuoidea, Noctuidae (part) Cuculliinae, Stiriinae, Psaphidinae (part). Fascicle 26.1. *In* The Moths of America North of Mexico. *Edited by* R.B. Dominick, D.C. Ferguson, J.G. Franclemont, R.W. Hodges, and E.G. Munroe. The Wedge Entomological Research Foundation, Washington, D.C.

Powell, J.A., and Brown, J.W. 2012. Tortricoidea, Tortricidae (part) Tortricinae (part): Sparganothini and Atteriini. Fascicle 8.1. *In* The Moths of North America North of Mexico. *Edited by* R.W. Hodges, R.L. Brown, D.R. Davis, J.D. Lafontaine, J.A. Powell, and M.A Solis. E. W. Classey Ltd. and the Wedge Entomological Research Foundation, London, U.K.

Prentice, R.M. (*Compiler*). 1962. Forest Lepidoptera of Canada. Vol. 2: Nycteolidae, Noctuidae, Notodontidae, Liparidae. Canada Department of Forestry Bulletin, **128**: 75–281.

Prentice, R.M. (*Compiler*). 1963. Forest Lepidoptera of Canada. Vol. 3: Lasiocampidae, Thyatiridae, Drepanidae, Geometridae. Canada Department of Forestry Publication, **1013**: 281–543.

Prentice, R.M. (*Compiler*). 1965. Forest Lepidoptera of Canada. Vol. 4: Microlepidoptera. Canada Department of Forestry Publication, **1142**: 543–840.

Regier, J.C., Zwick, A., Cummings, M.P., Kawahara, A.Y., Cho, S., Weller, S., Roe, A., Baixeras, J., Brown, J.W., Parr, C., Davis, D.R., Epstein, M., Hallwachs, W., Hausmann, A., Janzen, D.H., Kitching, I.J., Solis, M.A., Yen, S.-H., Bazinet, A.L., and Mitter, C. 2009. Toward reconstructing the evolution of advanced moths and butterflies (Lepidoptera: Ditrysia): an initial molecular study. BMC Evolutionary Biology, **9**: 280. doi:10.1186/1471-2148-9-280.

Saskatchewan Conservation Data Centre. 2012. Species at Risk in Saskatchewan [online]. Available from http://www.biodiversity.sk.ca/Docs/SpeciesAtRiskinSK.pdf [accessed 28 August, 2012].

Schmidt, B.C. 2001. Biology of the Forest Tent Caterpillar at Low Population Densities. MSc thesis, University of Alberta, Edmonton.

Schmidt, B.C., Macaulay, D.A., Kondla, N.G., Lawrie, D., and Anweiler, G.G. 2003. Additional butterfly records from Alberta, 1999–2002. Blue Jay, **61**: 110–124.

Semmler, S.J., and Westwood, A.R. 2013. *Wallengrenia egeremet* (Hesperiidae): a new population for western Canada. Journal of the Lepidopterists' Society, **67**: 59–62.

Shorthouse, J.D. 2010. Ecoregions of Canada's prairie grasslands. *In* Arthropods of Canadian Grasslands, Vol. 1: Ecology and Interactions in Grassland Habitats. *Edited by* J.D. Shorthouse and K.D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 53–81.

Sims, P.L., Singh, J.S., and Lauenroth, W.K. 1978. The structure and function of ten western North American grasslands. 1. Abiotic and vegetational characteristics. Journal of Ecology, **66**: 251–285.

Taylor, P., De March, L., and Westwood, A.R. 2008. Extended range and flight period of the Common Buckeye butterfly in southern Manitoba. Blue Jay, **66**: 107–111.

Taylor, P., and Westwood, A.R. 2010. Records of the Baltimore Checkerspot butterfly in Manitoba. Blue Jay, **68**: 87–90.

Tuskes, P.M., Tuttle, J.P., and Collins, M.M. 1996. The Wild Silkmoths of North America: A Natural History of the Saturniidae of the United States and Canada. Cornell University Press, Ithaca, New York.

Tuttle, J.P. 2007. The Hawk Moths of North America. Wedge Entomological Research Foundation, Washington, D.C.

Westwood, A.R., and Blair, D. 2010. Effect of regional climate warming on the phenology of butterflies in boreal forests in Manitoba, Canada. Environmental Entomology, **39**: 1122–1133.

Chapter 6
Moths and Butterflies (Lepidoptera) of the Peace River Region: Case Study of a Disjunct Grassland Fauna

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Abstract. The Peace River grassland (PRG) (56°N) in Alberta and British Columbia marks the northern range edge for numerous Great Plains insects and plants. The PRG is separated from other grasslands of the prairie and montane ecoregions by 200 km or more of forest biomes. Its disjunct nature provides a unique opportunity to study the biogeography, postglacial colonization sources, and population genetic structure of a diverse group of insects such as the Lepidoptera. This chapter documents the "macrolepidoptera" fauna (butterflies and larger moths) of the PRG and explores hypotheses on the possible geographical origins of grassland-dependent species. Although this fauna is dominated by Great Plains species, which points to the Alberta prairie region as a postglacial source area, some species are otherwise strictly Western Cordilleran. Several species also occur in the montane grassland of the Beringian region (Yukon and Alaska), but none of these are at the southern range edge in the PRG. The Beringian glacial refugium was therefore not an important source area for PRG Lepidoptera, although molecular data suggest past contact with Beringian populations in at least one species. The PRG Lepidoptera are a unique combination of prairie and montane Cordilleran grassland species, existing as populations that are geographically isolated from the nearest core-range populations by 240–650 km. A number of the PRG taxa are morphologically and genetically distinct and warrant recognition as separate taxonomic units (subspecies) for conservation management purposes.

Résumé. Les prairies de la rivière de la Paix (PRG – 56 °N), en Alberta et en Colombie-Britannique, marquent la limite septentrionale de l'aire de répartition d'un grand nombre d'insectes et de plantes des Grandes Plaines. Elles sont séparées des autres écorégions des écozones des prairies et de la cordillère montagnarde par une zone de biomes forestiers de 200 km ou plus. Cette séparation offre une occasion unique d'étudier la biogéographie, les sources de colonisation postglaciaire et la structure génétique des populations d'un ordre diversifié d'insectes : Lepidoptera. Le présent chapitre examine la faune des « macrolépidoptères » (papillons diurnes et papillons nocturnes de plus grande taille) des PRG et se penche sur les hypothèses formulées concernant les origines géographiques possibles d'espèces dépendantes des prairies. Bien que cette faune soit dominée par des espèces des Grandes Plaines, ce qui donne à penser que la région des prairies albertaines pourrait avoir servi de source d'immigration postglaciaire, certaines espèces ont une origine strictement limitée à la cordillère nord-américaine. Plusieurs espèces s'observent également dans la prairie alpestre de la région béringienne (Yukon et Alaska), mais aucune de ces dernières n'a été observée à la limite sud de l'aire de répartition dans la PRG. Le refuge glaciaire béringien n'a donc pas servi de source d'immigration importante pour les lépidoptères de la PRG,

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même si les données moléculaires laissent deviner un contact passé avec les populations béringiennes chez au moins une espèce. Les lépidoptères de la PRG constituent un ensemble unique d'espèces des prairies et de la cordillère montagnarde dont les populations sont géographiquement isolées des populations du cœur de l'aire de répartition les plus proches par une distance de 240 à 650 km. Un certain nombre de taxons de la PRG sont morphologiquement et génétiquement distincts et méritent d'être considérés comme des unités taxonomiques séparées (sous-espèces) aux fins de la gestion de la conservation.

Introduction

The 56th parallel ranges across habitat that includes both polar bears and cactus, from the arctic fauna of the Hudson Bay coast to the Peace River grassland (PRG) straddling the Alberta–British Columbia border, highlighting the diversity and complexity of Canada's geography at this latitude. Although boreal forest is typical at this latitude, the PRG constitutes an island of prairie surrounded by forest, home to some remarkably "southern" prairie plants and insects. Numerous species occur as disjunct populations, defined here as those separated from the next nearest occurrence by a distance of >200 km. Disjunct PRG species are separated by 240–650 km from their main range, which is typically, but not exclusively, the prairie grassland of central and southern Alberta (Bird *et al*. 1995; Guppy and Shepard 2001; Strong and Hills 2003; this study). In contrast to the Great Plains species most commonly found in the PRG, several Cordilleran species also occur there, despite being several hundred kilometres distant from the nearest montane grassland (Natural Regions Committee 2006). This association of montane and prairie elements in a geographically isolated grassland underscores the uniqueness of the PRG.

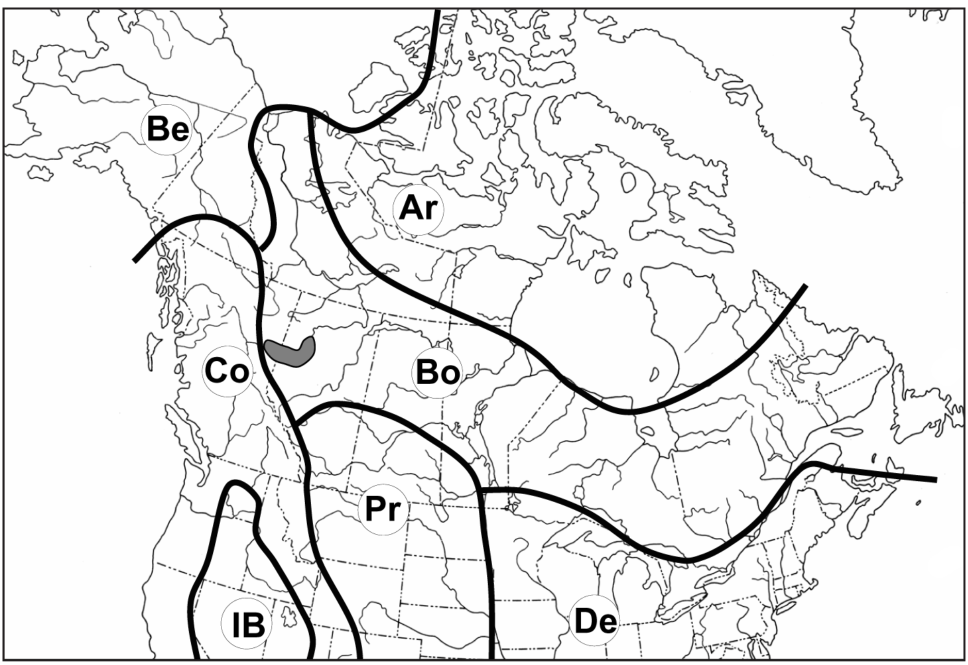


Fig. 1. Major phytogeographical regions of North America. Ar = Arctic; Be = Beringian; Bo = Boreal; Co = Cordilleran; De = Deciduous forest; IB = Intermountain Basin; Pr = Prairie (based on Catling 2009 and Takhtajan and Crovello 1986). Peace River grassland in gray.

A more accurate metaphor for the insular nature of the PRG would be "a shrinking collection of small islands"; less than 0.5% of the PRG remains in its native state as a result of agricultural land conversion (Baker 2005). From a conservation perspective, the PRG is an important reservoir of range-edge populations of numerous taxonomically unique plant (Strong and Hills 2003; Baker 2005) and butterfly species (Kondla *et al.* 1994; Bromilow and Sperling 2011). The PRG plant fauna is situated in a geographically intermediate position between four floristic regions containing major grasslands (Great Plains, Cordilleran, Beringian, and Arctic; Figs. 1 and 2), and studies into the source of this fauna have offered important insights into the postglacial history of western Canada (Raup 1934; Strong and Hills 2003, 2005). Peace River butterflies, the best-known insect group of the PRG, have similarly contributed to a better understanding of

Fig. 2. Approximate distribution of regions with major grassland in western Canada (after Shorthouse and Larson 2010) and localities mentioned in the text and Table 1. Dotted line indicates Peace River Grassland, as shown in Fig. 3.

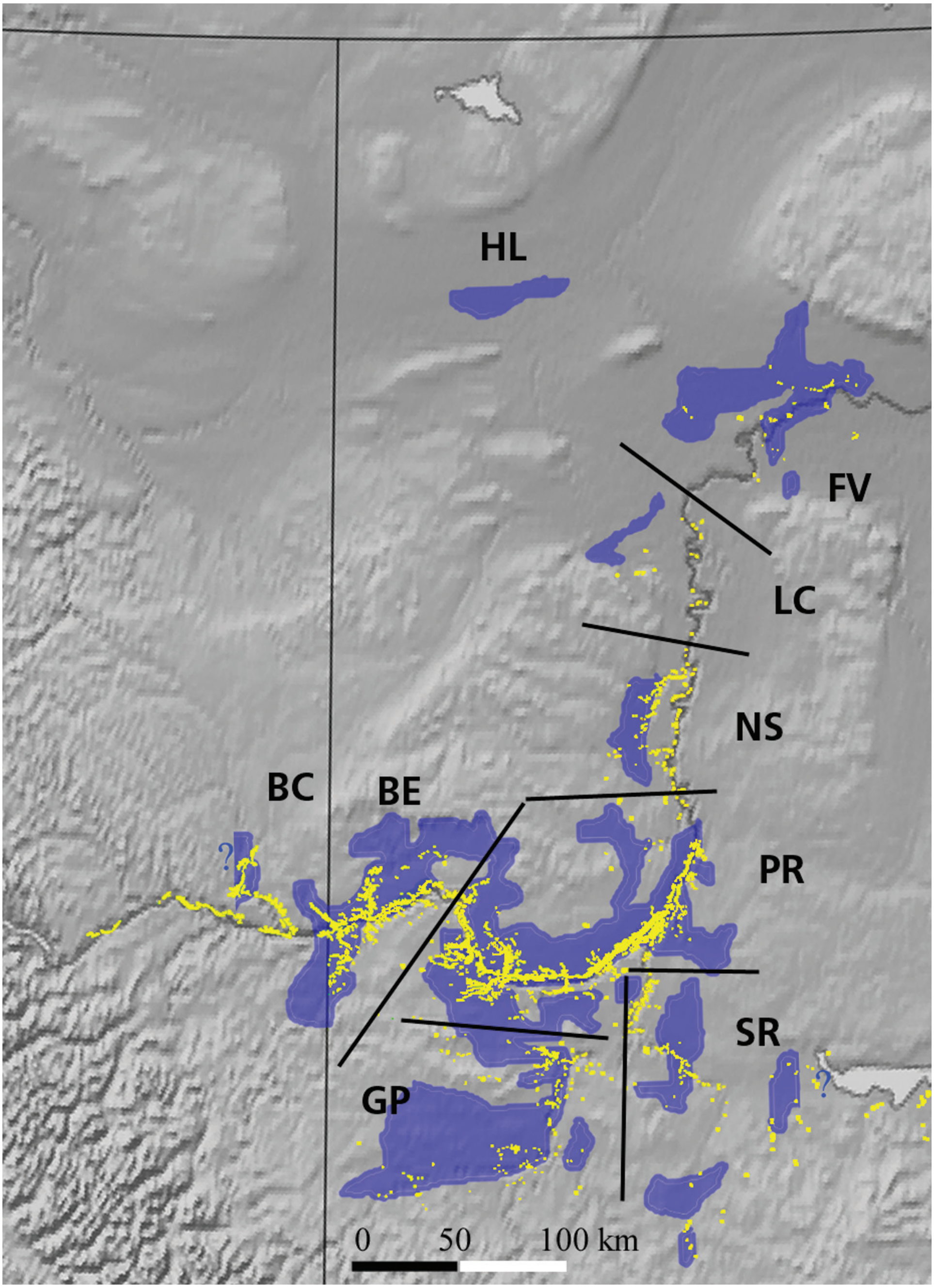


Fig. 3. Peace River Grassland. Blue indicates historical extent of biomes containing grassland, as determined by Moss (1952) and Wilkinson and Johnson (1983). Question marks indicate areas not mapped by these authors. Extant native grassland is indicated in yellow, on the basis of Baker (2005) for Alberta and GCCBC (2004) for British Columbia. Sectors discussed in the text are as follows: BC = British Columbia; BE = Bear Canyon; GP = Grande Prairie; SR = Smoky River; PR = Peace River; NS = North Star; LC = LaCrete; FV = Fort Vermilion. The High Level (HL) grasslands mapped by Moss (1952) were not assessed by Baker (2005) and are now classified as wet saline meadows (Vujnovic and Bentz 2001).

the phylogeography of isolated populations (Sperling and Harrison 1994; Bromilow and Sperling 2011). However, even baseline knowledge of mega-diverse insect groups such as Lepidoptera remains scant; here, we document the macrolepidoptera fauna (butterflies and larger moths) of the PRG and explore hypotheses on the possible geographical origins of grassland-dependent species.

Natural History of the PRG

Northwestern Alberta and adjacent northeastern British Columbia are dominated by mixedwood boreal forest flora and fauna, with the Peace River Valley and adjacent regions classified as Aspen Parkland (Natural Regions Committee 2006). The PRG is surrounded by boreal forest, separated from the nearest grassland of the Central Parkland subregion by a minimum of about 350 km at the northwestern-most extent in the Edmonton area (Fig. 2). The grassland of the Peace River region occurs on xeric sites, particularly on south-facing valley slopes, and on adjacent uplands (Figs. 3 and 4). Microclimate is influenced by the topographic relief of the Peace River canyon, a deeply incised glacial outwash valley with maximum depths of 200–300 m below the surrounding plains. Compared with sites from adjacent ecoregions, the PRG receives less annual precipitation than the northern Parkland (Edmonton), with a trend for increased precipitation westward (Table 1). The drier parts are comparable to precipitation levels in northern montane grasslands to the south (Jasper), but with July averaging approximately 20% more hours of sunshine and 1 °C warmer (Table 1). Notably, the number of growing degree-days above 10 °C for the PRG averages only slightly less (3–5%) compared with Edmonton, but is considerably greater (~20%) than Jasper. The lower developmental threshold for Lepidoptera averages approximately 9.5 °C (Miller 2011 and references therein).

In addition to climate, edaphic conditions and surface geology are important determinants of plant communities in the PRG. Solonetzic soils in particular encourage grassland formation by preventing or slowing succession to tree-dominated communities, and dark soil types (such as Solonetzic) are closely correlated with extant and historical grasslands (Wilkinson and Johnson 1983). Solonetzic soils develop from high-sodium parent materials with poor drainage, forming a subsurface layer that is extremely hard when dry and very soft but impermeable when wet. High salinity and the relatively impermeable clay layer near the surface limit aeration and root/water penetration, conditions that are unfavourable for tree growth (Wilkinson and Johnson 1983).

The region is underlain primarily by Cretaceous shales, sandstones, and siltstones, with an upper layer of lacustrine silt and clay varying from several centimetres to several

Table 1. Select climate data (1971–2000 averages) for the Peace River region compared with northern aspen parkland (Edmonton) and northern montane (Jasper) sites south of the Peace region (Source: Environment Canada: http://www.climate.weatheroffice.gc.ca/climate_normals/index_e.html). Abbreviation: n.a. = not available.

Climatic Variable	Fort St. John	Grande Prairie	Peace River	High Level	Edmonton	Jasper
Annual precipitation (mm)	465.6	446.6	402.3	394.1	482.7	398
July hours of Sunshine	294.9	308.3	n.a.	299.7	303.4	253
July average temperature	15.7	15.9	16	16.2	15.9	15
Degree-days >10 °C	558.9	579	570.4	540.4	597.5	478.8

hundred metres (Jones 1966). Lacustrine deposits, particularly bentonite clay, form steep erosional banks on the slopes of the Peace River canyon and the major tributaries. When these have a south-facing aspect, they can form a hot, dry, sparsely vegetated biome favoured by several moth species disjunct in the PRG, such as *Protogygia querula* and *Euxoa taura* (Table 2). Erosional features are almost entirely restricted to river valleys, with the notable exception of the Kleskun Hills near Grande Prairie, rising 100 m above the surrounding landscape and with erosional slopes primarily along the eastern escarpment. The Kleskun Hills area contains the largest tract of extant native grassland in the Grande Prairie region. Surface deposits of glacial till occur locally, with several upland areas of sand deposits forming jack pine woodland, for example, south of Grande Prairie, west of Fairview, north of Peace River in the Whitemud River sand hills, and west of Fort Vermilion. Although many moth species are restricted to sandy habitats (Pohl *et al*. 2010), the flora of the PRG sand hills is primarily boreal, and PRG endemic moths are not known from the Peace region sand hills.

The plant communities of the Peace River were first documented in detail by Raup (1934) and Moss (1952), who recognized that numerous plants were regionally unique. Although allied to the mixedgrass prairie of southern Alberta, the PRG, dominated by *Agropyron*, *Stipa*, and *Carex*, differs in a number of ways (Wallis 1982), most notably by the absence of rough fescue, which in the southern grasslands is the dominant graminoid (Moss 1952). Wilkinson and Johnson (1983) classified steep slopes as a *Hesperostipa spartea* (Trin.) Barkworth–*Carex*–*Artemisia frigida* Willd. association and uplands as a *Carex*–*Danthonia intermedia* Vasey–*Hesperostipa spartea* association. Stone *et al.* (2007)

Fig. 4. Typical south-facing valley slope grassland of the Peace River region at Misery Mountain, Peace River. Photo by C. Schmidt.

provide an overview of ecosites of the Peace River region and identify 16 types of upland and slope grasslands. The PRG is also unique as a result of montane elements that are lacking in prairie grassland, such as *Sedum lanceolatum* Torr., *Pyrrocoma uniflora* (Hook.) Greene, *Festuca altaica* Trin., and *Corallorhiza striata* Lindl. (Moss 1983; Strong and Hills 2003).

In pre-settlement times, the Alberta portion of the PRG existed in three core regions, the Spirit River Prairie, Peace River Prairie, and Grande Prairie. From early land survey accounts and the distribution of soils associated with grasslands, these three regions are estimated to have extended over 1,500–2,300 km^2 (80% grassland), 1,600–2,000 km^2 (75% grassland), and 9,300 km^2 (80% grassland), respectively, for a total of 12,400–13,600 km^2 (Wilkinson and Johnson 1983). According to Moss (1952), smaller areas characterized by dark soil and parkland plant communities that supported grassland also occurred near Notikewin, Keg River, Fort Vermilion, and Hay Lakes, north of the core grassland region. Today, only a tiny fraction of these grasslands remain in their natural state; for example, of the approximately 7,400 km^2 of historic Grande Prairie grasslands (Wilkinson and Johnson 1983), a total of about 5 km^2 (0.07%) remains today (Hervieux 2002). The total native grassland remaining in the Alberta PRG was estimated at less than 0.5% of its historical extent; it is highly fragmented, with 39% occurring as patches of 1 ha or less (based on 2003 data; Baker 2005). Some patches are likely too small and isolated to support long-term, viable populations of vagile species such as Lepidoptera. The pre-settlement extent of PRG in British Columbia has not been mapped, but grasslands of the Peace River lowlands section of British Columbia are now estimated at about 190 km^2 (GCCBC 2004). This estimate includes steep erosional slopes and is therefore likely an overestimate of the extent of true grassland.

The origin of the unusual PRG flora has received attention from several authors. Raup (1934) first suggested that the PRG flora developed in situ from subarctic tundra ("Barren Lands") in proximity to the ice sheets during deglaciation. There is now little support for this hypothesis, as PRG lacks subarctic plants; subsequent work has instead focused on a northwest expansion of prairie grasslands during postglacial climatic fluctuations (Strong and Hills 2003, 2005) since the last glacial maximum at about 20,000 years before present (bp). The Peace River lowlands were entirely glaciated during this glacial maximum, but recent evidence suggests that small ice-free areas persisted in the Peace foothills region to the west (Catto *et al.* 1996), possibly serving as refugium for cold-adapted species. From palynological data and climatic modelling, the PRG is thought to have been the northwestern extent of contiguous grassland that extended through central and southern Alberta at about 6,000 years bp (Strong and Hills 2003) and was subsequently isolated by encroachment of boreal forest habitat during the climatic cooling of the past 6,000 years. However, Dyke (2005) depicts a much earlier maximum grassland extent in central Alberta at about 11,000 years bp. The timing and extent of Holocene changes in the montane grasslands of western Alberta and British Columbia is also poorly understood (Hebda 1995). The asynchrony of prairie versus central British Columbia postglacial vegetation changes is noteworthy; British Columbia was mostly glaciated at the time of maximum prairie grassland biome extent at 11,000 years bp (Dyke 2005). The most probable maximum extent of British Columbia montane grassland occurred between 9,000 and 10,000 years bp, on the basis of summaries presented by Hebda (1995) and Dyke (2005). The maximum extent of montane grassland in the Alberta front ranges was also not necessarily synchronous with the expansion of British Columbia montane grassland, and Strong and Hills (2003) suggest the Alberta montane expansion was coincident with the Great Plains expansion.

Intuitively, distribution patterns for herbivorous insects should be similar to those of their host plants, but with few exceptions, no directed studies of PRG insects have been carried out. Scudder (1993) included three Peace River species in a biogeographical analysis of eight xeric grassland Lygaeidae (Hemiptera). The PRG butterfly fauna includes several species that are habitat and host plant specialists (Kondla *et al.* 1994), yet this small subset of Lepidoptera (~5%) can only hint at the biogeography of the PRG phytophagous insect fauna. Expanding this exemplar set to other Lepidoptera should therefore be especially informative.

The earliest Peace River Lepidoptera records stem from Kenneth Bowman, who collected mostly at Beaverlodge and also at Fort Vermilion during the 1920s. Bowman resided in Edmonton and collected systematically at a number of localities throughout the province (Bird *et al.* 1995). He amassed an impressive reference collection of Alberta Lepidoptera, representing about 70% of the species now known to occur there (Bowman 1951; Pohl *et al.* 2010). Despite Bowman's extensive collecting, he recorded fewer than 20 species from the Peace region (Bowman 1951). In British Columbia, no moths were known from the PRG at the time of Llewellyn-Jones' (1951) provincial checklist, although he documented at least 12 butterfly species. Additional data on Peace River butterflies were summarized by Case and Bird (1977), and subsequent surveying of the butterfly fauna led to the discovery of several unique PRG segregates, including Pike's Old World Swallowtail, *Papilio machaon pikei* (Sperling 1987), named to honour Ted Pike, who surveyed much of the Fairview area west of Peace River from 1979 to 1986. Butterfly surveys carried out in the 1980s and 1990s were summarized by Kondla *et al.* (1994) and more recently by Hervieux (2002). In contrast to the butterfly fauna, moths of the PRG were essentially unknown until directed surveys were carried out in the late 1990s (Shepard 1999) and early 2000s (Baker 2005; Macaulay 2009; BCS, unpublished data).

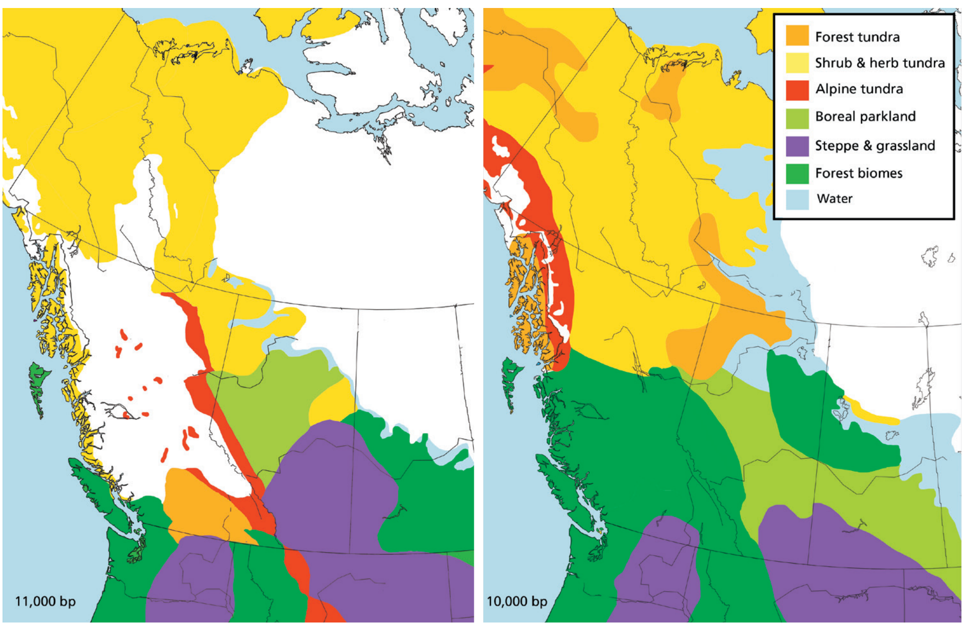


Fig 5. Distribution of western North American biomes 11,000 years bp (left) and 10,000 years bp (right), as inferred from pollen and fossil data (modified from Dyke 2005).

Table 2. Disjunct macrolepidoptera of the PRG and their geographical isolation, host plants, and distribution. Key: *distance to nearest core-range population; **parentheses indicate occurrence in Great Basin and Pacific Northwest, but not reaching southern British Columbia; ***sectors correspond to those in Fig. 3. A dash (-) indicates that at least some surveys have been done, but species is unrecorded; n/s indicates no surveying has been conducted using light traps. Abbreviations: BC = British Columbia; GP = Grande Prairie; SR = Smoky River; BE = Bear Canyon; PR = Peace River; NS = North Star; LC = LaCrete; FV = Fort Vermilion.

				Core Range				Peace River Sector***							
Note	Taxon	Isolation (km)*	Larval Host	Prairie	Cordillera**	Yukon	Eastern	BC	GP	SR	BE	PR	NS	LC	FV
	Butterflies														
	Hesperia assiniboia	360	Poaceae: native grasses	x	-	-	-	x	x	-	x	x	-	-	-
	Pyrgus communis	360	Malvaceae: *Sphaeralcea coccinea*	**x**	**x**	-	-	-	-	-	-	**x**	-	-	-
	Oarisma garita	270	Poaceae: native grasses	**x**	**x**	-	-	**x**	**x**	-	**x**	**x**	-	-	-
1	*Papilio machaon*	500	Asteraceae: *Artemesia dracunculus*	**x**	**x**	**x**	**x**	**x**	**x**	-	**x**	**x**	**x**	-	-
	Plebejus melissa	360	Fabaceae: ?*Hedysarum*, ?*Oxytropis*	x	x	-	-	-	**x**	-	-	**x**	-	-	-
2	*Agriades glandon*	270	Primulaceae: *Androsace septentrionalis*	x	-	-	-	x	x	-	**x**	**x**	**x**	**x**	**x**
	Lycaena helloides	270	Polygonaceae: *Rumex, Polygonum*	x	x	-	-	x	x	-	x	x	-	-	-
	Satyrium titus	270	Rosaceae: *Prunus*, ?*Amelanchier*	**x**	**x**	-	**x**	**x**	**x**	-	**x**	**x**	-	**x**	-
	Satyrium liparops	360	Rosaceae: *Prunus*, ?*Amelanchier*	**x**	-	-	**x**	**x**	-	-	**x**	**x**	**x**	-	-
	Chlosyne palla	240	Asteraceae: ?*Aster*	-	**x**	-	-	**x**	**x**	-	**x**	**x**	**x**	**x**	**x**
	Chlosyne gorgone	400	Asteraceae: ?*Helianthus*	x	-	-	**x**	-	-	-	-	**x**	-	-	-
3	*Speyeria aphrodite*	240	Violaceae: *Viola*	x	x	-	x	**x**	**x**	-	**x**	**x**	-	-	-
3,4	*Speyeria cybele*	240	Violaceae: *Viola*	x	-	-	x	x	x	-	**x**	**x**	-	-	-
	Oeneis alberta	370	Poaceae: native grasses	x	-	-	-	x	x	-	x	x	-	-	-
5	*Oeneis uhleri*	360	Poaceae: native grasses	**x**	-	-	-	**x**	**x**	-	**x**	**x**	**x**	-	-
6	*Cercyonis oetus*	200?	Poaceae: native grasses	**x**	-	-	-	**x**	-	-	-	-	-	-	-
7	*Cercyonis pegala*	(240)	Poaceae: native and tame grasses	**x**	**x**	-	**x**	**x**	**x**	**x**	**x**	**x**	**x**	-	-

Note	Taxon	Isolation (km)*	Larval Host	Core Range				Peace River Sector***							
				Prairie	Cordillera**	Yukon	Eastern	BC	GP	SR	BE	PR	NS	LC	FV
	Coenonympha tullia	240	Poaceae: native (and tame?) grasses	x	x	x	x	x	x	-	x	x	-	x	x
	Geometridae														
	Perizoma custodiata	400	Chenopodiaceae: ?*Atriplex*, ?*Chenopodium*	x	(x)	-	-	-	-	n/s	n/s	x	n/s	n/s	n/s
	Aspitates abberatus	360	generalist on herbaceous dicots?	x	-	-	-	x	x	"	"	x	"	"	"
	Horisme incana	320	Ranunculaceae: ?*Clematis*	x	x	x	-	x	x	"	"	x	"	"	"
	Leptostales ferruminaria	550	Rosaceae: *Prunus*, ?*Amelanchier*	x	-	-	x	x	-	"	"	x	"	"	"
	Drepanidae														
	Ceranemota albertae	380	Rosaceae: *Prunus*, ?*Amelanchier*	x	x	-	-	x	-	n/s	n/s	x	n/s	n/s	n/s
	Sphingidae														
3,8	*Sphinx vashti*	350	Caprifoliaceae: *Symphoricarpos*	x	-	-	-	x	-	n/s	n/s	x	n/s	n/s	n/s
	Erebidae														
	Grammia nevadensis	280	generalist on herb dicots	x	x	-	-	x	-	n/s	n/s	x	n/s	n/s	n/s
	Grammia margo	400	generalist on herb dicots	x	x	-	-	x	-	"	"	x	"	"	"
9	*Grammia elongate*	300	generalist on herb dicots	-	x	-	-	x	-	"	"	-	"	"	"
	Holarctia obliterate	280	generalist on herb dicots	x	x	x	-	x	-	"	"	x	"	"	"
	Catocala blandula	260	Rosaceae: *Prunus*, *Amelanchier*, *Crataegus*	x	-	-	x	-	-	"	"	x	"	"	"
	Noctuidae														
	Acronicta quadrata	360	Rosaceae: *Prunus*, *Amelanchier*	x	-	-	x	x	-	n/s	n/s	x	n/s	n/s	n/s
	Schinia cumatilis	380	Asteraceae: *Artemesia*	x	-	-	-	-	-	"	"	x	"	"	"
	Ponometia tortricina	380	Asteraceae: ?*Artemisia*, ?*Ambrosia*	x	(x)	-	-	-	-	"	"	x	"	"	"
	Anterastria teratophora	380	Labiaceae: *Monarda fistulosa*	x	-	-	x	-	-	"	"	x	"	"	"
	Apamea inordinata	520	Poaceae: native grasses	x	x	-	x	-	-	"	"	x	"	"	"

Apamea longula	530	Poaceae: native grasses	x	x	**x**	-	**x**	-	"	"	**x**	"	"	"
[10] *Sympistis stabilis*	350	Caprifoliaceae: *Symphoricarpos*, ?*Lonicera*	x	x	-	x	-	-	"	"	**x**	"	"	"
[10] *Sympistis pallidior*	500	Caprifoliaceae: *Symphoricarpos*, ?*Lonicera*	**x**	**(x)**	-	-	**x**	-	"	"	**x**	"	"	"
[11] *Sympistis chons*	550	unknown (?Scrophulariaceae: *Penstemon*)	**x**	**x**	-	-	-	-	"	"	**x**	"	"	"
[11] *Sympistis cibalis*	380	unknown (?Scrophulariaceae: *Penstemon*)	**x**	**x**	-	-	-	-	"	"	**x**	"	"	"
Scotogramma submarina	550	unknown (?generalist)	**x**	-	-	-	-	-	"	"	**x**	"	"	"
Scotogramma fervida	500	unknown (?generalist)	**x**	**(x)**	-	-	-	-	"	"	**x**	"	"	"
Trichordestra dodii	350	unknown (?generalist)	x	x	-	-	**x**	-	"	"	**x**	"	"	"
Protogygia querula	550	unknown (?generalist)	**x**	-	-	-	-	-	"	"	**x**	"	"	"
Euxoa taura	650	unknown (?generalist)	**x**	**x**	-	-	-	-	"	"	**x**	"	"	"
Euxoa setonia	380	unknown (?generalist)	**x**	**x**	-	-	-	-	"	"	**x**	"	"	"
Euxoa choris	380	unknown (?generalist)	**x**	**x**	**x**	-	-	-	"	"	**x**	"	"	"
Euxoa flavicollis	400	unknown (?generalist)	**x**	**x**	**x**	-	-	-	"	"	**x**	"	"	"
[12] *Anarta inconcinna*	500	unknown (?generalist)	x	**x**	-	-	-	**x**	"	"	**x**	"	"	"
Agrotis vancouverensis	380	unknown (?generalist)	x	x	x	-	-	-	"	"	**x**	"	"	"
Tesagrotis atrifrons	500	unknown (?generalist)	-	**x**	-	-	-	-	"	"	**x**	"	"	"

[1] Includes the taxon *bairdii*, which is sometimes treated as a separate species.

[2] Includes only the prairie populations, variously treated as subspecies *rusticus* (Bird *et al*. 1995) or *lacustris* (Guppy and Shepard 2001).

[3] May have undiscovered populations in the dry boreal forest of the Lesser Slave Lake region.

[4] Excludes the Cordilleran taxon *S. leto*, here treated as a species distinct from *S. cybele* (Pohl *et al*. 2010).

[5] Excludes the Yukon taxon *cairnesii*, which is a species distinct from *O. uhleri* (BCS and D. Lafontaine, unpublished).

[6] Likely disjunct in the Peace River region, but occurs also in native habitats adjacent to the PRG (see text).

[7] Likely disjunct historically but no longer so; now occurring also in non-native grassy habitats such as road corridors.

[8] Excludes the southern montane Cordilleran populations, which are distinct from nominate *S. vashti* (BCS, unpublished data).

[9] Undiscovered Cordilleran populations probably occur 100–200 km west of the PRG.

[10] Part of a species group that is likely exclusive to Caprifoliaceae as larval hosts, although hosts for *S. pallidior* remain unknown.

[11] Hosts remain unknown for this group of *Sympistis*, but *Penstemon* (and other Scrophulariceae) is a common host for other species in the genus.

[12] Previously called *Discestra montanica* (Lafontaine and Schmidt 2011).

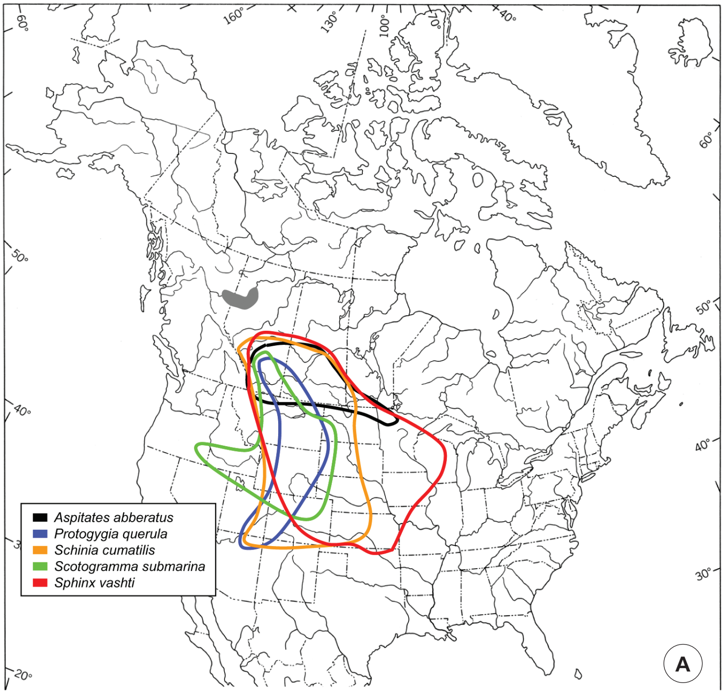
Here, we focus on macrolepidoptera species that are dependent on grassland habitat in the Peace River lowlands, that is, those species that also occur elsewhere in prairie and montane grasslands, but are absent from boreal habitats. Occurrence and habitat data are based on published information (Table 2); fieldwork carried out by the authors; the specimen holdings of the University of Alberta Strickland Museum (http://www.biology.ualberta.ca/facilities/strickland/); the Canadian National Collection of Insects, Arachnids and Nematodes; and the personal collection of one of the authors (DAM). Nomenclature follows Pohl *et al.* (2010) except as noted. We considered postglacial source areas of the PRG fauna from four regions: (1) prairie grassland of the northern Great Plains; (2) Cordilleran (interior British Columbia to Rocky Mountains); (3) Beringia (Yukon and Alaska); and (4) Arctic (Fig. 1). These regions were selected on the basis of the present-day distribution of grasslands (Fig. 2) and vegetation changes since the last glacial maximum (Fig. 5; Dyke 2005).

Geographical Isolation of PRG Lepidoptera

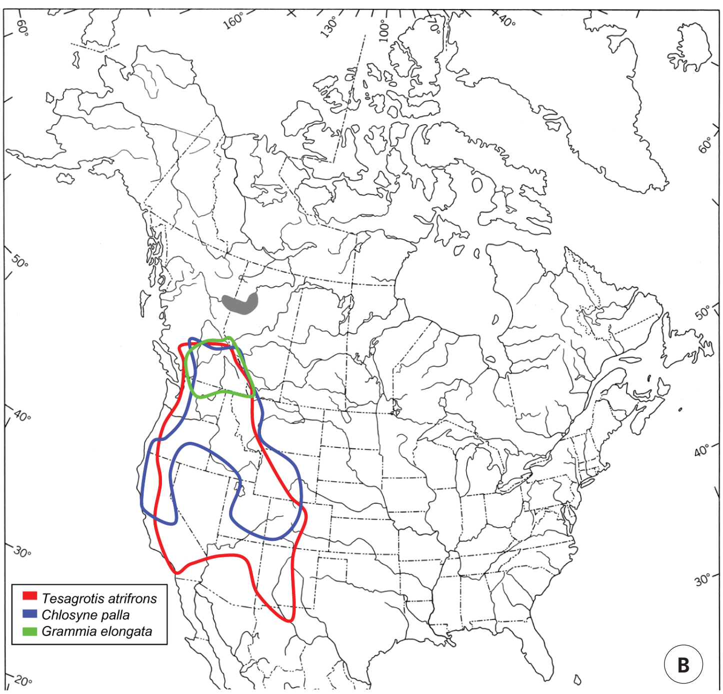
The PRG Lepidoptera fauna exhibits varying degrees of geographical disjunction, probably reflective of species-specific climate and habitat tolerances and host plant availability. Of the 315 PRG macromoths (Macaulay 2009), at least 32 species are grassland specialists with disjunct PRG populations, while 18 of the 76 butterfly species (Kondla *et al*. 1994) are disjunct (Table 2). Kondla *et al.* (1994) also considered 10 of these 18 butterfly species to be disjunct in the PRG, with an additional six species of uncertain status because of inadequate distributional or habitat information (*Lycaena hyllus*, *L. helloides*, *Agriades glandon* '*rusticus*,' *Speyeria aphrodite*, *Coenonympha tullia*), or because of taxonomic uncertainty (*Plebejus melissa*). With the exception of *Lycaena hyllus* and the addition of *Speyeria cybele*, we consider these six species to be disjunct, occurring at least 240–270 km northwest of their core range (Table 2). Two additional species, *Cercyonis pegala* and *C. oetus*, may have disjunct populations in the PRG and are further discussed below. *Lycaena hyllus* has since been discovered in a number of boreal wetlands in northeastern British Columbia (Guppy and Shepard 2001), northern Alberta (Schmidt *et al.* 2003), and north to Yellowknife, Northwest Territories (BCS, unpublished data), and therefore does not have disjunct PRG populations. Both *Lycaena helloides* and *Agriades glandon* '*rusticus*' have PRG populations that are regionally isolated, but the larval food plant and habitat preferences suggest they could occur in intervening boreal habitats (Table 2). *Speyeria cybele* appears to be absent from the central and northern boreal forest and is one of six taxa that fall into a similar distribution pattern, that is, one of a primarily southern grassland range, extending into sandy jack pine habitats of the southern boreal forest (Kondla 1992; Macaulay 2006). This distributional pattern is also evident in *Sphinx vashti*, *Acronicta quadrata*, *Catocala blandula*, and *Trichordestra dodii*. Although some careful surveying of dry boreal sites is needed in the intervening region, the lack of central and northern boreal records for these species suggests regional isolation in the PRG. Even if localized, intervening boreal populations were discovered, one would intuitively expect the gene flow between PRG and core-range populations to be limited, particularly for species of Lycaenidae that exhibit limited dispersal ability and high site fidelity (e.g., Gompert *et al.* 2010 and references therein). Three PRG disjunct butterflies require further comment, as occurrence records within the boreal forest region (Bird *et al*. 1995; Schmidt *et al*. 2003) suggest that their disjunct status is an artifact of undersampling. *Cercyonis oetus*, *Pyrgus communis*, and *Agriades glandon* '*rusticus'* occur in the Fort McMurray region of northeastern Alberta (dry mixedwood subregion) (Natural Regions Committee 2006), but we consider these records to represent remnant grassland rather than boreal forest populations. This is further discussed in the "Boreal Grasslands" section below.

PRG species intolerant of xeric southern boreal habitats, but occurring to the northern edge of prairie grassland in the Edmonton region, are more isolated from their core range, generally by 350–450 km. Small, localized patches of native grassland persist along the south-facing slopes of the North Saskatchewan River, the Sturgeon River, and the northwest shore of Beaverhill Lake, marking the northern edge of the core range for grassland species such as *Plebejus melissa*, *Oeneis alberta*, *Chlosyne gorgone*, *Pyrgus communis*, and *Sympistis stabilis* (Fig. 6A). Half (25 of 50) of the PRG species that are found in the prairie grasslands of Alberta also occur in the montane grasslands of the Cordillera (Table 2; Fig. 6), but Cordilleran populations are often geographically more distant. North of the Bow River valley, montane grasslands are limited to the large river valleys through the Rocky Mountain front ranges, including the Red Deer River, North Saskatchewan River, and Athabasca River (Natural Regions Committee 2006). Two species require additional comment, since they are currently not significantly isolated from populations outside of the PRG despite being grassland obligates. *Cercyonis pegala* has adapted to using anthropogenic habitats dominated by non-native grasses (presumably because larvae are able to feed on them), including tame pastures, hay fields, and roadside ditches. Consequently, *C. pegala* is now present along major highway corridors and agricultural areas, but is absent in undisturbed boreal habitats. Historically, *C. pegala* was therefore probably disjunct to the same degree as grassland species that occur up to the northern prairie terminus or into the southern boreal forest. Kondla *et al.* (1994) suggested that both native and introduced (agricultural) populations may be present in the PRG, differing in phenotype and habitat preference. No new data are available regarding this interesting situation, but population genetic surveys would be informative. A parallel situation may exist for *Coenonympha tullia*, a native species that appears to have adapted to non-native grassy habitats; it is, however, not currently known from intervening highway corridors. A different scenario exists for *Cercyonis oetus*, which is restricted to the British Columbia portion of the PRG, but with populations in isolated but nearby (<150 km) montane habitats (Guppy and Shepard 2001). The discovery of this species in Alberta's northernmost montane grasslands at Grande Cache (Schmidt *et al.* 2003) and the absence of populations in the eastern PRG and northern terminus of the prairies point to a closer affinity of PRG *C. oetus* with montane rather than with prairie source populations.

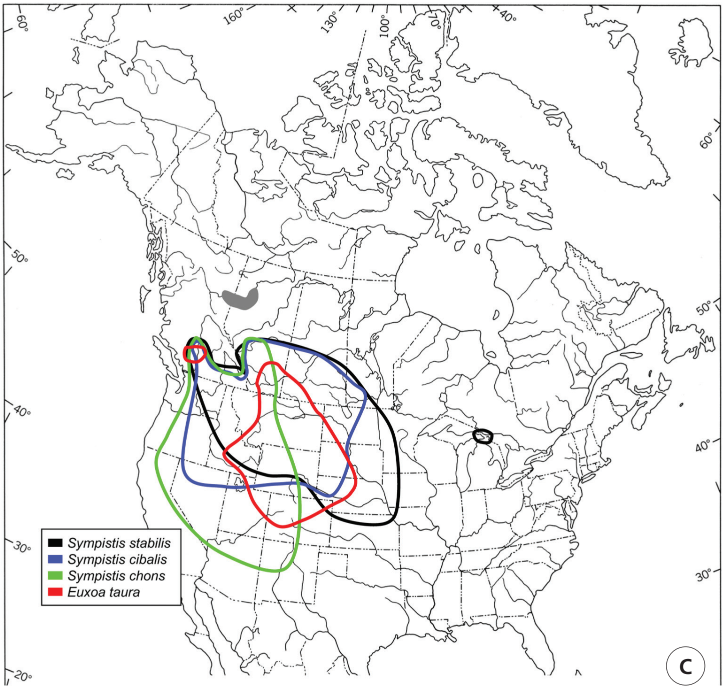
Of the 17 PRG butterflies also found in the prairie region (all but *Chlosyne palla*; Table 2), most reach the northernmost fescue grassland fragments in the Edmonton region (Bird *et al.* 1995; Schmidt *et al.* 2003). From another perspective, virtually all prairie species found north to Edmonton also occur in the PRG, with two exceptions: *Lycaena dione* and *Epargyrus clarus*. *Lycaena dione* is dependent on Dock (*Rumex*) species in prairie wetlands and disturbed sites; it occurs as small localized colonies. Possibly *L. dione* occurred historically in the PRG, but little native habitat remains on flat terrain where prairie wetlands form, since this is desirable agricultural land. The existence of extant, undetected PRG populations of *L. dione* should not be ruled out, particularly since surveys for PRG butterflies have focused on the xeric habitats favoured by PRG endemics. Neither *Epargyrus clarus* nor its larval host (American Licorice, *Glycyrrhiza lepidopta* Pursh) is known from the PRG.



Aspitates abberatus
Protogygia querula
Schinia cumatilis
Scotogramma submarina
Sphinx vashti
A



Tesagrotis atrifrons
Chlosyne palla
Grammia elongata
B



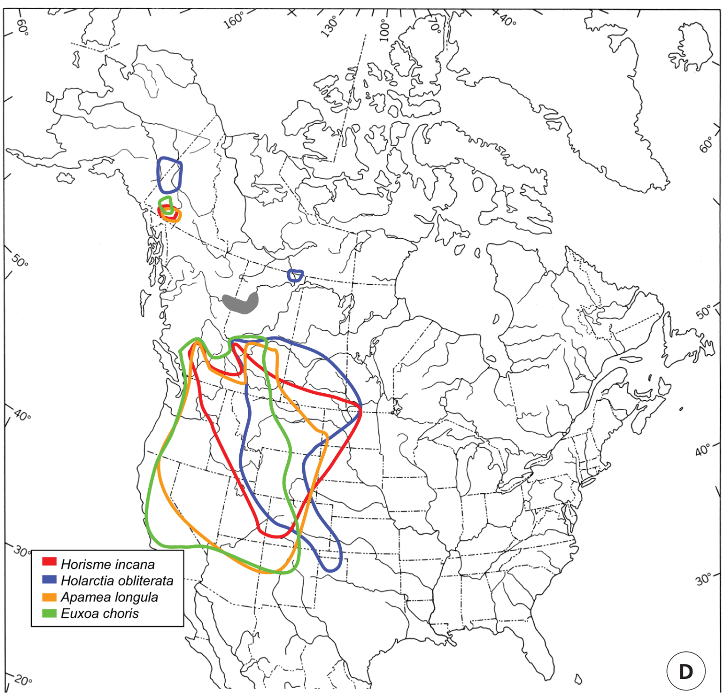


Fig. 6. Global distributions of representative Peace River Grassland (gray) Lepidoptera occurring primarily or entirely in A, the Great Plains; B, the Cordilleran; and C, both the Prairie and Cordilleran floristic regions. D, Those also found in the Beringian region.

Twelve PRG Lepidoptera exhibit remarkably large range disjunctions, separated from the nearest populations by 500 km or more (Table 2). All but one of these species are otherwise restricted to hot, dry habitats, occurring in eroding badlands and southern prairie biomes no farther north than the Battle River and Red Deer River valleys. *Tesagrotis atrifrons* occurs in southern montane grassland, but is absent from the prairie region (Fig. 6B), with the nearest core-range populations 500 km to the southwest in the Columbia Valley of British Columbia. Directed surveys in more northerly montane grasslands (e.g., Fischer *et al.* 2000; Schmidt 2007) may turn up additional populations of montane species such as *T. atrifrons*, but for prairie species requiring hot, arid habitats (xerothermophiles), the absence of this habitat type in the geographically intermediate boreal region makes it extremely unlikely that additional populations will be discovered. The degree of range disjunction is correlated with habitat preference: Xerothermophiles show the most extreme disjunctions. As the climate ameliorated following the maximum extent of grasslands around 6,000 bp, xerothermophiles would have become geographically isolated before non-xerothermophiles. Such a progression of isolation may also have left molecular signatures, a hypothesis that could be tested using a population genetics approach (e.g., Bromilow and Sperling 2011).

The distributions of at least three species, *Euxoa taura* (Fig. 6C), *Anarta inconcinna*, and *Speyeria aphrodite*, are atypical of the main geographical patterns observed for other PRG Lepidoptera (i.e., a core range in the prairies and/or Cordillera). These three species are found in the Great Plains and the PRG, but are also disjunct in central British Columbia grasslands, being absent from most or all of the Pacific Northwest, including southern interior British Columbia. This pattern leads to the question: Could the PRG have been linked to grasslands of the Cariboo-Chilcotin during postglacial grassland expansions, thus acting as a dispersal route for a Great Plains fauna into central British Columbia via the PRG? Certainly this is a plausible scenario that would be a fascinating avenue for phylogeographical research.

As more data on habitat requirements and distribution become available, the status of several PRG species should be assessed. These include *Euxoa intrita*, which also occurs in subalpine grasslands and xeric boreal habitats east to Quebec, and *Euxoa idahoensis*, a western prairie–montane species complex with both subalpine and localized prairie populations. Another possible PRG disjunct is *Hemaris diffinis*. Once thought to be a species widespread throughout Alberta, true *H. diffinis* appears to be a grasslands specialist while populations from mesic boreal habitats have proven to be a separate, cryptic species (Schmidt 2009*a*). Like some other PRG disjuncts, *H. diffinis* relies on *Symphoricarpos* as a larval host.

Another potential complicating factor in assessing population isolation is recent invasions of competing species. *Oarisma garita* provides an interesting example, since this species seems to have become much less common in its historic range in recent years due to a rapid range expansion by *Thymelicus lineola* (Schmidt *et al.* 2003). Now the PRG comprises the only grassland region of Alberta that has not yet been colonized by *T. lineola*, and it will be instructive to see how long it takes for this species to expand its range northward.

Comparison between PRG butterflies and moths reveals that moths exhibit more extreme disjunctions. This could in part be due to sampling artifacts, in that moth distributions are more poorly known, yet many of these patterns are unlikely to change substantially—the Edmonton area is the most intensively sampled in Alberta, and many species such as *Euxoa taura* and *Protogygia querula* have specific habitat requirements (hot, dry erosional habitats that are rare or absent in intervening areas) that would make discovery of intervening populations unlikely. This taxonomic pattern of disjunction is possibly a product of greater habitat exploitation by moths than by butterflies, where larger evolutionary radiations have resulted in moths occupying niches that butterflies do not.

An additional aspect of PRG Lepidoptera that remains poorly studied is the extent to which the isolation of their populations has resulted in diminished genetic variation, as would be expected in isolated island populations. In the only PRG study of its kind to date, Bromilow and Sperling (2011) used a single genetic marker, mitochondrial DNA, to examine genetic variation in five species of butterflies that had PRG populations isolated by at least 300 km from populations of the same species in southern Alberta prairie. This group of five species was compared with another group of five species with parkland habitat affinities that had continuous distributions throughout central Alberta. Bromilow and Sperling (2011) found that single-species divergences varied substantially within both the disjunct and the continuous groups. Taken as a whole, however, the five species with disjunct populations had greater divergence between the PRG and southern Alberta, as well as reduced genetic diversity in the PRG, compared with the five parkland species with continuous distributions. The most pronounced divergences among the PRG disjunct species were found in *Oeneis uhleri*, *Satyrium liparops*, and *S. titus*, while *Papilio machaon* and *Oeneis alberta* had smaller, but still significant, divergences. Of the five parkland species (*Coenonympha tullia*, *Erebia epipsodea*, *Glaucopsyche lygdamus*, *Plebejus saepiolus*, *Papilion canadensis*), only two (*C. tullia* and *E. pepipsodea*) had significant divergences; *C. tullia* arguably in part comprised populations that were isolated in the PRG prior to recent contact with southern populations via expansions of southern populations along road margins. A further interesting finding was that PRG populations of two species, *P. machaon* and *C. tullia*, contained a few specimens with highly diverged mitochondrial haplotypes in the PRG region (Bromilow and Sperling 2011). Considering the extent of variation among species within each of the groups, it is clear that single species and single markers provide only limited insight into the biogeographical histories of the PRG biota, and therefore comparative phylogeographical and genomic approaches are necessary.

Biogeographical Affinities: Where Did the PRG Lepidoptera Come From?

The distribution of western North American grasslands is related to the postglacial history of the region. The PRG was entirely glaciated during the last glacial maximum (White *et al.* 1985, but see Catto *et al.* 1996, who suggest that western parts of the Peace River region were not completely ice covered). The expansion of grasslands in central Alberta during the Hypsithermal is generally thought to have permitted the Great Plains flora to reach the PRG, with subsequent climatic amelioration isolating the PRG through boreal forest expansion (Strong and Hills 2003, 2005). The timing of these events remains uncertain, with estimates of the expansion occurring as late as 6,000 years bp (Strong and Hills 2005), or as early as 10,000–11,000 years bp (Fig. 5) according to Dyke (2005). Furthermore, the maximum extent of Cordilleran xeric and grassland habitats probably did not coincide with that of the central Alberta prairie expansion, as British Columbia was still mostly glaciated during 10,000–11,000 years bp (Fig. 5). If correct, this suggests an early influx of Great Plains fauna into the PRG, followed by a link to British Columbia montane grasslands 1,000–3,000 years later (Fig. 5), as suggested by Dyke (2005).

The current distribution of western North American grasslands indicates several possible scenarios for postglacial source areas of PRG Lepidoptera. The PRG are equidistant from the northernmost prairie grasslands to the southeast and the interior grasslands of central British Columbia to the southwest (Fig. 2). Extensive grasslands throughout central

Alberta during the Hypsithermal (Strong and Hills 2003, 2005) would have provided a continuous band of prairie habitat between southern Alberta and the PRG, and, as for many disjunct PRG plants, a northward expansion of southern prairie Lepidoptera is the simplest and most obvious explanation. By comparison, central British Columbia montane grasslands would be expected to contribute fewer species to the PRG because of the dispersal barrier imposed by the Rocky Mountains. In several areas with low-elevation mountain passes (notably the Peace River canyon where it traverses the Rockies and Pine Pass), development of a montane grassland habitat during the Hypsithermal could have allowed for dispersal of montane species. However, paleovegetation data for this region are limited (Hebda 1995), making it difficult to do more than speculate about these patterns. A third possible source of grassland taxa is the alpine or subalpine region of the adjacent Rocky Mountain ranges. Given the considerable differences in climate conditions between alpine and prairie habitat, this may at first seem unlikely, but the PRG flora shows several notable examples of plants shared with higher elevation sites in the Rockies (*Sedum lanceolatum*, *Pyrrocoma uniflora*, *Festuca altaica*, and *Corallorhiza striata*; Moss 1983; Strong and Hills 2003). Each of these scenarios would leave a particular geographical distribution signature, and phylogeography molecular data would be especially revealing. For example, *Papilio machaon* populations in the PRG show affinities to both the prairie and Beringian regions (Sperling and Harrison 1994; Bromilow and Sperling 2011).

Great Plains

Much as in plants (Strong and Hills 2003), the dominant pattern of PRG disjunct Lepidoptera reflects a Great Plains distribution, providing good evidence that these species reached the PRG during the grassland expansion of the Hypsithermal when suitable habitat would have been continuous throughout central Alberta. Nearly half (21 of 50) of the PRG grassland-associated Lepidoptera have core ranges mostly or entirely restricted to the prairies of the Great Plains (Table 2). Of these 21 species, six also extend into eastern North America and four into the Great Basin region of the Cordillera to the south of British Columbia (Table 2). The remaining 29 species are either (1) broadly western (Prairie, Cordilleran, Yukon); (2) transcontinental; or (3) Cordilleran only. Most (19 of 29) are western species that occur in both prairie and montane habitats of the Great Plains and Cordilleran regions, respectively, but are not found east of the Great Plains; six of these have a Yukon range component (e.g., Fig. 6D). Seven of the 29 species have some part of their range extending east of the Great Plains, with *A. inordinata* and *S. stabilis* (Fig. 6C) being essentially western species with restricted eastern populations. Five transcontinental species, all butterflies, exhibit considerable geographical variation segregated into subspecies, where PRG populations are allied with prairie or Cordilleran taxa (Guppy and Shepard 2001). Three PRG species are otherwise found only in the Cordilleran region (Table 2; Fig. 6B).

The northern limits of the Great Plains grasslands incursion during the Hypsithermal is unknown, but likely extended into the southwestern Northwest Territories, as evidenced by remnant pockets of Great Plains plants (Catling 2009) and endemic grassland butterflies (*O. uhleri nahanni*, *C. tullia mackenziei*), which are absent from the Cordilleran and Beringian regions. Grassland Lepidoptera also persisted as far east as the Fort McMurray area (see “Boreal Grasslands” section below). In the Yukon and northwestern Northwest Territories, *Coenonympha tullia mackenziei* is replaced by the distinctive *C. tullia kodiak*, while *O. uhleri* is replaced by its sister species, *O.* ‘*uhleri*’ *cairnesii* (which has generally been considered to be a subspecies of O. *uhleri*; B.C. Schmidt and J.D. Lafontaine, unpublished data.). *Coenonympha tullia* may be a particularly useful species for phylogeographical studies of graminoid-dependent insects, owing to its broader tolerance of grassland habitats. It is the only PRG disjunct that occurs in the wet saline meadows of the High Level grasslands (treated by Moss 1952 as part of the Peace grasslands); no other PRG obligates are known from these grasslands.

Although the prairie grassland component of the western Canadian Lepidoptera fauna is predominantly Great Plains species, several have broader distributions, expanding into the eastern North American deciduous forest region. Such distributions can be explained by habitat and host plant use, where some species such as *Satyrium liparops* and *S. titus* are dependent on shrubs (*Prunus*, *Amelanchier*), and their potential distribution is governed more by host plant availability in suitable climatic conditions, rather than by grasslands in the strict sense. These species occur in openly wooded biomes in the East. *Speyeria aphrodite* and *S. cybele* are similar in this sense, depending on violets in dry, open places, including wooded habitats. Their absence from the boreal region suggests that only shrubland modified by the warm, dry climate of grasslands is suitable habitat in western Canada. In contrast, *Apamea inordinata* and *Sympistis stabilis* are more directly dependent on grasslands, with an eastern range extension that may be the result of expansion along a finger of suitable parkland habitat that stretched to the Great Lakes and New England region following deglaciation. Subsequent climatic changes have left isolated populations of other prairie species in specialized, local habitats such as alvars and sand hills, best documented in plants (Catling and Brownell 1995) but also in planthoppers (Bouchard *et al.* 2001).

Cordilleran

The PRG has been typified as prairie parkland, and so the presence of Cordilleran flora and fauna is noteworthy. Among the Lepidoptera, at least three examples of species are unequivocally those that are otherwise restricted to mountain habitats: *Chlosyne palla, Tesagrotis atrifrons*, and *Grammia elongata*. The recent discovery of *Grammia elongata* is particularly interesting, since it otherwise occurs in alpine and subalpine meadows—currently the only known PRG insect to do so. A fourth species, *Agrotis vancouverensis*, is a predominantly Cordilleran species, although it occurs also in the southern Alberta prairies and the southwestern corner of Saskatchewan. The possible influence of an alpine fauna on the PRG is also evidenced by the occurrence of alleles from alpine populations of *Papilio machaon* in the PRG endemic *P. machaon pikei* (Bromilow and Sperling 2011). However, more extensive sampling is required before it is possible to evaluate the extent of the contribution to the genome of *P. m. pikei* by *P. m. dodi* McDunnough of the prairie region versus alpine *P. m. aliaska* Scudder.

The source region for PRG species found today in both Cordilleran and prairie grasslands is less obvious, as either (or both) regions could have acted as a source. In some cases, geographical morphological variation provides some clues: PRG *Cercyonis oetus* is similar to the montane phenotype, but distinct from the pale prairie form, suggesting a montane source is more likely. Additional evidence for this scenario is given by the discovery of a *C. oetus* population in the Grande Cache region (Schmidt *et al.* 2003), the nearest montane grasslands to the PRG and possibly linked in the geologically recent past through the Smoky River corridor, which today still exhibits localized south-facing grassy slopes. For other species, such as *Papilio machaon*, either region (or both) could have acted as a source area, and elucidating these patterns will require a multi-locus population genetics approach (Dupuis *et al.* 2012). Other montane animals show disjunct populations in the PRG as well; a striking example is the long-toed salamander (Walsh 1998).

Beringia and Subarctic

No PRG Lepidoptera species have their core range solely in Beringia or the subarctic, although several species do occur in the Beringian region (Fig. 6D). This is somewhat surprising, given that (1) the dominant vegetation of Beringia was thought to be dry tundra or steppe and likely linked to the PRG in postglacial times (Dyke 2005); and (2) Beringian plant species such as *Festuca altaica* are present in the PRG (Porsild and Cody 1980; Moss 1983). Beringian and subarctic plants are also present in alvars of the southwestern Northwest Territories (Catling 2009), a region likely connected to the PRG during the Hypsithermal, as evidenced by prairie plants and butterflies common to both regions. Beringian Lepidoptera occurring in the greater Peace River region are invariably alpine taxa reaching their southern limit along the Rocky Mountains, such as *Boloria alaskensis* (Holland), *Parnassius eversmanni* Ménétriés, and *Papilio machaon aliaska*. Noteworthy are several species with a widely disjunct, bimodal Beringian–southern distribution, evidence of a faunal exchange between Beringia and the Great Plains and Cordilleran regions: *Polites draco* (W. H. Edwards) is a montane grassland skipper found in the southern Yukon and the Alberta front ranges (Layberry *et al.* 1998), but is absent from seemingly suitable habitat in British Columbia and the PRG. Similarly, the following species occur in the Yukon and the prairies and/or southern Cordillera, but have not yet been recorded from the PRG: *Euxoa aequalis* (Harvey) (Lafontaine 1987), *Schinia persimilis* (Grote), and *Speranza decorata* (Hulst) (Schmidt 2004). The presence of species in Beringia and the Great Plains to the exclusion of British Columbia could be explained by a faunal interchange linking the two by a near-continuum of steppe or tundra habitat about 11,000 years bp, during which time British Columbia remained mostly glaciated (Fig. 5A; Dyke 2005). Judging from morphological divergence, two sibling taxa pairs that split between the Great Plains and Beringia exemplify a more ancient, possibly pre-Pleistocene vicariance: *Euxoa taura*–*E. macrodentata* Lafontaine and *Grammia nevadensis*–*G. yukona* Schmidt. Both *Euxoa macrodentata* and *Grammia yukona* are Yukon sister-species to *E. taura* and *G. nevadensis*, respectively (Lafontaine 1987; Schmidt 2009*b*) of the prairie–southern Cordilleran region. A striking plant example is the Beringian occurrence of *Eriogonum flavum* Nutt., a plant otherwise restricted to the Great Plains (Vetter 2000). Such distributions probably indicate a pre-glacial connection that was not (re-)achieved during the Hypsithermal. Although no obvious examples of Beringian Lepidoptera exist in the PRG fauna, the signature of a Beringian influence may be more cryptic, as in the example of *Papilio machaon* discussed earlier.

Alternatively, the lack of Beringian species in the PRG may largely reflect biome differences between the two regions, as Beringia was mostly tundra during the height of glaciation (Dyke 2005 and references therein), and tundra species simply did not adapt and expand into montane or Great Plains grasslands. Yet these species provide compelling evidence that xeric montane grasslands existed in (at least) the southern Yukon prior to the Pleistocene glaciations, followed by regional displacement by glacial advance.

Boreal Grasslands

Several occurrences of grassland Lepidoptera and plants in the boreal region of Alberta require comment, as these sites have largely been overlooked as harbouring remnant-grassland insects. The grasslands west of High Level (Figs. 2 and 3) were treated as part of the PRG by Moss (1952). These sites have subsequently been classified as sedge-dominated alkaline meadows (Vujnovic and Bentz 2001). Subsequent surveying of the butterflies

(DAM, BCS) and preliminary sampling of moths (DAM) suggest that these meadows do not include grassland obligate species, with the exception of *Coenonympha tullia*, which is tolerant of mesic grassland and meadow habitat. No moths have been recorded from this area, but an abundance of *Symphoricarpos albus* (L.) S.F. Blake (Snowberry; Vujnovic and Bentz 2001) could support moths specializing on this plant (Table 2). By comparison, the grassland remnants near Fort Smith, Wood Buffalo National Park, include more xeric plant communities, such as the *Agropyron trachycaulum*-dominated grassland similar to communities found in the PRG (Vujnovic and Bentz 2001 and references therein). Xerophilic moths such as *Euxoa flavicollis*, *Grammia margo*, *Holarctia obliterata* (Fig. 6D), and undoubtedly others occur here as isolated populations. The Fort Smith grasslands were likely part of the regional grassland expansion as far north as the southwestern Northwest Territories, where both prairie plants (Catling 2009) and butterflies such as *Coenonympha tullia* and *Oeneis uhleri* occur. Knowledge of the Lepidoptera fauna in these grassland remnants is fragmentary at best.

Lastly, records of grassland Lepidoptera from the Athabasca–Clearwater River valleys in the Fort McMurray region point to remnants of a grassland fauna. This region has not previously been recognized as harbouring disjunct grassland insects, although the presence of disjunct prairie plants along the Clearwater River east of Fort McMurray was documented by Downing *et al.* (1991). Small grassland patches are associated with the Athabasca and Clearwater rivers, particularly on south- or west-facing aspects and on well-drained sandy or gravelly substrates. Although not recorded in Bird *et al.* (1995), *Cercyonis oetus* occurred at least historically in floodplain or shoreline grassy habitat near the Fort McMurray townsite (G. Ball, pers. comm.; mapped in Layberry *et al.* 1998). *Pyrgus communis* has also been recorded here (Bird *et al.* 1995; Layberry *et al.* 1998), a species dependent on *Sphaeralcea cocinnea* (scarlet globemallow) as a larval host (Table 2). Although this plant is disjunct in the PRG, it has not been recorded from the Fort McMurray region (University of Alberta Vascular Plant Herbarium 2012). *Speyeria aphrodite* also occurs here as a possible disjunct, although its status in intervening dry boreal forest remains unclear, as discussed earlier. Finally, an isolated population of the prairie phenotype of *Agriades glandon* was discovered near Fort MacKay in 2000 (BCS, unpublished data). The presence of these species, all PRG disjuncts (Table 2), appears to be a remnant of a historically more widespread grassland fauna. Basic inventory work of the Lepidoptera of these small, localized boreal grasslands is urgently needed.

Faunal Patterns within the PRG

Grassland Lepidoptera are not homogeneously distributed across the PRG. With the caveat that the moth fauna of the PRG has been inadequately surveyed, preliminary faunal comparisons for better surveyed sites, particularly the butterfly fauna, yield some interesting patterns. The Peace River canyon (and major tributaries) between Fort St. John and Peace River contains the largest intact grasslands and probably also contains the highest diversity of habitat types. Virtually all PRG endemic Lepidoptera occur in this core region (Table 2), consisting of the British Columbia, Bear Canyon, and Peace River sectors shown in Fig. 3. By comparison, the relatively small and highly fragmented grasslands of the Grande Prairie sector notably lack a number of butterfly species, that is, *Speyeria cybele*, *Chlosyne gorgone*, *Pyrgus communis*, and *Satyrium liparops*. Five species are known only from single sites in the Grande Prairie sector: *Oeneis alberta*, *Satyrium titus*, *Plebejus melissa*, and *Papilio machaon pikei* from Kleskun Hills, and *Chlosyne palla* from Smokey Ridge

(Hervieux 2002). A historic site for *Plebejus melissa* in the Beaverlodge area (collected by K. Bowman in the 1920s) is no longer extant, on the basis of field searches by BCS. It is difficult to determine to which extent the lower diversity of the Grande Prairie sector represents habitat loss versus unsuitable native habitat, but both factors are likely involved. The eroding eastern escarpment of the Kleskun Hills appears suitable for several of the xerothermophilic moths found in the Peace Canyon to the north, yet only one such species (*Anarta inconcinna*) has been found there to date. The regionally cooler, moister conditions of the Grande Prairie versus the Peace River sector may be suboptimal for these species. Similarly, climatic and plant community variation may explain the limited occurrence of two Cordilleran species (*Cercyonis oetus* and *Grammia elongata*), which are restricted to the British Columbia sector (Table 2).

The northern extension of the PRG contains progressively fewer grassland endemics than the southern part of the region. Of the 17 butterfly species present in the Peace River sector of the PRG, only six range north to North Star, four to La Crete, and three to Fort Vermilion (Table 2). North of the town of Peace River, the north–south-bearing Peace River Canyon eliminates much of the south-exposed valley slopes that are so dominant along the east–west-tending valley west of town. This topographic effect would limit solar heating and in turn the xeric, hot microhabitats prevalent elsewhere; together with latitudinal climatic changes (e.g., fewer degree days at High Level; Table 1) and less available grassland habitat (Fig. 3), this no doubt limits the range extent of PRG Lepidoptera. Insufficient moth sampling has been conducted outside of the British Columbia, Peace River, and Grande Prairie sectors, but the available data show a trend similar to that of butterflies, with most but not all species in the Peace River sector, considerably fewer for Grande Prairie, and possibly a Western Cordilleran element restricted to the British Columbia sector, as exemplified by *Grammia elongata*.

Larval Host Plants and Distribution of PRG Lepidoptera

To the extent that larval host plants are known for PRG Lepidoptera, a number of species use hosts that are also disjunct in the PRG. Examples include *Chlosyne gorgone* on *Helianthus* (sunflowers), *Pyrgus communis* on *Sphaeralcea coccinea* (scarlet globemallow), and *Anterastria teratophora* on *Monarda fistulosa* L. (wild bergamot) (Table 2). Other potential moth and plant disjuncts include *Perizoma custodiata* likely on *Atriplex* or *Chenopodium* (Goosefoot) and *Sympistis chons* and *S. cibalis* likely on *Penstemon* (Penstemon; Table 2); these three plant genera all include disjunct PRG species (Moss 1983; Strong and Hills 2003), but host plant associations for these moths need confirmation. *Artemisia frigida* is not as markedly disjunct as many of the PRG plants, but occurs as regionally isolated populations in grassland or grassland-like habitats (e.g., montane region and Fort Smith grasslands; Moss 1983). *Schinia cumatilis*, which feeds on *A. frigida* (Hardwick 1996) and possibly other *Artemisia*, appears to be more regionally isolated and rarer than PRG *Artemisia* species (Moss 1983) and is known from only one PRG sector (Table 2). Conversely, some PRG disjunct plants have dependent Lepidoptera in the prairie or Cordilleran region, but are not known from the PRG, such as *Melitara* species on *Opuntia* (prickly pear cactus; Simonsen *et al.* 2009) and *Parnassius smintheus* on *Sedum lanceolatum* (lance-leaved stonecrop; Bird *et al.* 1995).

Other disjunct PRG Lepidoptera rely on plants that do not have a disjunct PRG distribution, growing also in dry boreal habitats. Examples include *Papilio machaon pikei* on *Artemisia dracunculus* L. (wild tarragon), *Satyrium titus* and *S. liparops* on *Prunus*

Table 3. Provincial conservation status ranks of Peace River Grassland (PRG) butterflies. Abbreviations: BC = British Columbia; AB = Alberta; S1 = Critically Imperiled; S2 = Imperiled; S3 = Vulnerable. Dash indicates species unrecorded from PRG of that province. NR indicates that PRG populations are not ranked separately from other provincial populations. Based on data from the British Columbia Conservation Data Centre (http://www.env.gov.bc.ca/cdc) and the Alberta Conservation Information Management System (http://albertaparks.ca/albertaparksca/management-land-use/alberta-conservation-information-management-system-(acims)/tracking-watch-lists.aspx).

Taxon	BC	AB
Hesperia assiniboia	S2	NR
Pyrgus communis	-	NR
Oarisma garita	NR	NR
Papilio machaon pikei	S3	S1S2
Plebejus melissa	-	NR
Agriades glandon lacustris	S3	NR
Lycaena helloides	NR	NR
Satyrium titus	S2	NR
Satyrium liparops	S2	NR
Chlosyne palla	NR	NR
Chlosyne gorgone	-	NR
Speyeria aphrodite	S3	NR
Speyeria cybele	S2	NR
Oeneis alberta	S2	NR
Oeneis uhleri	S3	NR
Cercyonis oetus	NR	-
Cercyonis pegala nephele	S3	NR
Coenonympha tullia benjamini	S3	NR

(cherry), and *Sphinx vashti* and *Sympistis pallidior* on *Symphoricarpos* (snowberry). In these cases, the combination of grassland habitat and host plant availability—not solely host distribution—presumably dictates the species' distribution. The unknown host plants for many of the PRG Lepidoptera highlight the lack of basic natural history knowledge for many of the species found in the PRG, particularly so for moths, but surprisingly even for butterflies. For example, wild sunflowers are suspected to be the only suitable host for *C. gorgone*, but larval diet and habitat requirements remain unsubstantiated. *Speyeria* larvae are specialists on violets, but again, species-specific requirements are unknown—both *Viola adunca* Sm. and *V. canadensis* L. are common in the PRG, but interestingly neither are PRG disjuncts, and the two prairie grassland species (*V. nuttalli* Pursh and *V. petadifida* Don) have not been recorded from the PRG (Moss 1983).

The most frequent host plant group is, perhaps not surprisingly, graminoids, which are used by at least nine species. Although forming the dominant plant cover, most graminoid species are not disjunct in the PRG, occurring also in dry sites of the boreal forest (Moss 1983) and azonal grasslands (small patches of grassland habitat most often forming along steep, south-facing slopes of major river valleys). More specific data are also needed for the graminoid-feeding species; the hosts in the literature are all too often simply recorded as "grasses." There are no doubt species-specific requirements, such as *Hesperia* whose larvae usually require bunch-forming grasses for larval shelters (MacNeill 1964). Clearly, there is a large gap in our knowledge regarding the link between the PRG flora and the dietary requirements of the Lepidoptera dependent on these plants.

No fewer than nine disjunct species depend on woody shrubs for larval host plants (Table 2), underscoring the importance of wide-ranging shrubs such as *Prunus* (cherry), *Amelanchier* (saskatoon), and *Symphoricarpos* (snowberry) as a local determinant of PRG endemics. Prairie thickets are also important determinants of Lepidoptera diversity in the prairie grasslands (Pohl *et al.*; see Chapter 5, this volume).

Research Priorities

The discrepancy in provincial conservation rankings for PRG butterflies (Table 3) highlights an interesting problem: Since no separate subspecies have been formally named for disjunct PRG butterflies (except for *Papilio machaon pikei*), PRG butterflies have not been ranked separately from the core-range populations in Alberta. By comparison, it was possible to designate rankings in British Columbia with existing subspecific names, simply because these subspecies, even as currently defined, occur nowhere else in British Columbia. This highlights the need for critical taxonomic comparison of the PRG butterfly fauna. A number of the PRG butterflies are known or expected to be subspecies endemic to the PRG (Kondla *et al*. 1994; Bromilow and Sperling 2011).

One butterfly species in urgent need of conservation status assessment and additional survey effort has unfortunately also "flown under the radar": As pointed out by Macaulay (2009), the Gorgone Checkerspot (*Chlosyne gorgone*) is the rarest of the PRG disjuncts and known from only a single extant site (and one additional historic site nearby). Recent butterfly surveys (Hervieux 2002; Macaulay 2009) have failed to locate additional colonies. *Chlosyne gorgone* was historically present as far north as the Edmonton area, but it has not been recorded there since 1915, although it is still occasionally common in the southern grasslands of the Prairie Provinces. Similarly, surveys should be conducted for other target species of concern, such as *Lycaena helloides*, *Speyeria cybele*, and *S. aphrodite*, to establish the extent of isolation of the PRG populations. Some surprising gaps (whether real or perceived) still exist, such as the absence of *S. cybele* records from the Grande Prairie region. Even for well-known groups such as butterflies, basic natural history data are still scant: Specific larval host plant, nectar source, and microhabitat requirements are incompletely known for many species.

As demonstrated here, the moth fauna can provide important insights into insect biogeography by virtue of their species- and food-plant diversity. Our knowledge of grasslands Lepidoptera still has much to gain through expanding surveys to poorly known groups such as the microlepidoptera and to undersampled areas such as the boreal grassland remnants discussed earlier. The moth fauna of the Bulkley River basin, the northern-most interior grassland of British Columbia (Haeussler 1998), remains completely unknown and could shed light on the Cordilleran–PRG faunal connection.

Lastly, PRG Lepidoptera provide an excellent model system to examine further the effects of geography and postglacial history on population genetics. Particularly desirable are genetic surveys of the extent to which (1) the PRG fauna is genetically depauperate (e.g., low allelic variation) relative to source populations; and (2) composed of genetic mixtures from more than one source population.

Conclusions

The disjunct Lepidoptera fauna of the PRG is dominated by Great Plains–prairie species, but the uniqueness of the PRG is highlighted by the juxtaposition of species that are otherwise found only in remarkably dissimilar biomes: cool, dry montane (and even alpine) grasslands and hot, arid prairie badlands. Such a unique faunal assemblage occurs nowhere else in Canada and will reveal many insights into the surprisingly complex signature that postglacial vegetation changes have left on the flora and fauna of western Canada.

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References

Baker, A. 2005. A Synthesis of 2001–2004. Peace Native Grasslands Program. Technical Report (T-2004-002) produced by the Alberta Conservation Association, Peace River, Alberta.

Bird, C.D., Hilchie, G.J., Kondla, N.G., Pike, E.M., and Sperling, F.A.H. 1995. Alberta Butterflies. The Provincial Museum of Alberta, Occasional Publications, Edmonton, Alberta.

Bouchard, P., Goulet, H., and Wheeler, T.A. 2001. Diversity and conservation status of prairie endemic Auchenorrhyncha (Homoptera) in alvars of the Great Lakes region. Proceedings of the Entomological Society of Ontario, **129**: 19–29.

Bowman, K. 1951. An annotated list of the Lepidoptera of Alberta. Canadian Journal of Zoology, **29**: 121–165.

Bromilow, S.M., and Sperling, F.A.H. 2011. Phylogeographic signal variation in mitochondrial DNA among geographically isolated grassland butterflies. Journal of Biogeography, **38**: 299–310.

Case, J.W., and Bird, C.D. 1977. Butterflies and skippers of west-central Alberta. Blue Jay, **35**: 208–219.

Catling, P.M. 2009. Composition, phytogeography, and relict status of the vascular flora of alvars and cliff tops southwest of Great Slave Lake, Northwest Territories, Canada. Rhodora, **111**: 189–208.

Catling, P.M., and Brownell, V.R. 1995. A review of the alvars of the Great Lakes region: distribution, floristic composition, phytogeography, and protection. Canadian Field-Naturalist, **109**: 143–171.

Catto, N., Liverman, D.G.E., Bobrowsky, P.T., and Rutter, N. 1996. Laurentide, cordilleran, and montane glaciation in the western Peace River-Grande Prairie region, Alberta and British Columbia, Canada. Quaternary International, **32**: 21–32.

Downing, D.J., Bayer, R.J., and Vitt, D.H. 1991. Rare and disjunct plants from Whitemud Falls Ecological Reserve, northeastern Alberta. Canadian Field-Naturalist, **105**: 376–381.

Dupuis, J.R., Roe, A.D., and Sperling, F.A.H. 2012. Multi-locus species delimitation in closely related animals and fungi: one marker is not enough. Molecular Ecology, **21**: 4422–4436.

Dyke, A.S. 2005. Late quaternary vegetation history of northern North America based on pollen, macrofossil, and faunal remains. Géographie physique et quaternaire, **59**: 211–262.

Fischer, A.I., Shepard, J.H., and Guppy, C.S. 2000. Macrolepidoptera Inventory of the Chilcotin District. Available from http://www.env.gov.bc.ca/cariboo/env_stewardship/wildlife/inventory/butfly/mothinv.pdf [accessed 8 June 2012].

GCCBC (Grasslands Conservation Council of British Columbia). 2004. BC Grasslands Mapping Project: A Conservation Risk Assessment—Final Report. Available from http://www.bcgrasslands.org [accessed 12 June 2012].

Gompert, Z., Lucas, L.K., Fordyce, J.A., Forister, M.L., and Nice, C.C. 2010. Secondary contact between *Plebejus idas* and *L. melissa* in the Rocky Mountains: extensive admixture and a patchy hybrid zone. Molecular Ecology, **19**: 3171–3192.

Guppy C.S., and Shepard, J.H. 2001. Butterflies of British Columbia. University of British Columbia Press, Vancouver.

Haeussler, S. 1998. Rare and Endangered Plant Communities of the Southeastern Skeena Region. Prepared for BC Environment and Habitat Conservation Trust Fund, Smithers, British Columbia.

Hardwick, D.F. 1996. A Monograph of the North American Heliothentinae. D. F. Hardwick, Ottawa, Ontario.
Hebda, R.J. 1995. British Columbia vegetation and climate history with focus on 6ka BP. Géographie physique et quaternaire, **49**: 55–79.
Hervieux, M. 2002. Survey of Native Grassland Butterflies in the Peace Parkland Region of Northwestern Alberta—2001. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 47.
Jones, J.F. 1966. Geology and Groundwater Resources of the Peace River District, Northwestern Alberta. Research Council of Alberta Bulletin 16.
Kondla, N.G. 1992. An update on the butterflies of the Redwater sand dunes. Alberta Naturalist, **22**: 10–17.
Kondla, N.G., Pike, E.M., and Sperling, F.A.H. 1994. Butterflies of the Peace River region of Alberta and British Columbia. Blue Jay, **52**: 71–89.
Lafontaine, J.D. 1987. Noctuoidea, Noctuidae (part), Noctuinae (Part –*Euxoa*). Fascicle 27.2. *In* The Moths of America North of Mexico. *Edited by* R.B. Dominick, D.C. Ferguson, J.G. Franclemont, R.W. Hodges, and E.G. Munroe. The Wedge Entomological Research Foundation, Washington, D.C.
Lafontaine, J.D., and Schmidt, B.C. 2011. Additions and corrections to the check list of the Noctuoidea (Insecta, Lepidoptera) of North America north of Mexico. ZooKeys, **149**: 145–161.
Layberry, R.A., Hall, P.W., and Lafontaine, J.D. 1998. The Butterflies of Canada. NRC Research Press, Canada Institute for Scientific and Technical Information, in association with University of Toronto Press, Toronto, Ontario.
Llewellyn-Jones, J.R.J. 1951. An annotated check list of the macrolepidoptera of British Columbia. Entomological Society of British Columbia. Occasional Paper No. 1.
Macaulay, D. 2006. Survey of the Lepidoptera Fauna from the Holmes Crossing Ecological Reserve, the Fort Assiniboine Sandhills Wildland Park, and Nearby Areas. Report prepared for the Alberta Lepidopterists' Guild, Edmonton, Alberta. Available from http://www.biology.ualberta.ca/old_site/uasm//alg/downloads/HolmesLepReport06DEC06.pdf [accessed 9 December 2011].
Macaulay, D. 2009. Lepidoptera Survey of the Peace River Parkland Subregion in Northwestern Alberta. Report prepared for the Alberta Lepidopterists' Guild, Edmonton, Alberta.
MacNeill, C.D. 1964. The skippers of the genus *Hesperia* in western North America with special reference to California (Lepidoptera: Hesperiidae). University of California Publications in Entomology, **35**: 1–230.
Miller, W.E. 2011. Temperature-dependent development in capital-breeding Lepidoptera. Journal of the Lepidopterists' Society, **65**: 227–248.
Moss, E.H. 1952. Grassland of the Peace River region, western Canada. Canadian Journal of Botany, **30**: 98–124.
Moss, E.H. 1983. Flora of Alberta: A Manual of Flowering Plants, Conifers, Ferns and Fern Allies Found Growing Without Cultivation in the Province of Alberta, Canada, 2nd edition, revised by J.G. Packer. University of Toronto Press, Toronto, Ontario.
Natural Regions Committee. 2006. Natural Regions and Subregions of Alberta. *Compiled by* D.J. Downing and W.W. Pettapiece. Alberta Natural Heritage Information Centre, Edmonton, Alberta, Government of Alberta Publication No. T/852. Available from http://www.tpr.alberta.ca/parks/heritageinfocentre/docs/NRSRcomplete%20May_06.pdf [accessed 31 May 2012].
Pohl, G.R., Anweiler,G.G., Schmidt, B.C., and Kondla, N.G. 2010. An annotated list of the Lepidoptera of Alberta, Canada. ZooKeys, **38**: 1–549.
Porsild, A.E., and Cody, W.J. 1980. Vascular Plants of Continental Northwest Territories. National Museums of Canada, Ottawa, Ontario.
Raup, H.M. 1934. Phytogeographic Studies in the Peace and Upper Liard River Regions, Canada. Arnold Arboretum, Harvard University, Jamaica Plain, Massachusetts. Contribution VI.
Schmidt, B.C. 2004. Moth Survey for Southwestern Yukon. Unpublished report prepared for the Department of Environment, Government of Yukon.
Schmidt, B.C. 2007. 2006 Survey of Montane Macro-Moths. Summary Report for Jasper & Waterton National Parks and Kootenay Plains Ecological Reserve, Alberta. Unpublished report prepared for the Alberta Lepidopterists' Guild. Available from http://www.biology.ualberta.ca/uasm/alg/downloads/Schmidt_2006_Montane_Survey_BCS_23Nov07.pdf
Schmidt, B.C. 2009*a*. *Hemaris thetis* (Boisduval, 1855) (Sphingidae) is a distinct species. Journal of the Lepidopterists' Society, **63**: 100–109.
Schmidt, B.C. 2009*b*. Taxonomic revision of the genus *Grammia* Rambur (Lepidoptera: Noctuidae: Arctiinae). Zoological Journal of the Linnean Society, **496**: 507–597.
Schmidt, B.C., Macaulay, D., Kondla, N., Lawrie, D., and Anweiler, G. 2003. Additional butterfly records from Alberta, 1999–2002. Blue Jay, **61**: 110–124.

Scudder, G.G.E. 1993. Geographic distribution and biogeography of representative species of xeric grassland-adapted Nearctic Lygaeidae in western North America (Insecta: Heteroptera). Memoirs of the Entomological Society of Canada, **165**: 75–113.

Shepard, J.H. 1999. Final Report for the 1997 and 1999 Survey of Macrolepidoptera of the Peace River Canyon. Unpublished report prepared for BC Ministry of Environment, Lands and Parks, Environment Branch, Fort St. John, British Columbia.

Shorthouse, J.D., and Larson, D.J. 2010. Grasslands and grassland arthropods of Canada. *In* Arthropods of Canadian Grasslands, Vol. 1: Ecology and Interactions in Grasslands Habitats. *Edited by* J.D. Shorthouse and K.D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 1–24.

Simonsen, T.J., Dombroskie, J.J., and Pohl, G.R. 2009. *Melitara* Walker (Lepidoptera: Pyralidae) in western Canada: the documentation of *M. subumbrella* (Dyar) in the Prairie provinces demonstrates the value of regional collections and species lists. Journal of the Lepidopterists' Society, **63**: 31–36.

Sperling, F.A.H. 1987. Evolution of the *Papilio machaon* species group in western Canada. Quaestiones Entomologicae, **23**: 198–315.

Sperling, F.A.H., and Harrison, R.G. 1994. Mitochondrial DNA variation within and between species of the *Papilio machaon* species group. Evolution, **47**: 408–422.

Stone, C., Willoughby, M., and Rosendal, A. 2007. Guide to Range Plant Community Types and Carrying Capacity for the Peace River Parkland Subregion of Alberta. Sustainable Resource Development, Agriculture and Agri-Food Canada. Publication No. T/143.

Strong, W.L., and Hills, L.V. 2003. Post-hypsithermal plant disjunctions in western Alberta, Canada. Journal of Biogeography, **30**: 419–430.

Strong, W.L., and Hills, L.V. 2005. Late-glacial and Holocene palaeovegetation zonal reconstruction for central and north-central North America. Journal of Biogeography, **32**: 1043–1062.

Takhtajan, A., and Crovello, T.J. 1986. Floristic Regions of the World. University of California Press, Berkeley.

University of Alberta Vascular Plant Herbarium. 2012. Online database. Available from http://vascularplant.museums.ualberta.ca/index.aspx [accessed 10 October 2012].

Vetter, M.A. 2000. Grasslands of the Aishihik-Sekulmun Lakes Area, Yukon Territory, Canada. Arctic, **53**: 165–173.

Vujnovic, K., and Bentz, J. 2001. Preliminary Classification of Native Wheat Grass (*Agropyron* spp.) Community Types in Alberta. Report prepared for Alberta Natural Heritage Information Centre, Alberta Environment, by Geowest Environmental Consultants Ltd., Edmonton, Alberta.

Wallis, C.A. 1982. An overview of the mixed grassland of North America. *In* Grassland Ecology and Classification. *Edited by* A.C. Nicholson, A. Mclean, and T.E. Baker. Symposium Proceedings, BC Ministry of Forests, Victoria, British Columbia. pp. 195–208.

Walsh, R. 1998. An extension of the known range of the long-toed salamander, *Ambystoma macrodactylum*, in Alberta. Canadian Field-Naturalist, **112**: 331–333.

White, J.M., Mathewes, R.W., and Mathews, W.H. 1985. Late Pleistocene chronology and environment of the "Ice free corridor" of northwestern Alberta. Quaternary Research, **24**: 173–186.

Wilkinson, K., and Johnson, E.A. 1983. Distribution of prairies and solonetzic soils in the Peace River District, Alberta. Canadian Journal of Botany, **61**: 1851–1860.

Chapter 7
The Robber Flies (Diptera: Asilidae) of Western Canadian Grasslands

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Abstract: Robber flies (Asilidae) are predatory Diptera that kill other insects with paralyzing saliva injected through the proboscis. Over 7,000 species of the family are described worldwide and, although there is no list of species, well over 200 are reported in Canada. The present analysis indicates that grasslands and grassland–forest interface areas in western Canada (Yukon and British Columbia east to Manitoba) support 134 species of robber flies, and more remain to be recorded. A checklist and a systematic overview of these species are presented. The geographical scope of the Canadian grassland fauna is described briefly with respect to the grasslands of the Cordillera and the Great Plains. The species' geographical ranges are defined and summarized. Of the 134 grassland species, seven are boreal (including two with Holarctic ranges), three are East Beringian, one is Palearctic–East Beringian, four are transition, 66 are Cordilleran, five are Pacific coastal, eight are western, 23 are Great Plains, four are southern, 10 are eastern, and three are widespread species, according to the definitions given here. A summary of studies on grassland Asilidae is provided, as well as recommendations for inventory and taxonomic research.

Résumé. Les asilides (Asilidae) sont des diptères prédateurs qui tuent d'autres insectes en leur injectant une salive paralysante à l'aide de leur trompe. Plus de 7 000 espèces de cette famille ont été décrites à travers le monde, et le nombre d'espèces présentes au Canada est de loin supérieur à 200, bien qu'on n'en ait pas encore établi la liste. La présente analyse indique que les habitats des prairies et de l'interface prairie–forêt de l'ouest du Canada (Yukon et Colombie-Britannique, jusqu'au Manitoba vers l'est) abritent 134 espèces d'asilides, et qu'il pourrait y en avoir plus. Ce chapitre présente une liste et un aperçu de la systématique de ces espèces. La portée géographique de la faune de la prairie canadienne est brièvement décrite en ce qui a trait aux habitats des prairies qui se trouvent dans la Cordillère et dans les Grandes Plaines. Les aires de répartition géographiques des espèces sont définies et brièvement décrites. Sept des 134 espèces répertoriées dans les prairies sont boréales (y compris deux à aire de répartition holarctique), trois sont de la Béringie orientale, une vient de la zone paléarctique–Béringie orientale, quatre sont des espèces de transition, 66 sont de la Cordillère, cinq sont de la côte du Pacifique, huit sont occidentales, 23 viennent des Grandes Plaines, quatre sont méridionales, 10 sont orientales et trois sont largement réparties, selon les définitions utilisées dans ce chapitre. Le chapitre présente un résumé des études réalisées sur les Asilidae, ainsi que des recommandations concernant les travaux d'inventaire et les études taxonomiques à réaliser.

Introduction

The Asilidae contain over 7,000 described species worldwide (Geller-Grimm 2013). More than 200 species are reported in Canada (McAlpine 1979), although this number is out of date; no list exists, and the true number is certainly considerably higher. The Asilidae are predominantly a group of warm regions and are especially diverse in open arid and semi-arid environments. Grasslands are good places to find a wide range of genera and species, and probably more than half of the Canadian fauna is known from western grasslands.

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Knowledge of the Canadian fauna as a whole is only fair, and any attempt to put the fauna of Canadian grasslands into perspective must be preliminary. Collections are full of unidentified and inaccurately identified specimens.

The world genera of Asilidae are examined by Hull (1962), and the North American genera are keyed by Wood (1981), although these treatments are out of date. Wood (1981) gives a summary of the morphology, biology, and classification of the North American fauna, and Fisher (2009) updates this with an excellent overview of the family, with special reference to Central America. A comprehensive website devoted to the Asilidae (Geller-Grimm 2013) covers topics from morphology and identification to behaviour and phylogenetics, and includes a worldwide catalogue.

The higher classification of the family is still in some turmoil and additional comprehensive phylogenetic studies are required to clarify understanding of the relationships of taxa at all levels. The scheme of Papavero (1973) and Artigas and Papavero (1988) for the New World fauna was adopted tentatively by Fisher and Wilcox in their Nearctic catalogue of the family (1997), and Fisher (2009) used a modified version of the Papavero classification in his major work on the Central American asilids. Dikow's (2009*a*, 2009*b*) phylogenetically based family classification was an ambitious and welcome attempt to inject scientific rigor and stability into the classification; the new work answered some old questions but also presented new ones. Fisher (2012) wrote a summary of his view of the problems and concluded by stating that some version of the Papavero classification is, for the time being, still preferable to any other. He recommended using the subfamilies found in Fisher and Wilcox (1997) without recognizing any tribes. I follow his suggestion in this chapter.

Although the oldest unambiguous asilid fossil is from the Lower Cretaceous of Brazil (97.5–144 million years before present (mbp)) (Grimaldi 1990), robber flies do not appear in the fossil record in western North America until the Late Early to the Late Middle Eocene, 52–47 mbp (Green River shales of the Utah Eocene) (Wilson 1978). The Florissant shales of Colorado (Oligocene, 23.7–36.6 mbp) contain a variety of genera living in Canadian grasslands today, including *Leptogaster* (Leptogastrinae); *Cophura, Lestomyia*, and *Nicocles* (Dasypogoninae); *Dioctria* and *Holopogon* (Stenopogoninae); and *Machimus* (Asilinae). The Florissant fossil site was subtropical savanna woodland (Cronquist 1978).

Biology

Asilids are predatory flies that as adults pursue other insects (usually flying ones), seize them, and kill them with paralyzing saliva injected through the hypopharynx. The liquified contents of the prey are then sucked up through the proboscis (Wood 1981). The morphology of the adult fly (especially the prominent eyes separated by a cleft, the mouthparts, and the raptorial legs) reflects this mode of prey capture and feeding.

In temperate climates, robber flies usually hunt in open areas where there is plenty of light, and they are most active in the warmest parts of the day (Cannings 2002). Overcast skies greatly curtail their activity. Different genera, and often different species within a genus, have different hunting behaviours and preferences for perching sites (Fisher 2009).

There is usually little obvious difference between the sexes, except for the terminalia (the morphology of which is sometimes striking, as in *Efferia*), although females tend to be larger than males and often have broader abdomens. Colour patterns sometimes differ between males and females; this is particularly evident in some Canadian grassland species such as *Cyrtopogon bimaculus,* where the male's wings are prominently spotted and those of the female are not. Other secondary sexual characteristics occur in males; some that are displayed in grassland species include the expanded silver abdominal apex in *Nicocles*, the striking white abdomens of *Efferia*, and the tarsal ornamentation of some *Cyrtopogon* species, especially *C. willistoni*. Males of these latter species signal with their decorated legs during mating displays.

Records of prey taken by Asilidae indicate that they are usually opportunistic predators, feeding upon any insect that they can subdue and kill. However, some species show a strong preference for prey from one or two insect orders (Wood 1981). In many instances, this may simply reflect the availability of prey in the habitat where the particular robber fly lives.

Detailed life history studies of robber flies are rare. In a study on Asilidae in Sweden, Melin (1923) showed that in northern species, at least, the larva is the overwintering stage and the pupal stage lasts two to six weeks. He estimated that the life cycle of *Laphria* species was at least three years and that of *Lasiopogon cinctus* (Fabricius) was at least two. Both genera are found in Canadian grasslands, although *Laphria* is predominantly a forest group. Larval growth is likely faster in warmer regions and many species probably live only one year (Theodor 1980).

Robber fly larvae are predators of the larvae and pupae of other insects in the soil or in rotting wood, although in a few species studied, the immature larvae are ectoparasitic on their hosts (Wood 1981). Knutson (1972) and Dennis *et al.* (2013) reviewed the literature on the biology of immatures, and Dennis *et al.* (2008) documented the diversity of Nearctic robber fly pupal cases. Dennis and Barnes (2013) described the pupal case of *Machimus occidentalis*, an important Cordilleran grassland species.

Summary of Taxonomic and Biodiversity Studies in the Region

General Faunal Treatments and Annotated Lists

The standard catalogue of North American Asilidae (Martin and Wilcox 1965) is significantly outdated but still useful. More modern treatments are Fisher and Wilcox (1997) and Geller-Grimm and Artigas (2004), although the latter contains some unfortunate innovations, such as the creation of new *Efferia* genera based on Wilcox's (1966) species groups. The basic work on Canadian Asilidae is Wood (1981), which outlines morphology and keys the genera of the North American fauna. The list of genera is out of date. Although the family's biology is summarized, there is no specific grassland context to the work. No list of species for Canada as a whole has yet been published. The most significant treatments of provincial or territorial faunas are for Yukon (Cannings 1997) and Alberta (Adisoemarto 1967), but the latter needs revision. There is an up-to-date annotated list for British Columbia (Cannings 2012), but not for any other province. Cannings (1994) added species names to the known fauna of Canada as a whole, as well as to that of British Columbia, Yukon, and the Northwest Territories.

Taxonomy at the genus level is often inadequate for species identification. The diverse and complex genera in the Asilini, for example, are major components of the grassland fauna, but species keys and descriptions are out of date. Few attempts have been made to revise this group (e.g., Martin 1975); therefore, the early treatments such as that by Hine (1909) remain useful.

However, some studies are essential to the inventory of Canadian grassland Asilidae. Revisions of large genera such as *Cyrtopogon* (Wilcox and Martin 1936), *Dioctria* and related genera (Adisoemarto and Wood 1975), *Efferia* (Wilcox 1966), *Lasiopogon*

(Cole and Wilcox 1938; Cannings 2002), *Machimus* (Martin 1975), and *Stenopogon* and *Scleropogon* (Wilcox 1971) included grassland species in Canada. The various taxonomic works of Curran, for example, on *Cyrtopogon* and *Eucyrtopogon* (Curran 1923), and other descriptions of new species (e.g., *Promachus dimidiatus* and *Laphystia canadensis*; Curran 1927) are also relevant. Treatments of other genera vary widely in their usefulness.

Studies of Particular Areas or Sites

Few published studies have examined the asilid fauna of particular areas or grassland sites. In British Columbia, Foxlee's intensive collecting around Robson in the Columbia Valley of the West Kootenay resulted in specimens (a few are reported in Foxlee 1942) that are still the main source of information for that region. Although the Robson area is mostly dry coniferous forest, the area is transitional with grasslands. Most of the species Foxlee recorded are forest species, but some, such as *Machimus callidus*, *Cyrtopogon montanus*, *C. banksi*, and *Laphria gilva*, are grassland–forest interface species. Others, including *Machimus occidentalis* and *Stenopogon inquinatus,* also are common grassland species. Cannings (1989) published an account of the species from a mesic *Festuca* grassland in the southern Okanagan Valley. Norman Criddle's collections of robber flies from Aweme, Manitoba, in the early 1900s (mostly in the Canadian National Collection of Insects) remain the basis of our understanding of the southern Manitoba fauna.

Conservation Studies

General inventories or conservation-motivated collecting in rare habitats (e.g., Cannings 1989, 2011*a*) have improved knowledge of the status of rare asilid species, but few species have been targeted for conservation study. It should be noted that in Ontario (outside the scope of this chapter), several robber fly surveys have been undertaken in threatened tallgrass prairie ecosystems (Skevington 1999; Skevington *et al*. 2000; Paiero *et al*. 2008, 2010). Nationally, species of various groups have been given a general conservation rank (Wild Species 2005, 2010), but the Asilidae have yet to be examined. Provincial and territorial jurisdictions have also not assessed or ranked robber flies. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has commissioned status reports on only one asilid, *Efferia okanagana*, a grassland species from the southern interior of British Columbia. It is assessed as "Endangered" (Cannings 2011*a*; COSEWIC 2012).

Other Studies

Other specific studies dealing with taxonomy, morphological variation, distribution, life histories, and other aspects of asilid biology in Canadian grasslands are cited under the relevant genus or species in the systematic treatment below.

Research Priorities

Little significant directed inventory of robber flies has been undertaken in Canadian grasslands. Knowledge of the distribution and status of the species on the list in Table 1 has come mostly from sporadic collecting over many years and analysis of specimens in the following insect collections: Royal BC Museum, Victoria; Spencer Entomological Collection, Beaty Biodiversity Museum, University of British Columbia, Vancouver; Strickland Museum, University of Alberta, Edmonton; Royal Alberta Museum, Edmonton; Biological Sciences Collection, University of Calgary, Calgary; Royal Saskatchewan Museum, Regina; the Wallis-Roughley Museum, University of Manitoba, Winnipeg; University of Guelph Collection, Guelph; Royal Ontario Museum, Toronto, and especially the Canadian National Collection of Insects, Agriculture and Agri-Food Canada, Ottawa. Increased inventory efforts would especially improve our knowledge of the species that probably range widely across grassland regions, but are known from few localities. A detailed examination of some of the genera in grassland–forest transition areas, such as *Cyrtopogon*, *Holopogon*, and *Laphria*, will result in a better understanding of species requirements and distributions in these habitats.

Unfortunately, despite considerable effort, many asilid specimens in Canadian collections remain unidentified or inaccurately identified because of a lack of expertise, time, modern generic revisions, and useful identification keys. Systematic work is required to clarify the identity and evolutionary relationships of species in a number of genera. *Leptogaster, Lestomyia, Eucyrtopogon, Machimus*, and other genera require revision. There are undescribed species in these genera and many specimens cannot be identified to species.

More studies are required to better define occurrence and abundance for almost all species of asilids in grasslands. This is especially true in parts of the Prairies Ecozone where some areas (southern Saskatchewan, in particular) have been poorly collected. Detailed, annotated site lists developed over several years would be extremely valuable in all regions. With potential climate warming, baseline data on distribution and habitat (including detailed soil and vegetational characteristics) are of the utmost value, and continuous monitoring of sites, especially in areas of transition between grassland and forest, would be useful in detecting any changes in species composition and abundance of asilid populations. Studies examining the effects of disturbance and habitat change on species are needed. No work has been undertaken that examines the effects of human activity on grassland robber flies, such as overgrazing and fire, increases in soil temperature, and infestations of alien plants. Our knowledge of the habitat requirements of most species is non-existent and more autecological studies would be helpful.

Climate change may significantly affect present asilid distributions if grasslands increase in extent and forest types shift in altitude and coverage. Hebda (1982, 1995) revealed that grassland-steppe vegetation was much more prevalent in the southern part of the Montane Cordilleran Ecozone (containing most grasslands in British Columbia) during warmer climatic regimes in the early to mid-Holocene than it is today. Arid grassland asilids such as *Lasiopogon albidus* Cole and Wilcox and *L. chaetosus* Cole and Wilcox, which now range as far north as the Columbia Basin in Washington State, might enter some of the valleys of southern British Columbia if dry habitats proliferate.

Monitoring of conservation status is also a priority as habitats and climate fluctuate in character. Even when species have already been assessed (such as *Efferia okanagana*, noted above), COSEWIC and provincial agencies require regular updates; therefore, more status reports will likely be required as drying habitats affect populations of rare species.

Overview of the Asilidae of Western Canadian Grasslands

Grassland Habitats and Robber Fly Communities

The correlation of robber fly distribution and habitat requirements with detailed schemes of grassland vegetation or soil classification is largely lacking in western Canada or elsewhere, except for the general association of species with particular sites or areas. Cannings (2011*a*) is a rare example of a study that links the presence of a robber fly species (*Efferia okanagana*) to particular vegetational and soil characteristics in the Thompson-Okanagan region of southern British Columbia.

Some complexities of robber fly communities in grasslands can be illustrated by a brief summary of a few grassland types in southern interior British Columbia and some asilid species associated with them. The dry intermountain grasslands or steppes are dominated by various bunchgrass species and occur in three biogeoclimatic zones (Bunchgrass, Ponderosa Pine, and Interior Douglas-fir zones) (Meidinger and Pojar 1991; Cannings and Cannings 1996; BC Ministry of Forests and Range 2013). Lower elevation grasslands, below about 500 m, are characterized by an arid community of plants dominated by bluebunch wheat grass, *Pseudoroegneria spicata* (Pursh) A. Löve, and big sagebrush, *Artemisia tridentata* Nutt. In sandy soils in the south Okanagan and southern Rocky Mountain Trench, antelope brush (*Purshia tridentata* (Pursh) DC.) may replace sagebrush as a shrub. Middle grasslands on north-facing slopes in the main valleys and in areas such as the Nicola Valley generally lack sagebrush. Sandberg bluegrass (*Poa secunda* J. Presl)

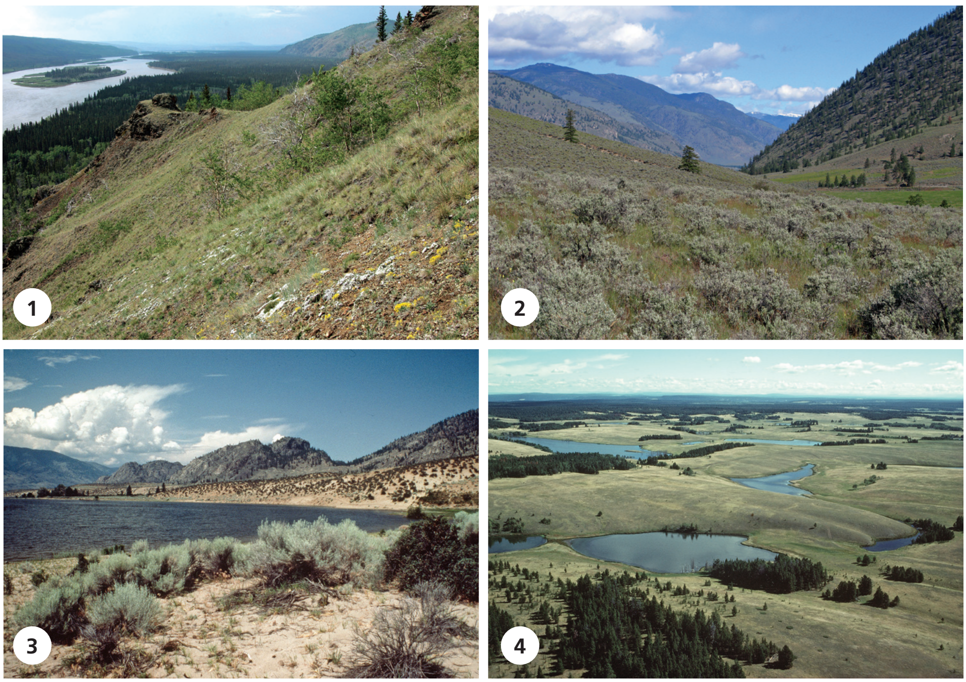

Figure 1. South-facing grassland slopes along the Yukon River, downstream of Minto Bluff, Yukon. The dominant grass is *Calamagrostis purpurascens*. Robber flies frequenting this habitat include *Lasiopogon canus*, *L. hinei*, *L. prima*, *L. yukonensis*, *Cyrtopogon bimaculus*, and *Rhadiurgus variabilis*. Photograph courtesy of Syd Cannings. **Figure 2.** *Artemisia tridentata* (Big Sagebrush) steppe at Chopaka, British Columbia. View north up Similkameen Valley towards Keremeos. Typical robber flies in this habitat are *Stenopogon inquinatus*, *Scleropogon neglectus*, *Efferia benedicti*, *E. harveyi*, and *Machimus occidentalis*. Photograph by Rob Cannings. **Figure 3.** Sandy grassland on east shore of Osoyoos Lake, southern Okanagan Valley, British Columbia. Pale blue shrubs in foreground are Big Sagebrush (*Artemisia tridentata*); dark shrubs in middle distance are Antelope-brush (*Purshia tridentata*). *Efferia albibarbis*, *Proctacanthus occidentalis*, and *Stichopogon fragilis* are some asilid inhabitants of this area. Photograph by Rob Cannings. **Figure 4.** Aerial view of Becher's Prairie, Riske Creek, Chilcotin, British Columbia. Surrounded by coniferous forests on BC's extensive central plateau, these grasslands are home to asilids such as *Cyrtopogon willistoni*, *Dicropaltum mesae*, *Efferia coulei*, *Eucyrtopogon comantis*, and *Stenopogon rufibarbis*. *Laphria* species (e.g., *L. fernaldi*, *L. janus*, and *L. sadales*) and other forest asilids often appear in the grassland-forest interface. Photograph by Rob Cannings.



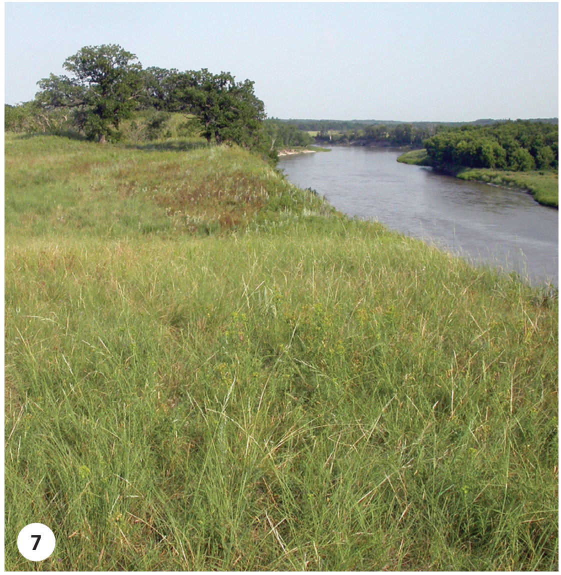

Figure 5. South Saskatchewan River Valley north of Burstall, Saskatchewan, just east of the Alberta border. *Efferia bicaudata*, *E. frewingi, Machimus aridalis, Ospriocerus aeacus, Proctacanthella cacopiloga, Stenopogon coyote,* and *S. inquinatus,* among other species, live here. Photograph courtesy of John Acorn. **Figure 6.** Great Sand Hills, Saskatchewan. *Dicropaltum cumbipilosus, D. mesae, Laphystia flavipes, Lasiopogon terricola, Stenopogon inquinatus,* and *Stichopogon trifasciatus* are typical species. Photograph courtesy of John Acorn. **Figure 7.** Grasslands in the Aspen Parkland Ecoregion (Prairies Ecozone) along the north bank of the Assiniboine River at its confluence with the Souris River, northeast of Treesbank, Manitoba. Robber flies expected in this habitat include *Efferia helenae, Holopogon vockerothi, Machimus erythocnemius, Proctacanthus milbertii,* and *Promachus dimidiatus*. Photograph courtesy of Colin Jones.

predominates with bluebunch wheat grass and other species. The Upper Grasslands lie above about 800 or 1,000 m on hillsides and on the southern plateaus. Various species of fescues (*Festuca* spp.) usually dominate the cover, although wheat grass and needlegrasses (*Stipa* spp.) are common and prevail in such regions as the Cariboo and Chilcotin plateaus (Nicholson *et al.* 1982). Some robber flies prefer specific grassland habitats that depend on elevation, soil type, and vegetation composition and structure; others are more widespread across different grassland types. Some species range into open ponderosa pine (*Pinus ponderosa* Lawson & C. Lawson) or Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) woods because much of the understorey of such habitats is similar to that of adjacent grasslands. Widespread, common species include *Scleropogon neglectus, Stenopogon inquinatus, Efferia benedicti, E. harveyi, Proctacanthus milbertii, Machimus occidentalis*, and *Neomochtherus willistoni*. Examples of others that occur in grasslands and adjacent open forests in the southern valleys, but are rare, are *Dicolonus nigricentrus, Leptogaster fornicata, Nicocles utahensis, Ospriocerus aeacus*, and *Willistonina bilineata*. In low-elevation, sandy, xeric habitats, characteristic species are *Stichopogon fragilis*, *Efferia albibarbis*, and *Proctacanthus occidentalis*. In silty soil where big sagebrush flourishes, *Efferia benedicti* is common. If forbs are abundant, the rare *Megaphorus willistoni* may occur. *Efferia staminea* and *E. okanagana* prefer bluebunch wheat grass communities in well-drained sites. Middle and higher grasslands dominated by *Festuca* grasses support species such as *Comantella pacifica* and *Lestomyia* sp., with *Myelaphus lobicornis* apparently occurring only where common rabbitbrush (*Chrysothamnus nauseosus* (Pall.) Britt.) grows. Species typical of the central plateaus tend to be widespread grassland species in British Columbia: *Dicropaltum mesae, Efferia coulei, E. harveyi, Stenopogon inquinatus, Scleropogon neglectus*, and *Machimus occidentalis*.

Robber Fly Faunas of Regional Grasslands
Cordillera

Yukon

The most familiar Yukon grasslands are those on steep south-facing slopes in dry parts of the south and central Yukon (Boreal Cordillera Ecozone), dominated by pasture sage (*Artemisia frigida* Willd.) and grasses such as *Calamagrostis purpurascens* R. Br., *Festuca brachyphylla* Schult. ex Schult. and Schult., and *Poa glauca* Vahl (Scudder 1997; Shorthouse 2010*b*) (Fig. 1). Extensive dune systems in southern Yukon, whose primary vegetation is sparse sedges and grasses (e.g., *Carex sabulosa* Tircz. ex Kunth and *Elymus calderi* Barkworth), support asilid species that are similar to those found on grassland ridges and the edges of dry, open pine and spruce woodlands. The main dune systems examined for asilids in Yukon are those at Carcross, Takhini River, Alsek River, Slims River, Sekulmun Lake, and several sand blowouts along the Yukon River, especially near Whitehorse (COSEWIC 2011). Characteristic robber flies of these grasslands are the East Beringian *Lasiopogon canus*, *L. prima*, and *L. yukonensis*, as well as the Palearctic–East Beringian *L. hinei*. The boreal *Rhadiurgus variabilis* is common, as is the boreal *Cyrtopogon bimaculus* and the Cordilleran *C. banksi*.

British Columbia

Shorthouse (2010*b*) discusses the wide distribution and complexity of grasslands in British Columbia. About three-quarters of the province's known asilid species are recorded in grasslands. Diversity is greatest in intermontane grasslands in the Montane Cordillera Ecozone east of the Coast Mountains (Cannings 2011*b*), especially in the warm valleys south of 51°N. Two biogeoclimatic zones, the Bunchgrass and Ponderosa Pine zones, in the Thompson-Okanagan, Cariboo-Chilcotin, and East Kootenay regions are the main focus. Big sagebrush and bluebunch wheat grass occur in the bottomlands of the Thompson and Okanagan valleys, usually below 500 m (Fig. 2), although antelope brush is often a more common shrub in sandy or gravelly soils (Fig. 3). At higher elevations and in more northern plateaus in the Cariboo-Chilcotin (Fraser Plateau Ecoregion) (Fig. 4), other grass ecosystems develop. East Kootenay grasslands lie in the Ponderosa Pine Zone at low elevations in the Southern Rocky Mountain Trench Ecoregion, immediately west of the Rockies. Although these grasslands are similar to those in the Bunchgrass Zone to the west, in some areas they support species typical of the Great Plains east of the Rockies, such as blue grama, *Bouteloua gracilis* (Willd. ex Kunth) Lag. ex Griffiths. Asilid species found in the grasslands of the Montane Cordillera Ecozone that are absent or rare elsewhere in Canadian grasslands include *Dicolonus nigricentrus*, *Efferia benedicti*, *E. coulei*, *E. harveyi*, *E. okanagana*, *Stichopogon fragilis*, *Willistonina bilineata, Dioctria henshawi*, *Megaphorus willistoni, Myelaphus lobicornis,* and *Proctacanthus occidentalis.* Other characteristic species are *Efferia staminea*, *Machimus occidentalis, M. vescus, Neomochtherus willistoni*, *Proctacanthus milbertii*, *Scleropogon neglectus*, *Stenopogon inquinatus*, and *S. rufibarbis*.

In the Boreal White and Black Spruce Biogeoclimatic Zone east of the Rockies (Boreal Plains Ecozone), special grasslands occur on the south-facing slopes of the Peace River Valley (Peace Lowland Ecoregion). These river valley “breaks” are composed of grasses such as western porcupine grass (*Stipa curtiseta* Hitchc.) and Columbia needlegrass (*Achnatherum nelsonii* (Scribn.) Barkworth) and have characteristics that suggest they were connected to the mixed grasslands of what is now south-central Alberta during warmer and dryer periods, 4,000 to 8,000 years ago (Shorthouse 2010*a*). Most other grasslands in the ecoregion have been converted to agriculture. The robber fly fauna is similar to that of the adjacent Aspen Parklands of Alberta. Species such as *Stenopogon inquinatus* and *Lasiopogon hinei* are typical along trails in the grasslands, with the Great Plains species *Lasiopogon quadrivittatus* hunting along the banks of the Peace River itself.

The Garry oak meadows of southeastern Vancouver Island and the Gulf Islands are coastal grassland and savanna, the driest part of the Coastal Douglas-fir Biogeoclimatic Zone (Pacific Maritime Ecozone). Summer drought produces meadows and open parkland characterized by two broad-leaved trees, arbutus (*Arbutus menziesii* Pursh) and Garry oak (*Quercus garryana* Douglas ex Hook.). Characteristic asilid species include *Machimus occidentalis, Neomochtherus willistoni*, and *Scleropogon bradleyi*, all shared with the grasslands of the southern interior of the province. *Dicolonus simplex*, *Eudioctria nitida*, *Laphria ventralis*, *Nicocles canadensis*, and *N. rufus* are found in no other Canadian grasslands.

Great Plains

Shorthouse (2010*a*) gives an overview of the grasslands of the Central Plains of western Canada. The Prairies Ecozone has a diverse asilid fauna with several notable, but not surprising, patterns. Cordilleran species such as *Cyrtopogon willistoni*, *Lasiopogon cinereus, Machimus callidus*, and *Nicocles utahensis* range east from the Rockies into the western Prairies Ecozone to varying degrees. Most of the asilids in the region have extensive ranges on the Great Plains of the United States; species such as *Efferia costalis*, *E. subcuprea*, *Megaphorus guildiana*, and *Scleropogon coyote* have extended from the south into the Mixed Grassland Ecoregion (Figs. 5 and 6). In southern Manitoba, a few eastern species (e.g., *Laphria flavicollis*, *Holopogon vockerothi, Machimus notatus,* and *Tipulogaster glabrata*) have penetrated prairie habitats in the Aspen Parklands (Fig. 7) and Lake Manitoba Plain ecoregions, and at least one, *Lasiopogon terricola*, at home in open, sandy areas, ranges all the way to Alberta. Other eastern species, such as *Cyrtopogon varans* and *Laphria cinerea*, have not moved westward from the grassland–forest interface in southeastern Manitoba. Boreal and transition species living in the forests of the Boreal Plains Ecozone to the north also appear in grasslands and transitional areas (especially in the Aspen Parklands and in isolated forested uplands such as Cypress Hills). These include *Laphria gilva*, *L. insignis*, *L. janus*, *L. scorpio*, *Cyrtopogon bimaculus*, *C. falto*, and others. Species more or less restricted to the Prairies Ecozone in Canada are *Cyrtopogon platycaudus*, *Dicropaltum cumbipilosus*, *Efferia bicaudata*, *E. costalis*, *E. helenae*, *E. subcuprea*, *Heteropogon wilcoxi, Holopogon seniculus, Laphystia canadensis*, *Lasiopogon quadrivittatus, L. terricola, L. trivittatus, Machimus adustus, M. aridalis, M. delusus, Megaphorus guildiana*, *Ospriocerus latipennis, Promachus dimidiatus*, and *Scleropogon coyote*. A few, such as *Proctacanthella cacopiloga* and *Laphystia flavipes*, are mostly Great Plains species, but range east into southwestern Ontario grassland and dune remnants.

Defining Western Grassland Asilidae

There is a distinct robber fly fauna in western Canadian grasslands, although its composition varies geographically. As in most insect groups, considerable mixing of forest and grassland species occurs at the interface between the two biomes. In British Columbia, for example, the complex interdigitation of forest and grassland areas, both altitudinally and latitudinally, promotes the presence, in some grasslands, of montane species (*Cyrtopogon montanus*, *Laphria fernaldi*, *Machimus callidus*) or northern species (*Laphria insignis*, *Rhadiurgus variabilis*). This also happens more broadly at the interface of grassland and forest in the Prairie Provinces where northern species, such as *Cyrtopogon bimaculus*, *Laphria gilva*, and *L. janus*, encroach on the grasslands, especially on south-facing hillsides in the Aspen Parklands, but also along the southern parts of the boreal forest and more discrete areas such as the forest "islands" of southern Manitoba and the Cypress Hills of Alberta and Saskatchewan. In extreme southeastern Manitoba a similar phenomenon occurs where the eastern forest fauna meets that of the Prairies. Some eastern species that are at home in open habitats have spread into grasslands (or urban or agricultural areas that once were grassland) (e.g., *Machimus notatus, Holopogon vockerothi*), but some eastern forest species remain tied to the forests or the forest–grassland interface near the Ontario–Manitoba border (e.g., *Laphria cinerea*, *Neoitamus orphne*). Savanna habitats such as the Garry oak meadows of southeastern Vancouver Island and the Gulf Islands support some primarily grassland species (e.g., *Dicolonus simplex* and *Scleropogon bradleyi*). Although the tallgrass prairie and oak savanna remnants of southwestern Ontario are not treated in this chapter, it should be noted that they contain some grassland species not found in western Canada (e.g., *Holcocephala abdominalis* (Say)), as well as some that are widespread in the West (e.g., *Proctacanthella cacopiloga* and *Stichopogon trifasciatus*) (Skevington 1999). Dune systems in the Prairies Ecozone (Fig. 6) and in Ontario (e.g. *Laphystia* species) and Yukon (especially Beringian *Lasiopogon* species) are also home to a fauna mainly characteristic of grasslands, even though some of these dune habitats may be isolated in forested environments. A core list of typical grassland species can be established, but the makeup of a more complete and accurate list is complicated by the difficulty of defining a grassland species. In this examination of the fauna, I have arbitrarily included all species recorded within the ecoregions and localities that I use to represent the grassland environments of western Canada.

The robber fly species shared by all the various types of western Canadian grasslands discussed here (from Yukon to Manitoba) are few and include only boreal species that enter grasslands mostly in the interface with forests: *Laphria insignis*, *L. posticata*, and *Cyrtopogon bimaculus.* The small Yukon list results in the omission of many common, more southerly species. With the deletion of typically woodland flies and the inclusion of only species widespread in the majority of Canadian grasslands (British Columbia and at least two of the Prairie Provinces), the list is longer: *Leptogaster coloradensis*, *Holopogon albipilosa*, *Ospriocerus aeacus*, *Stenopogon inquinatus*, *S. rufibarbis*, *Lasiopogon prima*, *L. quadrivittatus*, *Dicropaltum mesae*, *Efferia frewingi*, *Machimus erythrocnemius*, and *M. paropus*.

Some genera are typical of western grasslands. For example, the 11 species of western Canadian *Efferia* are found only in grasslands in the region. Most species of *Comantella*, *Dicolonus*, *Dicropaltum*, *Laphystia*, *Lasiopogon*, *Leptogaster*, *Lestomyia*, *Machimus*, *Megaphorus*, *Myelaphus*, *Negasilus*, *Ospriocerus*, *Proctacanthella*, *Proctacanthus*, *Promachus*, *Scleropogon*, *Stenopogon*, and *Stichopogon* are largely restricted to grasslands or dune fields in western Canada. Many of the species found in the habitats at the interface between grasslands and forests belong to the large genera *Cyrtopogon*, *Laphria*, and *Machimus*. Regional grassland species lists are usually strikingly different from each other; taxa more or less restricted to the various grassland regions of Canada are indicated in the section on regional faunas above.

Systematic Review of the Grassland Asilidae

An annotated systematic checklist of the 134 western Canadian grassland species, including their faunal elements, is included in Table 1. The nomenclature follows that of Fisher and Wilcox (1997) and much of the information on total range is taken from this work. A brief review of these species, with biological and distributional information on selected taxa, is presented below. Terms such as "boreal," "Cordilleran," and "eastern" are faunal elements and are defined below in the section "Biogeography and Faunal Elements." Localities listed, unless otherwise noted, are examples only; these places are often reduced to the name of the closest town or city.

Table 1. Annotated list of the Asilidae species of Canadian grasslands. Nomenclature in this list of 134 species is based on the catalogue of Nearctic species of Fisher and Wilcox (1997), still the best, most authoritative list of North American Asilidae. This list was developed to replace Martin and Wilcox (1965) as part of a new Nearctic Diptera catalogue that was never published. In general, there are no English names yet given to robber flies. The terms following the species name provide distributional information. The first term is the faunal element (range type as defined above), followed by the species total range (mostly from Fisher and Wilcox) and provincial and territorial abbreviations for western Canadian jurisdictions where the species occurs in grasslands (species may also occur widely in other habitats in the same or other provinces and territories). An additional "(int)" indicates that the species occurs at the forest interface of the grassland biome (the montane forests in the Cordillera, the boreal forest and Cypress Hills and other "forest islands" on the Great Plains, and the eastern forests of southeastern Manitoba) and is primarily a woodland species.

Subfamily Leptogastrinae

Leptogaster arida Cole. Cordilleran. BC and Alberta to California and Arizona. BC, AB.

Leptogaster coloradensis James. Western. BC east to South Dakota, south to Kansas and Colorado. BC, AB, SK.

Leptogaster fornicata Martin. Cordilleran. BC to California. BC.

Leptogaster sp. One specimen of *Leptogaster* from Manitoba has been examined but, as yet, cannot be identified to species. MB.

Tipulogaster glabrata (Wiedemann). Eastern. Manitoba and Nebraska east to Quebec, south to Florida and Texas. MB.

Subfamily Dasypogoninae

Comantella fallei (Back). Western. Alberta to Colorado and Utah. AB.

Comantella pacifica Curran. Cordilleran. BC to Utah and Nevada. BC.

Comantella rotgeri James. Western. Alberta to Arizona and New Mexico. AB.

Cophura brevicornis (Williston). Cordilleran. BC and Montana to Colorado and California; Nebraska. BC.

Cophura vitripennis (Curran). Cordilleran. BC to Wyoming. BC (int).

Lestomyia sp. (probably undescribed species; Fisher and Wilcox (1997)). Cordilleran. BC and Alberta to Utah and California. BC, AB.

Nicocles canadensis Curran. Pacific Coastal. BC to California. BC.

Nicocles dives (Loew). Cordilleran. BC to Nevada and California. BC (int).

Nicocles pollinosus Wilcox. Cordilleran. BC and Montana to California. BC (int).

Nicocles rufus Williston. Pacific Coastal. BC to California. BC.

Nicocles utahensis Banks. Cordilleran. BC and Alberta to Arizona and California. BC, AB.

Subfamily Laphriinae

Andrenosoma fulvicaudum (Say). Southern. BC to New Brunswick, south to Florida and California; Mexico. BC (int).

Laphria aeatus Walker. Transition. Alberta east to Ontario and Vermont. AB (int)

Laphria aimatis McAtee. Cordilleran. BC and Alberta to New Mexico and California. BC (int).

Laphria asackeni Wilcox. Cordilleran. Alaska and BC to Montana, Colorado and California. BC (int).

Laphria sp. (*canis* group). Eastern. MB.
Laphria cinerea (Back). Eastern. Manitoba and Minnesota east to Michigan, New York and New Hampshire, south to Florida and Mississippi. MB (int).
Laphria columbica Walker. Cordilleran. Alaska, BC and Alberta to California. BC (int), AB (int).
Laphria felis (Osten Sacken). Cordilleran. BC and Alberta to New Mexico and California. BC (int).
Laphria fernaldi (Back). Cordilleran. BC and Alberta to New Mexico and California. BC.
Laphria ferox Williston. Cordilleran. BC and Montana to California. BC (int).
Laphria flavicollis Say. Eastern. Manitoba and Iowa to Nova Scotia and Maine, south to Florida and Texas. MB.
Laphria franciscana Bigot. Cordilleran. BC through Idaho and Washington to California. BC (int).
Laphria gilva (Linnaeus). Holarctic: Boreal. Northern Eurasia; Alaska and Yukon to New Brunswick, south to Pennsylvania, Colorado and California. YT (int), BC (int), AB, SK, MB.
Laphria index McAtee. Transition. BC to Oregon and Montana; Manitoba east to Quebec and Maine, south to South Carolina and Oklahoma. BC, MB.
Laphria insignis (Banks). Boreal. Yukon to Labrador and Nova Scotia, south to Maine, Michigan, Minnesota and BC. YT (int), BC (int), AB (int), SK (int), MB.
Laphria janus McAtee. Boreal. Alaska through Northwest Territories to New Brunswick, south to Pennsylvania, Colorado, Utah and Oregon. BC (int), AB, SK, MB.
Laphria partitor (Banks). Cordilleran. Yukon, BC and Alberta to California. YT (int), BC (int).
Laphria posticata Say. Boreal. Yukon to Quebec and Maine, south to Georgia, Tennessee, Wisconsin and British Columbia. YT (int), BC (int), AB (int), MB (int).
Laphria sadales Walker. Boreal. BC to New Brunswick, south to Connecticut, Pennsylvania, Colorado, Utah and California. BC (int).
Laphria scorpio McAtee. Transition. BC and Idaho to Quebec and Nova Scotia, south to Connecticut, Pennsylvania and Minnesota. BC (int), AB (int), SK (int).
Laphria ventralis Williston. Pacific Coastal. BC to California. BC.
Laphria vivax Williston. Cordilleran. Yukon and Alberta to New Mexico and California. YT (int), BC (int).
Pogonosoma ridingsi Cresson. Western. BC and Alberta to South Dakota, south to Texas and California; Michigan to Maine. BC (int), AB (int).

Subfamily Laphystiinae
Laphystia flavipes Coquillett. Great Plains. Saskatchewan and Montana to Ontario and Minnesota, south to Kansas and Colorado. AB, SK, MB.
Laphystia canadensis Curran. Great Plains. Montana east to Manitoba, south to Iowa, Kansas and Wyoming. MB.

Subfamily Stenopogoninae
Callinicus pollenius (Cole). Cordilleran. BC and Montana south to Wyoming, Utah and California. BC (int).
Coleomyia hinei Wilcox & Martin. Cordilleran. BC south to Montana, Idaho and Oregon. BC (int).
Cyrtopogon ablautoides Melander. Cordilleran. BC south to Utah and Oregon. BC.
Cyrtopogon auratus Cole. Cordilleran. BC and Alberta south to Colorado, Utah and Oregon. BC (int).
Cyrtopogon aurifex Osten Sacken. Cordilleran. BC and Alberta south to California. BC (int).
Cyrtopogon banksi Wilcox & Martin. Cordilleran. Yukon south to Colorado, Utah and California. YT, BC (int).
Cyrtopogon bimaculus (Walker). Boreal. Yukon to Quebec, south to New Mexico, Utah and Oregon. YT, BC (int), AB, SK, MB.
Cyrtopogon dasyllis Williston. Cordilleran. Alaska, Yukon and NWT south to Idaho and California. YT (int), BC (int).
Cyrtopogon falto (Walker). Transition. BC east to Nova Scotia, south to Florida and Illinois. AB, SK, MB.
Cyrtopogon fumipennis Wilcox & Martin. Cordilleran. Yukon south through BC to Wyoming and Utah. YT.
Cyrtopogon glarealis Melander. Cordilleran. Yukon and Alberta south to Colorado and California. YT, BC (int).
Cyrtopogon inversus Curran. Cordilleran. BC and Alberta south to Colorado, Nevada and Washington. BC.
Cyrtopogon montanus Loew. Cordilleran. BC and Alberta south to New Mexico and California. BC.
Cyrtopogon platycaudus Curran. Great Plains. Manitoba. MB.
Cyrtopogon varans Curran. Eastern. Manitoba to Quebec, south to Michigan. MB (int).
Cyrtopogon willistoni Curran. Cordilleran. BC and Alberta south to Colorado and California. BC, AB.
Dioctria henshawi Johnson. Cordilleran. BC to Utah and California. BC (int).
Dioctria pusio Osten Sacken. Cordilleran. BC south to Colorado, Utah and California; Baja California. BC (int).

Dicolonus nigricentrus Adisoemarto & Wood. Cordilleran. BC to Idaho and Oregon. BC.
Dicolonus simplex Loew. Pacific Coastal. BC to California. BC.
Eucyrtopogon albibarbus Curran. Western. Alberta and Saskatchewan south to Montana, Nevada and California. AB, SK.
Eucyrtopogon calcaratus Curran. Cordilleran. BC and Alberta south to Washington. BC, AB.
Eucyrtopogon comantis Curran. Cordilleran. BC and Alberta south to Colorado and Utah. BC, AB.
Eucyrtopogon diversipilosis Curran. Cordilleran. Yukon south to BC and Alberta. YT, BC, AB.
Eucyrtopogon nebulo (Osten Sacken). Cordilleran. BC and Alberta to Wyoming, Nevada and California. BC, AB (int).
Eucyrtopogon sp. near *nebulo*. Cordilleran. Northern Yukon. YT.
Eucyrtopogon punctipennis (Melander). Cordilleran. BC to Idaho and Washington. BC (int).
Eucyrtopogon spiniger Curran. Cordilleran. NWT to BC and Alberta. BC, AB.
Eucyrtopogon varipennis (Coquillett). Cordilleran. BC to California. BC.
Eudioctria nitida (Williston). Pacific Coastal. BC to California. BC.
Eudioctria sackeni (Williston). Cordilleran. BC south to Montana, Idaho and California. BC.
Heteropogon senilis (Bigot). Cordilleran. BC south to Utah and California. BC (int).
Heteropogon wilcoxi James. Great Plains. Alberta south to New Mexico and Arizona. AB.
Holopogon albipilosus Curran. Western. BC east to Manitoba, south to Minnesota, Utah, Nevada and California. BC, AB, SK, MB.
Holopogon seniculus Loew. Great Plains. Alberta and Saskatchewan east to North Dakota, south to New Mexico and California. AB, SK.
Holopogon stellatus Martin. Cordilleran. BC south to Utah, Nevada and California. BC.
Holopogon vockerothi Martin, Eastern. Manitoba east to Quebec, south to Connecticut, Georgia and Illinois. MB.
Myelaphus lobicornis (Osten Sacken). Cordilleran. BC to Colorado, Utah and California. BC.
Ospriocerus aeacus (Wiedemann). Western. BC east to Saskatchewan and Minnesota, south to Texas and California; Mexico. BC, AB, SK.
Ospriocerus latipennis (Loew). Great Plains. Alberta to Manitoba south to Texas, New Mexico and northern Mexico. AB, MB.
Scleropogon bradleyi (Bromley). Cordilleran. BC south to Utah, Nevada and California. BC.
Scleropogon coyote (Bromley). Great Plains. Alberta to North Dakota, south to Texas and Arizona. AB.
Scleropogon neglectus (Bromley). Cordilleran. BC and Alberta south to New Mexico and California. BC, AB.
Stenopogon inquinatus Loew. Western. BC east to Manitoba and Minnesota, south to Texas and California. BC, AB, SK, MB.
Stenopogon rufibarbis Bromley. Western. BC east to Saskatchewan, south to Colorado, Arizona and California. BC, AB, SK.
Willistonina bilineata (Williston). Cordilleran. BC south to Montana, Utah, Baja California. BC.

Subfamily Stichopogoninae
Lasiopogon canus Cole & Wilcox. East Beringian. Alaska east through Yukon to NWT, YK.
Lasiopogon cinereus Cole. Cordilleran. BC and Alberta south to Wyoming, Utah and California. BC, AB (int).
Lasiopogon hinei Cole & Wilcox. Palearctic–East Beringian. Northwestern Russia to Bering Strait; Alaska, Yukon, BC and Alberta. YT, BC, AB.
Lasiopogon prima Adisoemarto. East Beringian. Alaska, Yukon, NT, and BC east through central Alberta and Saskatchewan. YT, BC, AB, SK (int).
Lasiopogon quadrivittatus Jones. Great Plains. British Columbia and Alberta east to Saskatchewan and North Dakota, south to Utah, New Mexico and Nebraska. BC, AB, SK.
Lasiopogon terricola (Johnson). Eastern. Alberta to Manitoba, Michigan, New York and New Hampshire, south to Virginia, Indiana and North Dakota. AB, SK, MB.
Lasiopogon trivittatus Melander. Great Plains. Alberta and Montana. Plains and eastern slopes of Rockies. AB.
Lasiopogon yukonensis Cole & Wilcox. East Beringian. Yukon. YT.
Lasiopogon n. sp. Misidentified as *L. canus* by Adisoemarto (1967). Great Plains. BC and Alberta. BC, AB.
Stichopogon argenteus (Say). Widespread. Manitoba and Ontario to Massachusetts, south to Maryland and Colorado. MB.
Stichopogon fragilis Back. Cordilleran. BC to New Mexico and Baja California. BC.
Stichopogon trifasciatus (Say). Southern. Alberta to Manitoba, Ontario and Quebec; most of US south to southern Mexico. AB, SK, MB.

Subfamily Asilinae

Dicropaltum cumbipilosus (Adisoemarto). Great Plains. Alberta. AB.

Dicropaltum mesae (Tucker). Western. BC east to Saskatchewan south to Kansas, New Mexico and California. BC, AB, SK.

Efferia albibarbis (Macquart). Southern. BC and Ontario; entire United States south to Costa Rica. BC.

Efferia benedicti (Bromley). Cordilleran. BC south to Arizona and California. BC.

Efferia bicaudata (Hine). Great Plains. Alberta and Saskatchewan south to Texas, New Mexico and Utah. AB, SK.

Efferia costalis (Williston). Great Plains. Alberta and Saskatchewan south to Texas, New Mexico and Arizona. AB, SK.

Efferia coulei Wilcox. Cordilleran. BC and Washington. BC.

Efferia frewingi Wilcox. Cordilleran. BC east to Saskatchewan south to Utah and California. BC, AB, SK.

Efferia harveyi (Hine). Cordilleran. BC south to Utah and California. BC.

Efferia helenae (Bromley). Great Plains. Alberta to Manitoba, south to Arizona and Texas. AB, SK, MB.

Efferia okanagana Cannings. Cordilleran. British Columbia. BC.

Efferia staminea (Williston) Cordilleran. BC south to Colorado and Utah. BC, AB.

Efferia subcuprea (Schaeffer). Great Plains. Great Plains. Alberta to Nevada, New Mexico and Arizona. AB.

Megaphorus guildiana (Williston). Great Plains. Saskatchewan south to Utah, New Mexico, Oklahoma and North Dakota. SK.

Megaphorus willistoni (Cole). Cordilleran. BC south to Arizona, Mexico and Nevada. BC.

Proctacanthella cacopiloga (Hine). Great Plains. Alberta east to southern Ontario, south to Indiana, Texas and Utah. AB, SK, MB.

Proctacanthus milbertii Macquart. Southern. BC east to Ontario (not in AB, SK?), south to Florida (but absent in NE US north of Virginia), Texas, and Arizona. BC, MB.

Proctacanthus occidentalis Hine. Cordilleran. BC south to Idaho, Nevada and California. BC.

Promachus dimidiatus Curran. Great Plains. Alberta to Manitoba, south to Wisconsin, Kansas, New Mexico and Utah. AB, MB.

Machimus adustus Martin. Great Plains. Alberta south to Arizona. AB.

Machimus aridalis (Adisoemarto). Great Plains. Alberta and Saskatchewan. AB, SK.

Machimus callidus (Williston). Cordilleran. Yukon, BC and Alberta south to Colorado and California. YT (int), BC (int), AB (int).

Machimus delusus (Tucker). Great Plains. Alberta and Saskatchewan south through Idaho and Montana to Wyoming, Utah and Arizona. AB, SK.

Machimus erythocnemius (Hine). Widespread. BC east to Quebec south to Florida, New Mexico and Oregon. BC, AB, SK, MB.

Machimus notatus (Wiedemann). Eastern. Manitoba and Kansas east to New Brunswick and Maine, south to Texas and Florida. MB. A few specimens from Opal, Alberta are possibly this species but need more work for verification.

Machimus occidentalis (Hine). Cordilleran. BC south to Colorado and Baja California. BC.

Machimus paropus (Walker). Widespread. British Columbia east to Nova Scotia, south to Virginia, Texas and California. BC, AB, SK, MB.

Machimus snowii (Hine). Eastern. Manitoba east to Nova Scotia, south to Florida and Oklahoma. MB.

Machimus vescus (Hine). Cordilleran. BC south to Colorado, Arizona, Nevada and California. BC.

Negasilus belli Curran. Cordilleran. Washington, Alberta and Saskatchewan south to Colorado and California. AB, SK.

Negasilus gramalis (Adisoemarto). Great Plains. AB

Neoitamus brevicomus (Hine). Cordilleran. BC south to Utah and California. BC (int).

Neoitamus orphne (Walker). Eastern. Manitoba to Quebec and Maine, south to Georgia and Illinois; Montana, Colorado. MB (int).

Neomochtherus willistoni (Hine). Cordilleran. BC south to Arizona and California. BC.

Rhadiurgus variabilis (Zetterstedt). Holarctic: Boreal. Northern Eurasia; Alaska and Yukon east to Labrador, south to Michigan, Colorado and Oregon. YT, BC (int).

Subfamily Leptogastrinae (5 species)

Members of the Leptogastrinae are extremely slender, long-legged, almost bare species that fly slowly and hover among grasses and other vegetation, searching for small perching prey or spiders in webs (Fisher 2009). The identification of many species is difficult; apparently four, and perhaps more, species of the delicate little flies in the large genus *Leptogaster* (almost 300 world species) live in western Canadian grasslands. All certainly need to be better collected and studied. For example, a specimen from Manitoba has been examined that cannot, at present, be identified to species. *Leptogaster coloradensis* is the most widespread species, ranging from the British Columbia interior east to Saskatchewan. Fig. 8 pictures *L. fornicata*, an uncommon Cordilleran species found in the valleys of southern British Columbia. *Tipulogaster glabrata*, an eastern species, ranges as far west as Manitoba in Canada; a single specimen from Winnipeg has been examined.

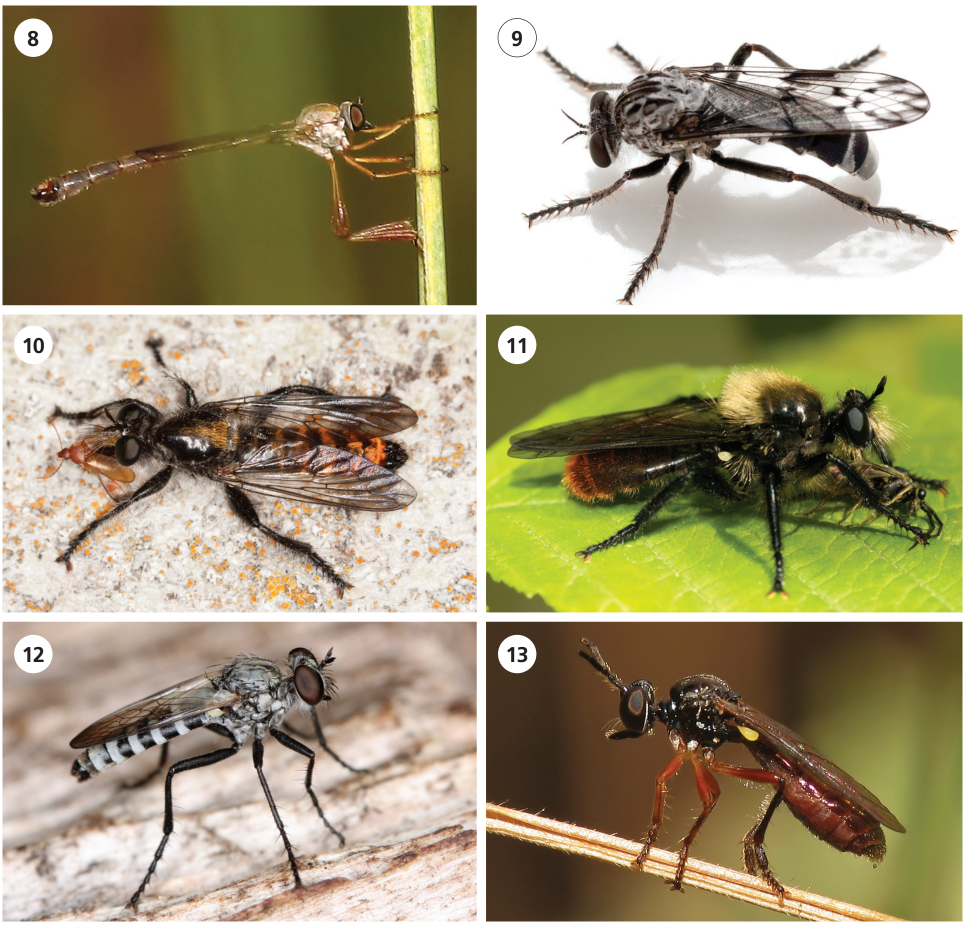

Figure 8. *Leptogaster fornicata*, male. Photograph courtesy of Werner Eigelsreiter. **Figure 9.** *Nicocles utahensis*, male. Photograph courtesy of John Acorn. **Figure 10.** *Laphria index*, male. Photograph courtesy of Werner Eigelsreiter. **Figure 11.** *Laphria janus*, female. Photograph courtesy of Deanna Dodgson. **Figure 12.** *Coleomyia hinei*, male. Photograph courtesy of Werner Eigelsreiter. **Figure 13.** *Dioctria pusio*, female. Photograph courtesy of Werner Eigelsreiter.

Subfamily Dasypogoninae (11 species)

The species of the Dasypogoninae reported in Canadian grasslands are small- to medium-sized flies in four genera: *Comantella*, *Cophura*, *Lestomyia*, and *Nicocles*. They are distinguished by a claw-like spur or curved spine at the apex of the fore tibia; Fisher (2009) discusses the phylogenetic problems associated with this structure. The three species of Canadian *Comantella* are Cordilleran flies, although *C. fallei* and *C. rotgeri* are both recorded from Alberta's Mixed Grassland Ecoregion (Medicine Hat). *Comantella pacifica* was originally described from mesic grasslands at Penticton, in the Okanagan Valley of British Columbia. It has an unusual flight period, flying late into October, and is the first species to appear in the spring (late March). There is evidence that adults overwinter in protected places. Tiny *Cophura* species mostly live in open forests, but *C. brevicornis* is not uncommon at forest edges and in grasslands of southern British Columbia. A silvery little *Lestomyia* species (in literature as *L. sabulona* (Osten Sacken)) hunts from the bare ground in grasslands of the southern Okanagan and southern Alberta. The genus badly needs revision, and it appears that the Canadian species is not *L. sabulona*, but is an undescribed species (E.M. Fisher, pers. comm.). *Nicocles* is a genus of beautiful flies with brown-marked wings and in the male, with flattened, brilliant silver terminal abdominal segments. *Nicocles canadensis* is restricted in Canada to Garry oak savanna and adjacent dry woodland on southern Vancouver Island (Saanich is the type locality), as is *N. rufus*, the only red species in the genus. The most widespread grassland species is *N. utahensis* (Fig. 9), known from southern British Columbia and Alberta. Some *Nicocles* specimens, at least in Canada, are difficult to identify, and the northern populations of the genus would benefit from more systematic study.

Subfamily Laphriinae (23 species)

The Laphriinae is primarily a woodland group; larvae burrow in rotting logs and stumps and prey on insect larvae living there. Many of them are large and colourful and mimic bees and wasps. Adults perch on leaves or logs, stumps, and tree trunks and wait for prey to fly by. Beetles are a favourite prey of some species (e.g., Baker and Fischer 1975).

About half the Nearctic species of *Laphria* belong to *Laphria* in the strict sense; with their colourful, fuzzy, yellow and black or yellow, red, and black bodies, they resemble bumble bees. The remainder can be assigned to other groups, including the Old World genus *Choerades* (the males have distinctive lamellae formed from fused bristles in the genitalia) and several potential undescribed genera. These taxonomic changes have yet to be formalized.

Laphria, with 21 species recorded in western Canadian grasslands (12 of them reported strictly as grassland–forest interface species), is the largest of the three genera of Laphriinae on this list. There are eight boreal and transition species ranging across the continent in northern forests, nine Cordilleran species in the western mountains, one Pacific coastal species, and three eastern species restricted to Manitoba. Three of the more common species that fly in grasslands across the West are the boreal species *Laphria gilva*, *L. insignis*, and *L. janus*. *Laphria gilva*, placed in *Choerades* in the Old World, is one of only two Holarctic asilids, ranging from Britain to Japan, from Alaska to the Atlantic Provinces. In British Columbia, it is an interface species, but on the Great Plains it encroaches on the grasslands considerably more (e.g., Alberta: Lethbridge, Medicine Hat). The same is true for *L. janus* (Fig. 10). *Laphria insignis*, a beautiful little bumble bee mimic of northern forests, is an interface species from Yukon and British Columbia to Saskatchewan (e.g., Alberta: Bilby, Opal dunes), but lives deeper in the grassland zones of Manitoba (e.g., Aweme, Brandon). *Laphria index* (Fig. 11) is a transition species known only from British Columbia and Manitoba in western grasslands; it represents a distinctive group of species in which the males bear paired protuberances on the sixth abdominal segment. Along the margins of British Columbia grasslands, Cordilleran *Laphria* species are diverse; examples are *L. asackeni* (clothed with glowing orange-gold pile), *L. felis* (black with red abdomen and legs), and *L. fernaldi* (a black, orange, and yellow *Bombus* mimic). A few of these are recorded in Alberta grasslands, too; for example, *L. columbica* occurs at Grimshaw in the Peace River grasslands. *Laphria ventralis*, a Pacific coastal species, is restricted to the Garry oak meadows and adjacent dry woodlands of southern Vancouver Island and the Gulf Islands. In southeastern Manitoba, *L. cinerea,* an eastern species, lives at the grassland–forest interface (e.g., Sandilands) and *L. flavicollis*, also eastern, ranges well into the grasslands at Morden.

The other two genera of the Laphriinae in western Canada are *Andrenosoma* and *Pogonosoma*; each has a single species in grasslands. *Andrenosoma fulvicaudum* is a black and orange fly that ranges across the continent south of the northern forests. It is attracted to forest fires; the females lay eggs in burned trees, where the larvae prey on metallic woodboring beetle (Buprestidae) larvae (Fisher 1986). In British Columbia, it occurs on grassland edges adjacent to ponderosa pine and Douglas-fir woods. *Pogonosoma ridingsi*, another black species, is a widespread Cordilleran asilid mostly living in habitats that are similar to those of *Andrenosoma fulvicaudum* in southern British Columbia and in the foothills of southwestern Alberta.

Subfamily Laphystiinae (2 species)

The Laphystiinae are closely related to the subfamily Laphriinae (and placed within it by many workers). The family is dominated by the large genus *Laphystia*, which is the only one in the subfamily in Canada. These asilids resemble small *Bembix* sand wasps and are frequently found on dunes. Western grasslands support only two species of *Laphystia*, both of the Great Plains faunal element and restricted to the Prairies Ecozone. *Laphystia flavipes* is recorded in Alberta (Empress dunes), Saskatchewan (e.g., Pike Lake, Sceptre) and Manitoba (Aweme, Glenboro, Onah), although it also occurs in southern Ontario dunes. *Laphystia canadensis* was described from Manitoba by Curran (1927); it is reported from Westbourne and Ste. Rose du Lac.

Subfamily Stenopogoninae (46 species)

Fourteen genera of Stenopogoninae are recorded in western Canadian grasslands, but some, especially *Callinicus*, *Coleomyi*a (Fig. 12), and *Dioctria* (Fig. 13), are interface taxa found only near forest edges. The subfamily's largest genus in Canada is the Holarctic *Cyrtopogon*, with 14 grassland-associated species in the West, although most of these species (and many more that are not listed) live in woodlands of various types. In western Canada, many (or all) of the species in some genera (*Dicolonus*, *Eucyrtopogon*, *Eudioctria*, *Heteropogon*, *Myelaphus*, *Ospriocerus*, *Holopogon*, *Scleropogon*, *Stenopogon*, and *Willistonina*) are, to a large extent, grassland inhabitants.

The Nearctic *Cyrtopogon* fauna is overwhelmingly western in distribution; this is reflected in the grassland species: 10 are Cordilleran, two are boreal, one is eastern, and one is a Great Plains species. With its fuzzy yellow and black abdomen, *C. dasyllis* looks a little like a *Laphria* species; it is an interface species in Yukon and British Columbia. *Cyrtopogon auratus* and *C. aurifex* are also interface species, but only in British Columbia, where most often they are found in montane and subalpine forests well away from grasslands.

However, the former lives east of the Coast Mountains and is recorded at the edge of interior grasslands, while the latter is a coastal mountain fly, found along the margins of Garry oak savanna on southern Vancouver Island. The males of both species have thick, tufted golden hair on the abdomen. *Cyrtopogon ablautoides* and *C. willistoni* (Fig. 14), both Cordilleran flies, are the most grassland-oriented of all Canadian *Cyrtopogon* species. The rare *Cyrtopogon ablautoides* is recorded only in dry grasslands in the Okanagan Valley, while *C. willistoni* is common in moist, often high-elevation grasslands across southern British Columbia and southwestern Alberta. The male has beautifully decorated legs with which it signals the female during mating displays. The fore tarsi are densely silver-haired and the mid tarsi are tipped with a fan-shaped tuft of black setae. The boreal *C. bimaculus*, with striking dark spots on the wings, is common across Canada and enters grasslands frequently, except in British Columbia, where it is largely a subalpine species. *Cyrtopogon falto* is one of the most often encountered asilids in eastern Canadian forests; in the West it has been recorded a few times in the Aspen Parkland in Alberta (e.g., Clyde, Opal, and Edmonton on south-facing, shrubby slopes; J. Acorn, pers. comm.) and Manitoba (e.g., Aweme, Erickson, Melita, Winnipeg). Manitoba is the only western province to record *C. varans*, an eastern species collected at Erickson, and *C. platycaudus*, a Great Plains species still known only from one place, the type locality at Glen Souris, from where it was described in 1924.

Eucyrtopogon (Fig. 15) contains 12 named species restricted to western North America, nine of which live in Canadian grasslands to some extent. The genus is badly in need of revision; specimens are frequently impossible to identify, and there certainly are undescribed species in collections. The wings are brown-spotted in both sexes and some species are abundantly hairy (Fig. 15), a feature that may help them regulate temperature. Some *Eucyrtopogon* species are notable for late or early seasonal activity and, like *Comantella* species, may overwinter as adults. For example, in British Columbia grasslands, *E. calcaratus* has been collected on 23 November in Vernon and 23 January in Penticton. Most of the *Eucyrtopogon* species listed here are recorded in both British Columbia and Alberta: *E. albibarbus* (also ranges east to Saskatchewan, e.g., Moose Jaw, Swift Current), *E. calcaratus, E. comantis, E. diversipilosis, E. nebulo,* and *E. spiniger*. *Eucyrtopogon diversipilosis* also lives on the Carcross dunes in the Yukon and a second, undescribed, Yukon species, similar to *E. nebulo*, is known from the sage slopes at Old Crow. Although I have designated this species as Cordilleran, it might have Beringian affinities with Asia, but *Eucyrtopogon* is not yet recognized there. Several *Eucyrtopogon*-like species are still placed in *Cyrtopogon* in the Eurasian fauna (Lehr 1998).

Myelaphus lobicornis lives in intermontane grasslands from southern British Columbia to California and Utah (Adisoemarto and Wood 1975). In Canada, it is known from only two grassland sites, one at Penticton and the other at Dutch Creek in the Rocky Mountain Trench. At Penticton, it flies only around rabbitbrush in June. With its almost hairless body, elongate antennae, red abdomen, yellow legs, and dark head, thorax, and wings, *M. lobicornis* resembles an ichneumon wasp.

Dicolonus and *Eudioctria* are related genera that contain both coastal and interior British Columbia grassland species. *Dicolonus simplex* is the most characteristic robber fly of the coastal Garry oak meadows, flying in April when camas and other wildflowers are in full bloom. Its Cordilleran relative in the grasslands east of the Coast Mountains, *D. nigricentrus*, is seldom seen; it is recorded from Oliver and Keremeos. *Eudioctria sackeni* is a small dark asilid that hunts from leaves and twigs in forest openings and grassland copses at low and mid-elevations across southern British Columbia. It has two striking

Figure 14. *Cyrtopogon willistoni*, male. Photograph courtesy of Werner Eigelsreiter. **Figure 15.** *Eucyrtopogon* sp., male. Photograph courtesy of Werner Eigelsreiter. **Figure 16.** *Eudioctria sackeni*, male. Photograph courtesy of Werner Eigelsreiter. **Figure 17.** *Ospriocerus aeacus,* female. Photograph courtesy of John Acorn. **Figure 18.** *Stenopogon inquinatus*, female. Photograph courtesy of Werner Eigelsreiter. **Figure 19.** *Lasiopogon terricola*, female. Photograph courtesy of Deanna Dodgson. **Figure 20.** *Stichopogon trifasciatus*, male. Photograph courtesy of Dennis Paulson. **Figure 21.** *Efferia benedicti*, male. Photograph courtesy of Werner Eigelsreiter.

colour morphs; in the male of the more common one, the wings are orange basally and dark gray apically (Fig. 16). The Pacific coastal *E. nitida* ranges from south coastal British Columbia to California; it lives in Garry oak savanna habitat but also occurs in open areas on the mainland.

Heteropogon and *Holopogon* contain species that are at home in both grasslands and woodland openings, where they usually hunt for prey from perches on the tips of bare branches of shrubs and small trees. *Heteropogon senilis*, a Cordilleran fly, is recorded from the margins of southern British Columbia grasslands; *H. wilcoxi* is a Great Plains species collected in southern Alberta. The four *Holopogon* species in western grasslands are symmetrically distributed: *H. albipilosa* from British Columbia (e.g., Vernon) across the Prairies to Manitoba (e.g., Glen Souris), *H. stellatus* in British Columbia (e.g., Penticton), *H. seniculus* in Alberta (e.g., Lethbridge) and Saskatchewan (e.g., Saskatoon), and *H. vockerothi* in Manitoba (e.g., Aweme).

The medium-sized to large elongate species of *Ospriocerus*, *Scleropogon*, and *Stenopogon* are closely related; Canadian species are often typical of grasslands and hunt from the ground or low shrubs. The striking black and red, wasp-mimicking *Ospriocerus aeacus* (Fig. 17) ranges widely in western grasslands, from British Columbia (e.g., Walhachin) to Saskatchewan (Matador). The gray and orange *O. latipennis* is strictly a Great Plains species in Canada and is reported from Alberta and Manitoba. *Scleropogon bradleyi* flies in late summer in Garry oak meadows on British Columbia's south coast, although there is a single record from east of the Coast Mountains (Lytton). The Cordilleran *S. neglectus* is one of the most common asilids of the southern interior British Columbia grasslands; it ranges east into the Alberta prairies around Medicine Hat. This dry Mixed Grassland Ecoregion in southern Alberta (e.g., Drumheller, Orion, Brooks) is also home to *S. coyote*. *Stenopogon inquinatus* (Fig. 18) is perhaps the most familiar robber fly in western Canada. Big, and varying from blackish to rust coloured, it hunts a variety of large prey in habitats ranging from arid sagebrush steppe to open pine forests. It ranges from British Columbia's Peace River district to the province's south coast and hot interior valleys, from southern Alberta and Saskatchewan to the Manitoba tallgrass prairies. The smaller, orange-haired *S. rufibarbis* also ranges widely, from British Columbia's interior grasslands east to Saskatchewan.

Willistonina bilineata is a Cordilleran asilid, the sole species in its genus. Seldom encountered in Canada, it inhabits open woods and grassland borders in the southern Okanagan Valley.

Subfamily Stichopogoninae (12 species)

Two genera represent the Stichopogoninae in western Canadian grasslands: *Lasiopogon* and *Stichopogon*. They are small gray, black, or brown flies that usually inhabit sandy areas where they hunt from rocks, logs, or the ground.

The large and widespread Holarctic genus *Lasiopogon* contains the only known Beringian fauna in the Asilidae (Cannings 1997). Three species (*L. hinei, L. canus*, and *L. prima*) are East Beringian species closely related to Eurasian forms; they or their ancestors entered North America through ice-free Beringia. *Lasiopogon yukonensis* is restricted to the southern and central Yukon and distributionally qualifies as an East Beringian species, but evidently is related to Pacific coastal species (Cannings 2011*b*). These four species live on the Yukon's south-facing grassland slopes and in dune habitats. *Lasiopogon hinei* is a Palearctic–East Beringian species, with most of its range across Eurasia; since the disappearance of continental glaciers, it has expanded its range down the east side of the

Rockies into central Alberta. *Lasiopogon prima* ranges through Alaska and Yukon, reaching the Arctic Ocean to the north, Saskatchewan's Athabasca dunes in the east, and Alberta's foothills in the south. An undescribed *Lasiopogon* species closely related to *L. canus* lives along rivers in central Alberta (e.g., Edmonton) and the Peace River region of British Columbia and Alberta. *Lasiopogon cinereus* is a widespread and common Cordilleran fly of cobbly stream banks; usually it lives in forested sites, but in British Columbia's Peace River area and along the Alberta foothills and adjacent prairie (e.g., Blackfalds), it spreads into grassland. *Lasiopogon trivittatus* and *L. quadrivittatus* are Great Plains species living along streams; the former is recorded only from Alberta (e.g., Edmonton, Redcliff) and Montana, but the latter is a common grassland asilid from northeastern British Columbia (e.g., Attachie) east to Saskatchewan (e.g., Elbow, Pike Lake) and south to Nebraska and New Mexico. *Lasiopogon terricola* (Fig. 19) is common in sandy sites in the northeastern United States; its distribution map shows a long narrow finger pointing northwestward into the grasslands of Manitoba (e.g., Aweme, Carberry) and Saskatchewan (e.g., Great Sand Hills) and all the way to Alberta (e.g., Orion).

Only three *Stichopogon* species are recorded in Canada and all of them live in grasslands and sandy spots such as dunes and beaches. *Stichopogon fragilis* is a tiny silver fly (about 4 mm long) from the Okanagan grasslands at Osoyoos, British Columbia, adjacent to the United States border. Only a single specimen has been collected in Canada. The common Canadian species, *S. trifasciatus* (Fig. 20), lives on the southern Prairies from Alberta (e.g., Medicine Hat, Pakowki Lake) through Saskatchewan (e.g., Condie) to Manitoba (e.g., Aweme, Mars Sand Hills, Onah). It is the most common dune species in the southern Prairies. It also lives in southern Ontario and Quebec and over most of the United States and Mexico (Barnes 2010). *Stichopogon argenteus* ranges mostly in the northeastern United States and the northern and central Great Plains; in western Canadian grasslands, it is confined to Manitoba (e.g., Onah) (Barnes 2013).

Subfamily Asilinae (35 species)

The 11 genera of western grassland asilines contain mostly gray or brown, elongate, medium-sized to large flies, although there are small species in several genera (e.g., *Dicropaltum*, *Machimus*, *Negasilus*).

Perhaps the most distinctive and abundant grassland robber flies in western Canada are the 11 species of *Efferia*. This is the largest genus of New World asilids, with about 230 named species and many undescribed species (Fisher 2009). The genus is most diverse in the western United States and Mexico. The males have large club-shaped genitalia; the ovipositors of the females are long and sword-like and are used to place the eggs in the soil and in dead plant inflorescences. Adults fly with a loud buzzing or whining noise and mainly perch on the ground, at least in northern North America. The larvae, as in all species in the subfamily, as far as is known, develop in the soil, and those studied feed on the larvae of scarab beetles (Knutson 1972). Adult males of all species have silver-white abdominal segments; in most, only the sixth and seventh segments are white, but in some, such as *E. benedicti* (Fig. 21) and *E. staminea*, most of the segments are white and clothed with long, white hairs parted along the midline. *Efferia albibarbis* is widespread across the United States, but in Canada it occurs only in sandy grasslands in the extreme southern Okanagan Valley in British Columbia and on the beaches and associated dunes of Lake Erie and Lake Huron in Ontario. In British Columbia grasslands, *Efferia coulei* and *E. okanagana* (Fig. 22) are spring species, flying mostly in May and early June; *E. benedicti* and *E. staminea* fly mainly from mid-June to the end of July.

Efferia harveyi is active mostly from August through September. *Efferia benedicti* and *E. harveyi*, especially, often occur in high densities. Where these species occur in the same locations, their staggered flight seasons allow them to fill similar ecological niches. *Efferia okanagana* is restricted to bluebunch wheat grass habitats, especially gravelly ones, in the Okanagan and Thompson valleys and is assessed as “Endangered” by COSEWIC (Cannings 2011*a*; COSEWIC 2012). In Canada, *E. frewingi* is mainly an asilid of the Prairies Ecozone (e.g., Alberta: Calgary, Manyberries; Saskatchewan: Eastend, Estevan), but in the United States, in most of its range, it is a Cordilleran species. It is Cordilleran in British Columbia, too; it lives in the grasslands along the Columbia and Kootenay rivers immediately west of the Rocky Mountains. *Efferia bicaudata* and *E. helenae* are Great Plains species closely related to *E. frewingi*; *E. bicaudata* is the common species of dry grasslands in Alberta and Saskatchewan, while *E. helenae*, although found in all three Prairie Provinces, is the only species in Manitoba (e.g., Aweme). *Efferia costalis* and *E. subcuprea* are seldom-collected species in the Mixed Grassland Ecoregion in Alberta, and *E. costalis* is also recorded from Saskatchewan (Rockglen, Saskatchewan Landing). Males of both, but especially *E. costalis*, have a thorax that is laterally compressed, with a dense mane of long setae along the midline.

Machimus, with 10 species in western grasslands, comes a close second to *Efferia* in species diversity in the region. Species can be abundant, however, and general collections of Canadian grassland Asilidae are usually dominated by *Machimus* specimens. Unfortunately, much work is needed on this large group and species are notoriously difficult to identify. Many *Machimus* species live in both grassland and open woodland habitats, and so they are frequently common along grassland edges. This is true of the common Cordilleran species *M. callidus* (e.g., Yukon: Whitehorse; British Columbia: Vaseux Lake, Victoria; Alberta: Cowley, Opal), *M. occidentalis* (e.g., British Columbia: Penticton, Victoria), and *M. vescus* (e.g., British Columbia: Kelowna, Oliver), although *M. occidentalis* (Fig. 23) is far more likely to be common in treeless grassland habitats than are the other two species. *Machimus aridalis* and *M. delusus* are species of the semi-arid Mixed Grassland Ecoregion of the Prairies Ecozone and prefer treeless ground. *Machimus aridalis* is recorded from many sites, including Dinosaur Provincial Park, Scandia, Medicine Hat, and Lethbridge in Alberta and Killdeer in Saskatchewan. *Machimus delusus* records include Orion, Empress, and Redcliff in Alberta and Tompkins in Saskatchewan. Two common species, *Machimus erythocnemius* (Fig. 24) and *M. paropus,* belong to the widespread element and range across most of the continent; they live in western grasslands from southern British Columbia (Okanagan Valley) to southern Manitoba. *Machimus notatus* is an eastern species that ranges to Manitoba grasslands. Some *Machimus* specimens from Opal, Alberta, are possibly *M. notatus* (E.M. Fisher, pers. comm.), but more work is required to verify this identification and the resulting significant range extension.

Neomochtherus, Neoitamus, Dicropaltum, *and Negasilus* species look superficially like *Machimus* species. *Neomochtherus willistoni* lives across southern British Columbia in grasslands (including Garry oak meadows) and open coniferous woods, and flies in late summer, replacing *M. occidentalis* as the common slender gray robber fly in these habitats. *Neoitamus brevicomus* is a Cordilleran species active at the grassland–forest interface in southern British Columbia (e.g., Victoria); its congener, *N. orphne*, is an eastern equivalent living in southern Manitoba (e.g., Sandilands). *Dicropaltum* and *Negasilus* species are small asilines that are active in grasslands far from woodlands. *Dictropaltum mesae* (Fig. 25), a beautiful golden fly, is widespread in the West. It is common from British Columbia’s Chilcotin grasslands (e.g., Riske Creek) to the Okanagan Valley (e.g., Penticton), east into

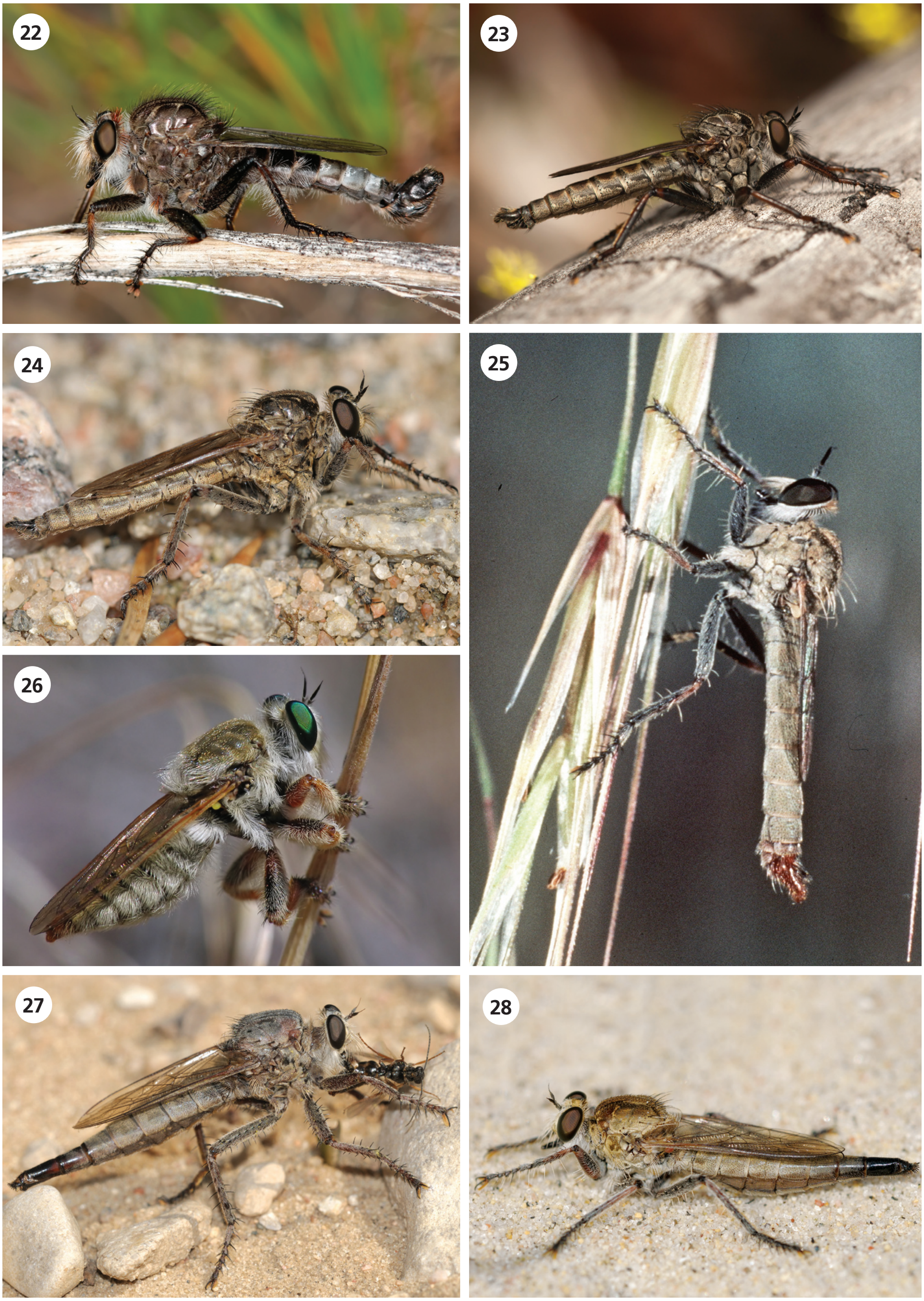

Figure 22. *Efferia okanagana*, male. Photograph courtesy of Werner Eigelsreiter. **Figure 23.** *Machimus occidentalis*, male. Photograph courtesy of Werner Eigelsreiter. **Figure 24.** *Machimus erythocnemius*, male. Photograph courtesy of Deanna Dodgson. **Figure 25.** *Dicropaltum mesae*, male. Photograph by Rob Cannings. **Figure 26.** *Megaphorus willistoni*, male. Photograph courtesy of Werner Eigelsreiter. **Figure 27.** *Proctacanthus milbertii*, female. Photograph courtesy of Deanna Dodgson. **Figure 28.** *Proctacanthella cacopiloga*, female. Photograph courtesy of Deanna Dodgson.

Alberta (e.g., Drumheller, Medicine Hat, Manyberries, Rolling Hills) and Saskatchewan (e.g., Empress Dunes, Ormiston). *Dicropaltum cumbipilosus* was described from Alberta (e.g., Etzicom Coulee, Welling, Orion, Lake Newell) (Adisoemarto 1967) and it is still not known from anywhere else. *Negasilus belli* and *N. gramalis* are similar small species that are at home in the dry Mixed Grasslands of the Prairies Ecozone, although *N. belli* is a Cordilleran element in its extensive range in the United States.

Megaphorus, *Promachus*, *Proctacanthus*, *Proctacanthella*, and *Rhadiurgus* round out the Asilinae fauna of western grasslands. *Megaphorus* species are little leaf-cutting bee mimics with fuzzy pale bodies, green eyes, and a bee-like flight around flowers. They are rare in Canada. In extreme southern British Columbia, the Cordilleran species *Megaphorus willistoni* is known from only one specimen (Chopaka, in the southern Similkameen Valley) and a single photograph (Fig. 26) from Oliver. A Great Plains species, *M. guildiana*, has been collected only in Grasslands National Park, Saskatchewan. *Promachus dimidiatus* is another Great Plains asilid from the dry southern Prairies, where it ranges from Alberta (e.g., Orion, Milk River) to Manitoba (e.g., Aweme). The two *Proctacanthus* species found in the Canadian West are the largest asilids in Canada, reaching a length of about 40 mm. Both are common in some grassland sites, especially sandy ones. *Proctacanthus milbertii* (Fig. 27), which ranges across much of the continent in the South, lives in southern British Columbia (e.g., Penticton) and Manitoba (e.g., Carberry, Elma), but has yet to be collected in Alberta or Saskatchewan. *Proctacanthus occidentalis* is a Cordilleran fly and in Canada is restricted to the southern interior of British Columbia (e.g., Osoyoos, Penticton, Big Bar). *Proctacanthella cacopiloga* (Fig. 28) is a Great Plains species common from Alberta (e.g., Medicine Hat, Writing-on-Stone Park, Wainwright), through Saskatchewan (e.g., Great Sand Hills) to Manitoba (e.g., Aweme). It is one of few Great Plains asilids that also occurs in tallgrass prairie remnants in southwestern Ontario, which at one time were connected to the more extensive western grasslands (Skevington 1999; Paiero *et al*. 2010). *Rhadiurgus variabilis* is an atypical grassland species. As a member of the boreal element, it is one of the most common asilids in the spruce forests of northern Canada, one of only two Holarctic robber flies, and one of the most northerly dwelling robber flies in the world. Cannings (1993) analyzed the geographical variation in *R. variabilis* over its huge range and documented its distribution. It is common on grassland slopes and dunes over much of Yukon, and in British Columbia, even in the south, it flies in grassland edges where high-altitude grasslands and sage steppes meet spruce and fir woods (e.g., Mt. Kobau, Osoyoos, 1,870 m).

Biogeography and Faunal Elements

Species can be grouped with others that share similar distributions to form what can be termed faunal elements. The majority of the 134 species reported here from western Canadian grasslands are restricted to the Nearctic region, although two species (*Laphria gilva* and *Rhadiurgus variablilis*) are Holarctic (defined here as species with transcontinental ranges in both North America and Eurasia). This section describes the Nearctic faunal elements; the two species with Holarctic distributions are also assigned to a North American faunal element. Those relevant to Canadian grassland Asilidae are as follows:

1. Boreal (7 species). Species mainly occurring in the northern transcontinental forests dominated by spruce (*Picea*). In general, these species range from the Atlantic Provinces across the northern New England states, Quebec, northern Ontario, parts of the northern

tier of the midwestern states, the Prairie Provinces north of the Great Plains, and northern British Columbia, often ranging considerably southward in the mountains and plateaus of the Cordillera. *Laphria gilva, L. insignis, L. janus, L. posticata, L. sadales, Cyrtopogon bimaculus, Rhadiurgus variabilis.*

2. East Beringian (3 species). Species originating in the unglaciated areas of Yukon and Alaska and restricted to the eastern (North American) side of the Bering Strait. *Lasiopogon canus, L. prima, L. yukonensis*.

3. Palearctic East Beringian (1 species). East Beringian in North America (Alaska, Yukon, and adjacent areas), but with a widespread range across Eurasia. *Lasiopogon hinei*.

4. Transition (4 species). Species generally most common at the southern margin of the boreal forest (and Aspen Parkland on the Great Plains) and adjacent montane forests in the West and in the mixed and deciduous forests in the East. *Laphria aeatus*, *L. index*, *L. scorpio*, *Cyrtopogon falto.*

5. Cordilleran (66 species). Species mostly confined to the western mountains and their intervening valleys and plateaus, but some species may extend on to the Great Plains to varying degrees. *Leptogaster arida, L. fornicata, Comantella fallei, C. pacifica, C. rotgeri, Cophura brevicornis, C. vitripennis, Lestomyia* sp., *Nicocles dives, N. pollinosus, N. utahensis, Laphria aimatis, L. asackeni, L. columbica, L. felis, L. fernaldi, L. ferox, L. franciscana, L. partitor, L. vivax, Callinicus pollenius, Coleomyia hinei, Cyrtopogon ablautoides, C. auratus, C. aurifex, C. banksi, C. dasyllis, C. fumipennis, C. glarealis, C. inversus, C. montanus, C. willistoni, Dioctria henshawi, D. pusio, Dicolonus nigricentrus, Eucyrtopogon calcaratus, E. comantis, E. diversipilosis, E. nebulo, E.* sp. near *nebulo, E. punctipennis, E. spiniger, E. varipennis, Eudioctria sackeni, Heteropogon senilis, Holopogon stellatus, Myelaphus lobicornis, Scleropogon bradleyi, S. neglectus, Willistonina bilineata, Lasiopogon cinereus, Stichopogon fragilis, Efferia benedicti, E. coulei, E. frewingi, E. harveyi, E. okanagana, E. staminea, Megaphorus willistoni, Proctacanthus occidentalis, Machimus callidus, M. occidentalis, M. vescus, Negasilus belli, Neoitamus brevicomus, Neomochtherus willistoni.*

6. Pacific Coastal (5 species). Coastal species restricted to the lowlands and lower slopes of the mountains west of the Coast Mountains. *Nicocles canadensis, Nicocles rufus, Laphria ventralis, Dicolonus simplex, Eudioctria nitida.*

7. Western (8 species). Species of western mountains and associated lowlands, but extending considerable distances eastward, often to the 100th meridian (Mississippi River). *Leptogaster arida*, *Pogonosoma ridingsi*, *Eucyrtopogon albibarbus, Holopogon albipilosus, Ospriocerus aeacus, Stenopogon inquinatus, S. rufibarbis, Dicropaltum mesae*.

8. Great Plains (23 species). Species more or less confined to the Great Plains. *Leptogaster* sp., *Laphystia canadensis*, *L. flavipes, Cyrtopogon platycaudus, Heteropogon wilcoxi, Holopogon seniculus, Ospriocerus latipennis, Scleropogon coyote, Lasiopogon quadrivittatus, L. trivittatus, L.* n. sp., *Dicropaltum cumbipilosus, Efferia bicaudata*, *E. costalis*, *E. helenae*, *E. subcuprea*, *Megaphorus guildiana, Proctacanthella cacopiloga, Promachus dimidiatus, Machimus adustus, M. aridalis, M. delusus, Negasilus gramalis.*

9. Southern (4 species). Species ranging from coast to coast south of the boreal and mixed forests. Transcontinental at least in the United States; in Canada only in extreme southern areas. *Andrenosoma fulvicaudum*, *Stichopogon trifasciatus*, *Efferia albibarbis*, *Proctacanthus milbertii*.

10. Eastern (10 species). Species ranging widely mostly east of the 100th meridian. *Tipulogaster glabrata*, *Laphria* sp. (*canis* group), *L. flavicollis*, *L. cinerea, Cyrtopogon varans, Holopogon vockerothi, Lasiopogon terricola, Machimus notatus, M. snowii, Neoitamus orphne.*

11. Widespread (3 species). Species with broad distributions in North America, from north to south and east to west, overlapping several of the other elements listed. *Stichopogon argenteus, Machimus erythocnemius*, *M. paropus.*

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References

Adisoemarto, S. 1967. The Asilidae (Diptera) of Alberta. Quaestiones Entomologicae, **3**: 3–90.

Adisoemarto, S., and Wood, D.M. 1975. The nearctic species of *Dioctria* and six related genera (Diptera, Asilidae). Quaestiones Entomologicae, **11**: 505–576.

Artigas, J.N., and Papavero, N. 1988. The American genera of Asilidae (Diptera): keys for identification with an atlas of female spermathecae and other morphological details. Part I. Key to subfamilies, subfamily Leptogastrinae. Gayana Zoologia, **52**: 95–114.

Baker, N.T., and Fischer, R.L. 1975. A taxonomic and ecologic study of the Asilidae of Michigan. The Great Lakes Entomologist, **8**: 3191.

Barnes, J.K. 2010. Revision of Nearctic *Stichopogon* species (Diptera: Asilidae) with white-banded abdomens, including description of *Stichopogon venturiensis*, new species, from coastal California. Proceedings of the Entomological Society of Washington, **112**(3): 367–380.

Barnes, J.K. 2013. The genus *Stichopogon* Loew (Diptera: Asilidae) in America north of Mexico. Proceedings of the Entomological Society of Washington, **115**(1): 936.

BC Ministry of Forests and Range. 2013. Biogeoclimatic Ecosystem Classification Program. Research Branch, Victoria, British Columbia. Available from http://www.for.gov.bc.ca/hre/becweb/ [accessed 13 February 2013].

Cannings, R.A. 1989. The robber flies (Diptera: Asilidae) of a *Festuca* grassland in the Okanagan Valley, British Columbia. Journal of the Entomological Society of British Columbia, **86**: 14–26.

Cannings, R.A. 1993. New synonomy of *Rhadiurgus variabilis* (Zetterstedt) (Diptera: Asilidae) with notes on morphology, natural history, and geographical variation. The Canadian Entomologist, **125**: 337–354.

Cannings, R.A. 1994. Robber Flies (Diptera: Asilidae) new to Canada, British Columbia, Yukon, and the Northwest Territories with notes on distribution and habitat. Journal of the Entomological Society of British Columbia, **91**: 19–26.

Cannings, R.A. 1997. Robber flies (Diptera: Asilidae) of the Yukon. *In* Insects of the Yukon. *Edited by* H.V. Danks and J.A. Downes. Biological Survey of Canada (Terrestrial Arthropods), Ottawa, Ontario. pp. 637–662.

Cannings, R.A. 2002. The Systematics of *Lasiopogon* (Diptera: Asilidae). Royal British Columbia Museum, Victoria, British Columbia.

Cannings, R.A. 2011*a*. *Efferia okanagana*, a new species of robber fly (Diptera: Asilidae) from the grasslands of southern British Columbia, Canada, with notes on taxonomy, biology, distribution and conservation status. The Canadian Entomologist, **143**: 578–593.

Cannings, R.A. 2011*b*. Robber flies (Insecta: Diptera: Asilidae). *In* Assessment of Species Diversity in the Montane Cordillera Ecozone (version 2). *Edited by* G.G.E. Scudder and I.M. Smith. pp. 461–483. Available from http://www.royalbcmuseum.bc.ca/assets/Montane-Cordillera-Ecozone.pdf [accessed 9 October 2012].

Cannings, R.A. 2012. A Checklist of the Robber Flies (Diptera: Asilidae) of British Columbia. Available from http://www.geog.ubc.ca/biodiversity/efauna/documents/RobberFliesofBCApril2012.pdf [accessed 2 August 2013].

Cannings, R.J., and Cannings, S.G. 1996. British Columbia: A Natural History. Douglas and McIntyre, Vancouver, British Columbia.

Cole, F.R., and Wilcox, J. 1938. The genera *Lasiopogon* Loew and *Alexiopogon* Curran in North America (Diptera - Asilidae). Entomologica Americana, **18**: 1–91.

COSEWIC. 2011. COSEWIC Assessment and Status Report on the Dune Tachinid Fly, *Germaria angustata*, in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario. Available from http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr%5Fdune%5Ftachinid%5Ffly%5F0911%5Feng%2Epdf [accessed 10 August 2013].

COSEWIC. 2012. COSEWIC Assessment and Status Report on the Okanagan Efferia, *Efferia okanagana,* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario. Available from http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_asile_okanagan_efferia%20_0912_e.pdf [accessed 15 September 2012].

Cronquist, A. 1978. The biota of the intermountain region in geohistorical context. Intermountain Biogeography: A symposium. Great Basin Naturalist Memoirs, **2**: 3–15.

Curran, C.H. 1923. Studies in Canadian Diptera. I. Revision of the asilid genus *Cyrtopogon* and allied genera. The Canadian Entomologist, **55**: 92–95, 116–125, 132–142, 169–174, 185–190.

Curran, C.H. 1927. Descriptions of Nearctic Diptera. The Canadian Entomologist, **59**: 79–92.

Dennis, D.S., and Barnes, J.K. 2013. Pupal cases of three Nearctic species of *Machimus* (Diptera: Asilidae). Zootaxa, **3683**(5): 561–570.

Dennis, D.S., Barnes, J.K., and Knutson, L. 2008. Pupal cases of Nearctic robber flies (Diptera: Asilidae). Zootaxa, **1868**: 1–98.

Dennis, D.S., Barnes, J.K., and Knutson, L. 2013. Review and analysis of information on the biology and morphology of immature stages of robber flies (Diptera: Asilidae). Zootaxa, **3673**(1): 164.

Dikow, T. 2009*a*. Phylogeny of Asilidae inferred from morphological characters of imagines (Insecta: Diptera: Brachycera: Asiloidea). Bulletin of the American Museum of Natural History, **319**: 1–175.

Dikow, T. 2009*b*. A phylogenetic hypothesis for Asilidae based on a total evidence analysis of morphological and DNA sequence data (Insecta: Diptera: Brachycera: Asiloidea). Organisms, Diversity and Evolution, **9**: 165–188.

Fisher, E.M. 1986. A Reclassification of the Robber Fly Tribe Andrenosomini, with a Revision of the Genus *Dasyllis* Loew (Diptera: Asilidae). Ph.D. thesis. University of California, Riverside.

Fisher, E.M. 2009. Asilidae (robber flies, assassin flies, moscas cazadoras, moscas ladronas). *In* Manual of Central American Diptera: Vol. 1. *Edited by* B.V. Brown, A. Borkent, J.M. Cumming, D.M. Wood, N.E. Woodley, and M.A. Zumbado. NRC Research Press, Ottawa, Ontario. pp. 585–632.

Fisher, E.M. 2012. Asilidae Classification. Available from http://bugguide.net/node/view/151 [accessed 15 February 2013].

Fisher , E.M., and Wilcox, J. 1997. Catalogue of the Robber Flies (Diptera: Asilidae) of the Nearctic Region. Available from http://royalbcmuseum.bc.ca/staffprofiles/files/2013/08/Catalog-Nearctic-Fisher-Wilcox-1997-manuscript-copy.pdf [accessed 7 November 2013].

Foxlee, H.R. 1942. A list of nineteen species of Asilidae collected at Robson, B.C. (Diptera). Proceedings of the Entomological Society of British Columbia, **38**: 14.

Geller-Grimm, F. 2013. Robber Flies (Asilidae) [online]. Available from http://www.geller-grimm.de/asilidae.htm [accessed 12 June 2013].

Geller-Grimm, F., and Artigas, J. 2004. Catalogue of the Nearctic Species of Asilidae. Available from http://www.geller-grimm.de/genera/nearctic/catspecies.html [accessed 12 September 2012].

Grimaldi, D. 1990. Diptera. *In* Insects from the Santana Formation, Lower Cretaceous, of Brazil. *Edited by* D. Grimaldi. Bulletin of the American Museum of Natural History, **195**: 1–191.

Hebda, R.J. 1982. Postglacial history of grasslands of southern British Columbia and adjacent regions. *In* Grassland Ecology and Classification Symposium Proceedings. *Edited by* A.C. Nicholson, A. McLean, and T.E. Baker. British Columbia Ministry of Forests, Victoria, British Columbia. pp. 157–191.

Hebda, R.J. 1995. British Columbia vegetation and climate history with focus on 6ka BP. Géographie Physique et Quaternaire, **49**: 55–79.

Hine, J.F. 1909. Robberflies of the genus *Asilus*. Annals of the Entomological Society of America, **2**: 136–172.

Hull, F.M. 1962. Robber flies of the world: the genera of the family Asilidae. Bulletin of the United States National Museum, **224**: 1–907.

Knutson, L.V. 1972. Pupa of *Neomochtherus angustipennis* (Hine), with notes on feeding habits of robber flies and a review of publications on morphology of immature stages (Diptera: Asilidae). Proceedings of the Biological Society of Washington, **85**: 163–178.

Lehr, P.A. 1998. Robber flies of the genus *Cyrtopogon* Loew, 1847 (Diptera: Asilidae) of the Palaearctic [English translation from the Russian]. Entomological Review, **78**: 1042–1065.

McAlpine, J.F. 1979. Diptera. *In* Canada and Its Insect Fauna. *Edited by* H.V. Danks. Memoirs of the Entomological Society of Canada, **108**: 389–424.

Martin, C.H. 1975. The generic and specific characters of four old and six new Asilini genera in the western United States, Mexico, and Central America (Diptera: Asilidae). Occasional Papers of the California Academy of Sciences, **119**: 1–107.

Martin, C.H., and Wilcox, J. 1965. Family Asilidae. *In* A Catalogue of the Diptera of America North of Mexico. *Edited by* A. Stone, C.W. Sabrosky, W.W. Wirth, R.H. Foote, and J.R. Coulson. United States Department of Agriculture, Agriculture Research Service, Washington, D.C. Agriculture Handbook, **276**: 360–401.

Meidinger, D.V., and Pojar, J. (*Editors*) 1991. Ecosystems of British Columbia. Special Report Series 6, Research Branch, BC Ministry of Forests, Victoria, British Columbia. Available from http://www.for.gov.bc.ca/hfd/pubs/Docs/Srs/Srs06.htm [accessed 20 October 2012].

Melin, D. 1923. Contributions to the knowledge of the biology, metamorphosis and distribution of the Swedish asilids in relation to the whole family of asilids. Zoologiska Bidrag från Uppsala, **8**: 1–317.

Nicholson, A.C., Pojar, J., and Hamilton, E.H. 1982. Introduction. *In* Grassland Ecology and Classification Symposium Proceedings. *Edited by* A.C. Nicholson, A. McLean, and T.E. Baker. British Columbia Ministry of Forests, Victoria, British Columbia. pp. 157–191.

Paiero, S.M., Marshall, S.A., Pratt, P.D., and Buck, M. 2008. Diptera. *In* Insects of Ojibway Prairie, a Southern Ontario Tallgrass Prairie. Available from http://www.uoguelph.ca/debu/Insects_Of_Ojibway_Species_List_2008.pdf [accessed 31 March 2013].

Paiero, S.M., Marshall, S.A., Pratt, P.D., and Buck, M. 2010. Insects of Ojibway Prairie, a southern Ontario tallgrass prairie. *In* Arthropods of Canadian Grasslands, Vol. 1: Ecology and Interactions in Grassland Habitats. *Edited by* J.D. Shorthouse and K.D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 199–225.

Papavero, N. 1973. Studies of Asilidae (Diptera) systematic and evolution. I. A preliminary classification in subfamilies. Arquivos de Zoologica da Universidade de São Paulo, **23**: 217–274.

Scudder, G.G.E. 1997. Environment of the Yukon. *In* Insects of the Yukon. *Edited by* H.V. Danks and J.A. Downes. Biological Survey of Canada (Terrestrial Arthropods), Ottawa, Ontario. pp. 13–57.

Shorthouse, J.D. 2010*a*. Ecoregions of Canada's prairie grasslands. *In* Arthropods of Canadian Grasslands, Vol. 1: Ecology and Interactions in Grassland Habitats. *Edited by* J.D. Shorthouse and K.D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 53–81.

Shorthouse, J.D. 2010*b*. Ecoregions with grasslands in British Columbia, the Yukon, and Southern Ontario. *In* Arthropods of Canadian Grasslands, Vol. 1: Ecology and Interactions in Grassland Habitats. *Edited by* J.D. Shorthouse and K.D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 83–103.

Skevington, J.H. 1999. New Canadian records of Asilidae (Diptera) from an endangered Ontario ecosystem. Great Lakes Entomologist, **32**: 257–265.

Skevington, J., Stead, K., Caloren, D., and Connop, J. 2000. The Insects of North Lambton County, Ontario, Canada [online]. Lambton Wildlife Incorporated. Available from http://www.uoguelph.ca/debu/Lambton-intro.htm [accessed 24 July 2013].

Theodor, O. 1980. Diptera: Asilidae. Fauna Palestina: Insecta II. The Israel Academy of Sciences and Humanities, Jerusalem.

Wilcox, J. 1966. *Efferia* Coquillett in America north of Mexico (Diptera: Asilidae). Proceedings of the California Academy of Sciences, **34**: 85–234.

Wilcox, J. 1971. The genera *Stenopogon* Loew and *Scleropogon* Loew in America north of Mexico (Diptera: Asilidae). Occasional Papers of the California Academy of Sciences, **89**: 1–134.

Wilcox, J., and Martin, C.H. 1936. A review of the genus *Cyrtopogon* Loew in North America (Diptera - Asilidae). Entomologica Americana, **16**: 1–95.

Wild Species. 2005. Wild Species: The General Status of Species in Canada [online]. Available from http://www.wildspecies.ca/searchtool.cfm?lang=e [accessed 28 June 2013].

Wild Species. 2010. Wild Species: The General Status of Species in Canada. Available at http://www.wildspecies.ca/wildspecies2010/results-insects-odonates.cfm?lang=e [accessed 28 June 2013].

Wilson, M.V.H. 1978. Paleogene insect faunas of western North America. Quaestiones Entomologicae, **14**: 13–34.

Wood, G.C. 1981. Asilidae. *In* Manual of Nearctic Diptera. Vol. 1. *Coordinated by* J.F. McAlpine, B.V. Peterson, G.E. Shewell, H.J. Teskey, J.R. Vockeroth, and D.M. Wood. Agriculture Canada Monograph **27**: 549–573.

Chapter 8
An Annotated List of Ants (Hymenoptera: Formicidae) from the Grasslands of Alberta and Saskatchewan

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Abstract. A list of 53 species of ants, all known from the grassland regions of Alberta and Saskatchewan, is presented, along with collecting localities and annotations regarding the biology of each species. As the fauna is not well-known, this list is considered preliminary.

Résumé. Ce chapitre présente une liste de 54 espèces de fourmis décrites dans les régions des prairies de l'Alberta et de la Saskatchewan, ainsi que des informations sur les lieux de capture et des détails sur la biologie de chaque espèce. Cette faune étant toujours mal connue, cette liste doit être considérée comme préliminaire.

Introduction

In North American grasslands, ants play a significant role in the turnover of soil, nutrient cycling, and the breakdown of organic matter (Briese 1982; Smidt *et al*. 2012). They are important predators of other invertebrates and significant prey for both invertebrates and vertebrates (Sanders and van Veen 2011). As herbivores, ants can be effective seed harvesters, which frequently results in seed dispersal (Turnbull *et al*. 1983; Berg-Binder and Suarez 2012), and are often counted as secondary herbivores by feeding on the honeydew from farmed Sternorrhyncha (Newton *et al*. 2011). With such diverse ecological roles, it is clear that ants are important to grassland ecosystems.

Many factors can affect the diversity of ants in grassland ecosystems, and grasslands in both Alberta and British Columbia show high ant diversity compared with other northern temperate ecosystems (Heron 2005; Glasier 2012). Soil attributes are often cited as the most influential determinant of ant diversity in grassland ecosystems (Bestelmeyer and Wiens 2001; Boulton *et al*. 2005). Soils with high clay content tend to have lower species diversity, whereas sandier soils have high species diversity (Bestelmeyer and Wiens 2001; Glasier 2012; Radtke *et al.* 2014). Croplands have a negative effect on ant diversity, both because of tillage (Robertson *et al*. 1994; Yates and Andrew 2011) and because of the use of pesticides (Choate and Drummond 2012); only an estimated 30% of the mixedgrass prairie remains undisturbed in North America (Hall *et al*. 2011). Grazing has varying effects on ant diversity in grassland ecosystems (Heron 1996; Folgarait 1998; Smidt *et al.* 2012), and moderate grazing has increased ant diversity in the Okanagan of British Columbia (Heron 1996; Smidt *et al*. 2012), suggesting that appropriate rangeland management can maintain or enhance biodiversity. Many grassland ants in Alberta have

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mutualistic relationships with sternorrhynchans (Newton *et al*. 2011), which can have both positive and negative effects on sternorrhynchan host plants (Perry *et al.* 2004). Invasive plant species tend to have little effect on ant diversity (French and Major 2001; Radtke *et al.* 2014), although the presence of ants may be beneficial to invasive plants (Berg-Binder and Suarez 2012). In Grasslands National Park, Saskatchewan, ant composition, but not diversity, has been shown to change when an introduced grass, *Agropyron cristatum* (Linnaeus), is present in an area (Radtke *et al.* 2014).

The following annotated list of grassland ants from Alberta and Saskatchewan is based on studies by Newton *et al*. (2011), Glasier (2012), and Radtke *et al*. (2014) and an examination of collections from the University of Alberta E. H. Strickland Museum, the University of Calgary entomology collection, and James Glasier's personal collection. It is noteworthy that in Alberta, 14 of the 16 known ant genera and 55 of the 93 known species are found in grasslands (Glasier *et al.* 2013), while in Saskatchewan (with a less well-known fauna), 11 of the 12 known ant genera and 33 of the 60 known species are found in grasslands (Glasier *et al.* 2013). Additionally, like many other organisms (e.g., Hall *et al*. 2011), many ant species found in Canadian grasslands are at the northerly extent of their ranges (Heron 2005; Glasier *et al.* 2013).

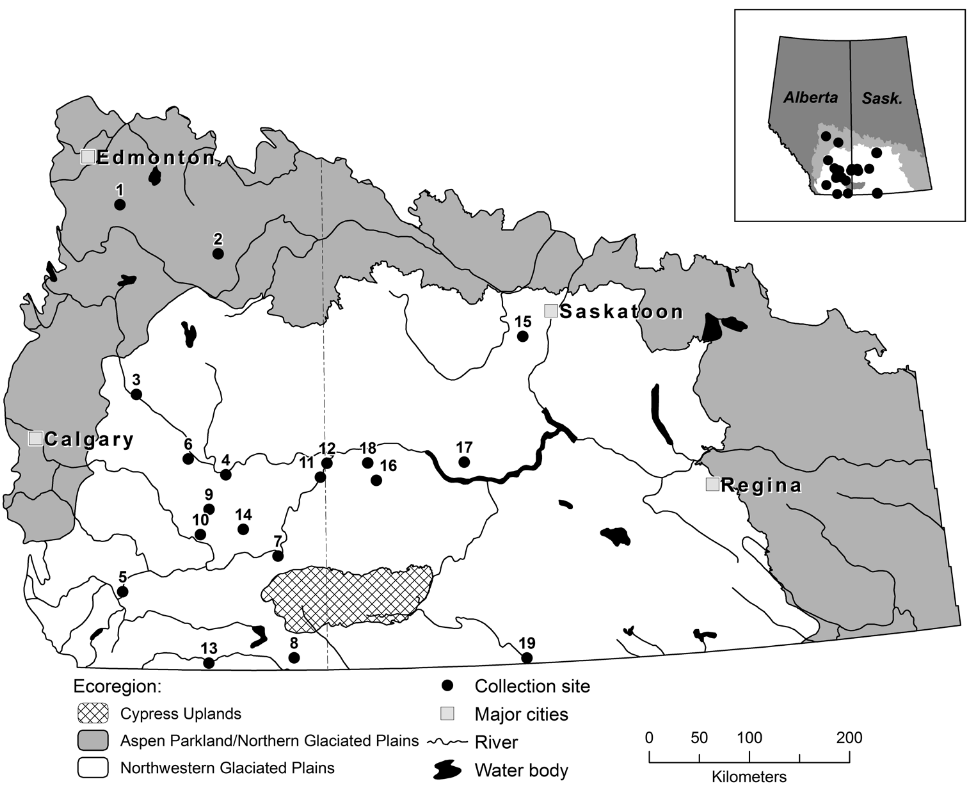

Fig. 1. Map of grassland localities where ants were sampled in Alberta and Saskatchewan. Locality names and descriptions can be found in Table 1.

Checklist of Grassland Ants of Alberta and Saskatchewan

The following checklist of 53 species is arranged according to the classification of Fisher and Cover (2007). All have been reported from grasslands in Alberta or Saskatchewan. Localities are described in Table 1 and are mapped out in Fig. 1.

Sources for Locality Records in Species List

A: Collected by the authors. Voucher specimens have been deposited in the E. H. Strickland Entomological Museum at the University of Alberta.
BDCU: University of Calgary Entomology Collection, Calgary, Alberta.
HK: Hansen and Klotz (2005).
JN: Newton *et al*. (2011).
PMAE: Royal Alberta Museum Entomology Collection, Edmonton, Alberta.
R: Radtke *et al*. (2014): Voucher specimens have been deposited in the E. H. Strickland Entomological Museum at the University of Alberta.
UASM: E.H. Strickland Museum, University of Alberta.
WW: Wheeler and Wheeler (1986).

Family Formicidae
- Subfamily Dolichoderinae:
  - Genus *Tapinoma*
    - *Tapinoma sessile* (Say)
- Subfamily Formicinae:
  - Genus *Brachymyrmex*
    - *Brachymyrmex depilis* Emery
  - Genus *Camponotus*
    - Subgenus *Camponotus*
      - *Camponotus modoc* Wheeler
    - Subgenus *Myrmetoma*
      - *Camponotus nearcticus* Emery
    - Subgenus *Tanaemyrmex*
      - *Camponotus vicinus* Mayr
  - Genus *Formica*
    - *Formica fusca* Group
      - *Formica argentea* Wheeler
      - *Formica canadensis* Santschi
      - *Formica montana* Wheeler
      - *Formica neoclara* Emery
      - *Formica subpolita* Mayr
      - *Formica podzolica* Francoeur
    - *Formica neogagates* Group
      - *Formica bradleyi* Wheeler
      - *Formica lasioides* Emery
      - *Formica limata* Wheeler
      - *Formica neogagates* Viereck
      - *Formica perpilosa* Wheeler
    - *Formica sanguinea* Group
      - *Formica aserva* Forel
      - *Formica emeryi* Wheeler
      - *Formica obtusopilosa* Emery
      - *Formica rubicunda* Emery
    - *Formica microgyna* Group
      - *Formica microgyna* Wheeler
    - *Formica rufa* Group
      - *Formica fossaceps* Buren
      - *Formica obscuripes* Forel
      - *Formica obscuriventris* Mayr
      - *Formica oreas* Wheeler
      - *Formica planipilis* Creighton
    - *Formica exsectoides* Group:
      - *Formica opaciventris* Mayr
  - Genus *Lasius*:
    - Subgenus *Acanthomyops*
      - *Lasius coloradensis* Wheeler
      - *Lasius latipes* (Walsh)
      - *Lasius subglaber* Emery
    - Subgenus *Lasius*
      - *Lasius alienus* (Förster)
      - *Lasius crypticus* Wilson
      - *Lasius neoniger* Emery
      - *Lasius niger* (Linnaeus)
      - *Lasius pallitarsis* (Provancher)
    - Subgenus *Cautolasius*
      - *Lasius fallax* Wilson
      - *Lasius flavus* (Fabricius)
    - Subgenus *Cthonolasius*
      - *Lasius subumbratus* Viereck
      - *Lasius umbratus* (Nylander)
- Subfamily Myrmicinae
  - Genus *Formicoxenus*
    - *Formicoxenus provancheri* (Emery)
  - Genus *Myrmica*
    - *Myrmica americana* Weber
    - *Myrmica brevispinosa* Wheeler
    - *Myrmica crassirugus* Francoeur
    - *Myrmica fracticornis* Forel
    - *Myrmica incompleta* Provancher
    - *Myrmica latifrons* Stärcke
    - *Myrmica* undescribed species code AF-eva André Francoeur
  - Genus *Leptothorax*
    - *Leptothorax muscorum* (Nylander)
  - Genus *Monomorium*
    - *Monomorium minimum* (Buckley)
  - Genus *Pogonomyrmex*
    - *Pogonomyrmex occidentalis* (Cresson)
  - Genus *Solenopsis*
    - *Solenopsis molesta* (Say)
  - Genus *Temnothorax*
    - *Temnothorax ambiguus* (Emery)
    - *Temnothorax rugatulus* (Emery)

Table 1. Grassland sites in Alberta and Saskatchewan where ant specimens have been collected. All sites are in alphabetical order and are mapped in Fig. 1.

Grassland Site	Province	Map ID Number	Description
Clearwater Lake	Saskatchewan	17	Semi-forested with *Populus* spp. with open prairie
Delisle	Saskatchewan	15	Grassed grassland
Dinosaur Provincial Park	Alberta	4	Badlands and cottonwood flats
Drumheller	Alberta	3	Badlands and cottonwood flats
Empress Sand Dunes	Alberta	12	Semi-overgrown sand dunes covered in prairie
Grasslands National Park	Saskatchewan	19	Dry mixed shortgrass prairie
Great Sand Hills	Saskatchewan	16	Open to semi-overgrown sand dunes covered in grassland with sporadic stands of *Populus* spp.
Hay Lakes	Alberta	1	Aspen parkland and grassland
Kinsella Ranch	Alberta	2	Aspen parkland and fescue grassland
Lethbridge	Alberta	5	Urban area
Mattheis Ranch: University of Alberta Rangeland Institute	Alberta	6	Mixed grazed natural prairie, along with overgrown sand dunes
Medicine Hat	Alberta	7	Urban area
Onefour Station	Alberta	8	Mixed grassland
Prelate	Saskatchewan	18	Prairie
Rolling Hills	Alberta	10	Prairie
Sandy Point	Alberta	11	Prairie, salt flats, and coulee areas
Suffield Military Base	Alberta	14	Native mixedgrass prairie
Tilley	Alberta	9	Prairie
Writing-on-Stone Provincial Park	Alberta	13	Badlands and cottonwood flats

Species Annotations:

Brachymyrmex depilis Emery

Distribution: Most of southern Canada and most of the United States (Wheeler and Wheeler 1986; Mackay and Mackay 2002).

Grassland Sites: Alberta: Sandy Point Park (A).

Biological Notes: Tiny (length 1.5–2.0 mm), monomorphic, light-amber coloured ants (Mackay and Mackay 2002). Colonies are often polygynous. This ant is widespread across North America. *B. depilis* is primarily subterranean, making it difficult to find (Wheeler and Wheeler 1963). It feeds on small arthropods and farms subterranean Sternorrhyncha (Wheeler and Wheeler 1963; Mackay and Mackay 2002).

Camponotus modoc Wheeler

Distribution: British Columbia to central Alberta, south to California and New Mexico (Wheeler and Wheeler 1986; Mackay and Mackay 2002; Hansen and Klotz 2005).

Grassland Sites: AB: Dinosaur Provincial Park (A), Kinsella Ranch (JN); SSK: Reported but no locality given (HK).

Biological Notes: Large (length 7.0–13.0 mm), dimorphic, black with blackish-red thoraces (Hansen and Klotz 2005). Colonies are usually monogynous (Hansen and Klotz 2005). Can be structural pests in rotten wood, but usually nest in the heartwood of live trees or in dead wood. Often farm Sternorrhyncha on trees or bushes (Hansen and Klotz 2005).

Camponotus nearcticus Emery
Distribution: Central Alberta south to New Mexico, British Columbia to Nova Scotia (Wheeler and Wheeler 1986; Mackay and Mackay 2002; Hansen and Klotz 2005).
Grassland Sites*:* AB: Dinosaur Provincial Park (A), Drumheller (UASM), Mattheis Ranch (A); SSK: Reported but no locality given (HK).
Biological Notes: Medium sized (length 4.0–7.0 mm), dimorphic, red and black ants (Hansen and Klotz 2005). Colonies are often polygynous (Hansen and Klotz 2005). An arboreal species, commonly nests in dead branches of deciduous trees. Probably far more common than collected, because nests are often found in the upper canopy of trees and therefore difficult to find. Colonies farm Sternorrhyncha on the leaves of their home trees (Hansen and Klotz 2005).

Camponotus vicinus Mayr
Distribution: Central Alberta south to New Mexico, British Columbia to Saskatchewan (Wheeler and Wheeler 1986; Mackay and Mackay 2002; Hansen and Klotz 2005)
Grassland Sites: AB: Dinosaur Provincial Park (A); SSK: Grasslands National Park (A).
Biological Notes: Large (length 7.0–13.0 mm), dimorphic, black and red ants. Colonies are polygynous (Hansen and Klotz 2005). Often nest in soil, though will also use dead wood. Often found in drier habitats compared to other *Camponotus* species. Sometimes structural pests of wooden structures (Hansen and Klotz 2005).

Formica argentea Wheeler
Distribution: Most common in central and western North America; from southern British Columbia to southern Quebec, and Central Alberta to southern Arizona (Franceour 1973; Wheeler and Wheeler 1986).
Grassland Sites: AB: Dinosaur Provincial Park (A), Lethbridge (A), Mattheis Ranch (A), Sandy Point Park (A); SSK: Clearwater Lake (BDCU), Great Sand Hills (BDCU).
Biological Notes: Medium sized (length 3.0–6.5 mm), polymorphic, black ants. Found in woodlands or areas with some brush cover, such as pin cherry (*Prunus pensylvanica* Linnaeus). Often nests in sandier soils; creating low mounds. Smaller colonies are often found under rocks. Farm Sternorrhyncha on low lying bushes and are predators of other arthropods. *Formica argentea* are a host for several slave-making ant species, including *Formica aserva* (Mackay and Mackay 2002).

Formica aserva Forel
Distribution: Most of North America except for the most extreme northern and southern areas (Wheeler and Wheeler 1986; Mackay and Mackay 2002).
Grassland Sites: AB: Dinosaur Provincial Park (A).
Biological Notes: Medium (length 4.0–6.0 mm), polymorphic, red and black ants. Colonies are polygynous. An adaptable species, found in a wide range of habitats. Often found nesting in dead wood. A facultative slave maker of *Formica podzolica, Formica argentea*, and *Formica neoclara* (Ellison *et al.* 2012). Farms Sternorrhyncha on shrubs and trees, and are major predators of other invertebrates (Wheeler and Wheeler 1963).

Formica bradleyi Wheeler
Distribution: Prairie provinces of Canada and great plains of the United States (Mackay and Mackay 2002).
Grassland Sites: AB: Empress Sand Dunes (A), Mattheis Ranch (A); SSK: Great Sand Hills (A).

Biological Notes: Small (length 3.0–5.0 mm), polymorphic, reddish-orange ants. Found exclusively in very sandy soils, most common in sand dune fields (Wheeler and Wheeler 1963). Farms Sternorrhyncha on grasses and hunts invertebrates for food (Mackay and Mackay 2002).

Formica canadensis Santschi
Distribution: South western Canada and the western United States (Francoeur 1973; Wheeler and Wheeler 1986; Mackay and Mackay 2002).
Grassland Sites: AB: Dinosaur Provincial Park (A), Sandy Point (A); SSK: Grassland National Park (PMAE), Great Sand Hills (A).
Biological Notes: Medium sized (length 4.0–6.0 mm), polymorphic, brownish-black ants (Mackay and Mackay 2002). Found in open prairies, often in domed nests with an extremely hard outer layer. Farms aphids on low-lying plants and is a predator of other invertebrates.

Formica emeryi Wheeler
Distribution: Alberta south to Colorado (Greg 1963).
Grassland Sites: AB: Medicine Hat (UASM); SSK: Grassland National Park (PMAE)
Biological Notes: Medium sized (5.0–7.0 mm), polymorphic, brownish-red and black ants. Facultative slave makers of the *Formica neogagates* group (Gregg 1963). A rare ant within its range.

Formica fossaceps Buren
Distribution: Southern parts west and central Canada and mid-western United States (Wheeler and Wheeler 1986; Mackay and Mackay 2002).
Grassland Sites: AB: Onefour Station (A), Writing on Stone Provincial Park (A).
Biological Notes: Large (length 3.5–8.0 mm), polymorphic, red and black ants. Build large, domed nests in woodlands and open grasslands (Wheeler and Wheeler 1963). This ant has been reported to farm Sternorrhyncha (Bradley and Hinks 1968) but little other biological information is known.

Formica lasioides Emery
Distribution: Southern-western Canada, and the majority of the western United States (Wheeler and Wheeler 1986; Mackay and Mackay 2002).
Grassland Sites: AB: Kinsella Ranch(JN), Mattheis Ranch (A), Sandy Point Park (A); SSK: Delisle (BDCU), Grassland National Park(R)(PMAE).
Biological Notes: Small (length 2.5–5.0 mm), polymorphic, reddish-black ants. Found in a wide range of habitats, but nests are usually cryptic and not very obvious (Wheeler and Wheeler 1963, 1986; Mackay and Mackay 2002). This species is host to several slave-making species, including *Formica obtusopilosa* and *Formica rubicunda* (Wheeler and Wheeler 1986; Mackay and Mackay 2002).

Formica limata Wheeler
Distribution: Southern-western Canada, and the majority of the western United States (Wheeler and Wheeler1986; Mackay and Mackay 2002).
Grassland Sites: AB: Empress Sand Dunes (A), Suffield Military Base (PMAE); SSK: Clearwater Lake (BDCU), Grasslands National Park (R)(PMAE).
Biological Notes: Small (length 2.5–5.0 mm), polymorphic, reddish-brown ants. Colonies

are small often cryptic and hard to find. Are known to tend Sternorrhyncha on grasses, but also hunt other invertebrates (Wheeler and Wheeler 1963).

Formica microgyna Wheeler
Distribution: South western Canada and west central United States (Wheeler and Wheeler 1986; Mackay and Mackay 2002).
Grassland Sites: AB: Mattheis Ranch (A); SSK: Grasslands National Park (R)(PMAE).
Biological Notes: Medium sized (length 5.5–7.0 mm), polymorphic, red and black ants. This species constructs thatched nests in open areas or nests under logs and stones. A temporary social parasite of *fusca* group ants (Wheeler and Wheeler 1963), once the colony becomes established it is known to enslave a wide range of *Formica* species, from the *fusca* group, *neogagates* group and even a few species from the *rufa* group (Mackay and Mackay 2002).

Formica montana Wheeler
Distribution: Southern extremes of western Canada and western United States (Franceour 1973; Wheeler and Wheeler 1986; Mackay and Mackay 2002).
Grassland Sites: AB: Sandy Point Park (A), Tilley (BDCU); SSK: Clearwater Lake (BDCU), Grasslands National Park (R)(PMAE).
Biological Notes: Medium sized (length 4.0–6.0 mm), polymorphic, dark brown ants (Mackay and Mackay 2002). Found in open prairies, often in domed nests. Farms aphids on low-lying plants and is a predator of other invertebrates.

Formica neoclara Emery
Distribution: Most of North America; from Yukon to California: British Columbia to North Dakota (Wheeler and Wheeler 1986).
Grassland Sites: AB: Dinosaur Provincial Park (A), Empress Sand Dunes (A), Lethbridge (A), Mattheis Ranch (A), Medicine Hat (A), Sandy Point Park (A), Tilley (BDCU); SSK: Clearwater Lake (BDCU), Grasslands National Park(R)(PMAE), Great Sand Hills (A), Prelate (BDCU),.
Biological Notes: Medium sized (length 3.0–6.0 mm), polymorphic, reddish-yellow and brown ants. Forms low-lying mound colonies which are often polygynous (Mackay and Mackay 2002). Commonly found in disturbed areas, including urban areas, and around farm buildings (Wheeler and Wheeler 1986). Host to many of the *Formica sanguinea* group slave making ants.

Formica neogagates Viereck
Distribution: Middle to Southern Canada, and the majority of the western United States (Wheeler and Wheeler1986; Mackay and Mackay 2002).
Grassland Sites: AB: Empress Sand Dunes (A), Mattheis Ranch (A), Sandy Point Park (A); SSK: Clearwater Lake(BDCU), Grasslands National Park(R)(PMAE), Great Sand Hills (A)(BDCU).
Biological Notes: Small (length 2.5–5.0 mm), polymorphic, brown ants. A common species, found in a wide range of habitats; from woodlands to open grasslands (Mackay and Mackay 2002). This species is host to several slave-making species, including *Formica obtusopilosa* and *Formica rubicunda* (Wheeler and Wheeler 1986; Mackay and Mackay 2002).

Formica obscuripes Forel
Distribution: Common across most of North America: New Mexico to Central Alberta;

British Columbia to Michigan (Wheeler and Wheeler 1986; Mackay and Mackay 2002).
Grassland Sites: AB: Dinosaur Provincial Park (A), Mattheis Ranch (A); SSK: Delisle (BDCU), Clearwater Lake (BDCU), Grasslands National Park (R)(PMAE), Great Sand Hills (BDCU).
Biological Notes: Medium sized (length 3.5–7.5 mm), polymorphic, red and black ants. This ant makes large, thatched, domed nests. They are often found farming Sternorrhyncha, but are also important predators of other invertebrates (Wheeler and Wheeler 1963, 1986). These are some of the more aggressive grassland ant species, vigorously defending their nests and "domesticated" Sternorrhyncha.

Formica obscuriventris Mayr
Distribution: Common across most western North America (Wheeler and Wheeler 1986; Mackay and Mackay 2002).
Grassland Sites: AB: Dinosaur Provincial Park (A), Kinsella (JN).
Biological Notes: Medium sized (length 3.5–7.5 mm), polymorphic, dark red and black ants. This ant makes large, thatched, domed nests. Aggressively defend their nests, food sources, and farmed Sternorrhyncha (Wheeler and Wheeler 1986). Often found in woodland areas (Wheeler and Wheeler 1963).

Formica obtusopilosa Emery
Distribution: Alberta to Minnesota, southward to New Mexico (Wheeler and Wheeler 1986).
Grassland Sites: AB: Mattheis Ranch (A), Rolling Hills (A); SSK: Grasslands National Park (R)(PMAE).
Biological Notes: Medium sized (length 3.5–6.5 mm), polymorphic, red and black ants. Quick moving, facultative slave making ant; enslaves *Formica neogagates* and *F. fusca* groups (Wheeler and Wheeler 1963). Builds low lying mounds or nests under rocks (Mackay and Mackay 2002).

Formica opaciventris Mayr
Distribution: Alberta to North Dakota; south to Nevada (Wheeler and Wheeler 1986).
Grassland Sites: AB: Sandy Point Park (A).
Biological Notes: Medium sized (length 4.5–6.0 mm), polymorphic, yellowish-red and black ants. Found in a range of habitats, from open grasslands to forest edges (Mackay and Mackay 2002). This species forms low domed mounds with some thatching (Wheeler and Wheeler 1963; Mackay and Mackay 2002). Farms Sternorrhyncha and can be aggressive in defending their nests (Wheeler and Wheeler 1963)

Formica oreas Wheeler
Distribution: West central North America: Alberta to New Mexico: British Columbia to Saskatchewan (Wheeler and Wheeler 1986; Mackay and Mackay 2002).
Grassland Sites: AB: Dinosaur Provincial Park (A), Kinsella Ranch (JN), Mattheis Ranch (A); SSK: Clearwater Lake (BDCU).
Biological Notes: Medium sized (length 3.5–7.0 mm), polymorphic, red and black ants. Aggressive in the defense of their nests and food sources (Wheeler and Wheeler 1986). Often tend Sternorrhyncha (Wheeler and Wheeler 1986). Build low lying, thatched nests. Found in woodlands and along the edge of forests (Mackay and Mackay 2002).

Formica perpilosa Wheeler
Distribution: Southern edge of western Canada, and the majority of the western United States (Wheeler and Wheeler1986; Mackay and Mackay 2002).
Grassland Sites: AB: Empress Sand Dunes (A); SSK: Grasslands National Park (R).
Biological Notes: Small (length 2.5–5.0 mm), polymorphic, dark-red and black ants. Often found in dry, open habitats. Build low mounds, often at the base of plants (Mackay and Mackay 2002).

Formica planipilis Creighton
Distribution: West central North America: Alberta to New Mexico: British Columbia to Saskatchewan (Wheeler and Wheeler 1986; Mackay and Mackay 2002).
Grassland Sites: AB: Dinosaur Provincial Park (A), Mattheis Ranch (A), Suffield Military Base (A); SSK: Reported but no locality given (WW).
Biological Notes: Medium sized (length 3.5–6.5 mm), yellowish-red and black ants. Found in a wide range of habitats; riparian woodlands to moist grasslands (Mackay and Mackay 2002). Builds low lying thatched nests. Often farms Sternorrhyncha, especially on shrubs (Wheeler and Wheeler 1963).

Formica podzolica Francoeur
Distribution: Most of North America except for the most extreme north and south areas (Francoeur 1973; Mackay and Mackay 2002).
Grassland Sites: AB: Dinosaur Provincial Park (A), Drumheller (A), Medicine Hat (A), Mattheis Ranch (A); SSK: Delisle (BDCU).
Biological Notes: Medium sized (length 3.0–6.0 mm), polymorphic, black ants. Often found in lawns, urban areas, and slightly disturbed areas (Mackay and Mackay 2002). Like *Formica argentea,* often found in areas with brush or tree cover, and builds large, low lying mounds. Colonies are polygynous. This species is a host for several slave-making ant species, including *Formica aserva* (Savolainen and Deslippe 2001).

Formica rubicunda Emery
Distribution: Southern Canada and most of the United States (Mackay and Mackay 2002).
Grassland Sites: AB: Mattheis Ranch (A); SSK: Grasslands National Park (PMAE).
Biological Notes: Medium sized (length 3.5–6.0 mm), polymorphic, red and black ants. This species constructs thatched nests in open areas or nests under logs and stones (Wheeler and Wheeler 1963). It is known to enslave a wide range of *Formica* species, from the *fusca* group, *neogagates* group, and even the *rufa* group (Mackay and Mackay 2002).

Formica subpolita Mayr
Distribution: Western North America, British Columbia south to California (Clark and Blom 2007).
Grassland Sites: AB: Medicine Hat (UASM).
Biological Notes: Medium sized (length 3.0–5.5 mm), polymorphic, dark red ants. Has been associated with sage brush (Clark and Blom 2007), and often found in riparian woodlands. Known to tend Sternorrhyncha (Mackay and Mackay 2002). Locally abundant, but uncommon in Alberta.

Formicoxenus provancheri (Emery)
Distribution: Canada and northern United States

Grassland Sites: AB: Hay Lakes (A), Sandy Point Park (A).
Biological Notes: Small (length 2.5–3.0 mm), monomorphic, red ants. A guest ant that has only been found in *Myrmica incompleta* nests. This ant relies on its host to supply food and protection, but often builds its own galleries adjacent to the host galleries, where it houses its larva.

Lasius alienus (Förster)
Distribution: Most of North America (Wheeler and Wheeler 1963)
Grassland Sites: AB: Dinosaur Provincial Park (A), Drumheller (UASM), Medicine Hat (UASM).
Biological Notes: Small (length 2.0–3.0 mm), monomorphic, dark brown ants. An uncommon species in Alberta. Farm Sternorrhyncha both above and below ground (Mackay and Mackay 2002). Commonly nests in wood or under stones in well shaded areas (Wheeler and Wheeler 1963).

Lasius coloradensis Wheeler
Distribution: British Columbia to Manitoba; South to New Mexico (Wheeler and Wheeler 1986).
Grassland Sites: AB: Kinsella Ranch (JN), Mattheis Ranch (A), Sandy Point Park (A); SSK: Grasslands National Park (PMAE).
Biological Notes: Small (length 2.0–4.0 mm), monomorphic, yellowish-orange ants. Nests are subterranean and can be difficult to find; small mounds at the base of plants can be used to help detect their colonies (Mackay and Mackay 2002). Farm subterranean Sternorrhyncha on plant roots (Newton *et al*. 2011). When crushed give off a strong citronella smell (Wheeler and Wheeler 1963).

Lasius crypticus Wilson
Distribution: Western North America
Grassland Sites: AB: Dinosaur Provincial Park (A), Drumheller (UASM), Kinsella Ranch (JN), Mattheis Ranch (A), Onefour Station (A), Sandy Point Park (A); SSK: Grasslands National Park(R)(PMAE), Great Sand Hills(A)(BDCU).
Biological Notes: Small (length 2.5–3.5 mm), monomorphic, yellowish-brown ants. Colonies are often polygynous and spread over a wide area. Common in grasslands and open areas (Mackay and Mackay 2002). Farms Sternorrhyncha below ground on plant roots, but also opportunistically hunts arthropods (Wheeler and Wheeler 1963; Newton *et al*. 2011).

Lasius fallax Wilson
Distribution: Most of North America (Wheeler and Wheeler 1963)
Grassland Sites: AB: Hay Lakes (A), Kinsella Ranch (JN).
Biological Notes: Tiny (length 2.0–2.5 mm), monomorphic, yellow ants. Often found in more wooded areas compared to *Lasius flavus* (Mackay and Mackay 2002). Colonies are subterranean, where workers farm Sternorrhyncha on the roots of plants (Newton *et al*. 2011).

Lasius flavus (Fabricius)
Distribution: Most of North America (Wheeler and Wheeler 1963)
Grassland Sites: AB: Kinsella Ranch (JN), Mattheis Ranch (A), Sandy Point Park (A).
Biological Notes: Tiny (Length 2.0–2.5 mm), monomorphic, yellow ants. Colonies are subterranean, where workers farm Sternorrhyncha on the roots of plants (Newton *et al*.

2011). Commonly found in grassland and more open areas.

Lasius latipes (Walsh)
Distribution: Southern Canada and most of the central United States (Mackay and Mackay 2002).
Grassland Sites: AB: Empress Sand Dunes (A), Mattheis Ranch (A), Suffield Military Base (PMAE), Sandy Point Park (A); SSK: Great Sand Hills (A).
Biological Notes: Small (length 3.0–4.0 mm), monomorphic, brownish-yellow ants. A temporary social parasite of other *Lasius* species such as *L. neoniger* and *L. crypticus* (Mackay and Mackay 2002); freshly mated queens invade host colonies, kill the host queen and the workers then help her raise her own workers until the colony becomes mono-specific with just *L. latipes* workers. Farm subterranean Sternorrhyncha on plant roots (Wheeler and Wheeler 1963). Mature colonies build small to medium mounds in the prairies.

Lasius neoniger Emery
Distribution: Most of North America (Wheeler and Wheeler 1963)
Grassland Sites: AB: Dinosaur Provincial Park (A), Drumheller (UASM), Empress Sand Dunes (A), Kinsella Ranch (JN), Lethbridge (A), Medicine Hat (A), Mattheis Ranch (A), Onefour Station (A), Sandy Point Park (A) Tilley (BDCU); SSK: Grasslands National Park (R)(PMAE), Great Sand Hills (A).
Biological Notes: Small (length 2.5–3.5 mm), monomorphic, yellowish-brown ants. A common ant species known for making small craters around a singular entrance (Mackay and Mackay 2002). Colonies are often polygynous and cover a large area. Farms Sternorrhyncha below ground on plant roots, but also opportunistically hunts other invertebrates (Newton *et al*. 2011).

Lasius niger Linnaeus
Distribution: Most of North America (Mackay and Mackay 2002)
Grassland Sites: AB: Dinosaur Provincial Park (A), Kinsella (JN).
Biological Notes: Small (length 2.5–3.5 mm), monomorphic, dark brown ants. Found shaded areas, often along forest edges (Mackay and Mackay 2002). Farms Sternorrhyncha below and above ground, but also opportunistically hunts other invertebrates (Newton *et al*. 2011).

Lasius pallitarsis (Provancher)
Distribution: Most of western North America (Wheeler and Wheeler 1963)
Grassland Sites: AB: Kinsella Ranch (JN), Mattheis Ranch (A); SSK: Clearwater Lake (BDCU), Delisle (BDCU), Grasslands National Park (R)(PMAE).
Biological Notes: Small (length 2.5–4.5 mm), monomorphic, yellowish-brown ants. A common ant across most of Alberta. Often nest in moist environments; including dead wood and under rocks (Wheeler and Wheeler 1963). Observed farming Sternorrhyncha on both the roots and bases of grasses and other plants (Newton *et al*. 2011).

Lasius subglaber Emery
Distribution: Southern Canada to Midwestern United States (Wheeler and Wheeler 1963).
Grassland Sites: AB: Kinsella Ranch (JN).
Biological Notes: Small (length 2.5–3.0 mm), monomorphic, brown ants. Difficult to find, because of its subterranean habits. As with most *Lasius*, this species farms subterranean Sternorrhyncha on plant roots (Newton *et al*. 2011).

Lasius subumbratus Viereck
Distribution: Most of North America (Wheeler and Wheeler 1963)
Grassland Sites: AB: Hay Lakes (A); SSK: Grasslands National Park (R)(PMAE).
Biological Notes: Small (length 3.0–4.0 mm), monomorphic, pale yellow ants. Temporary social parasite of *Lasius pallitarsis*; Queens invade host colonies, kill the host queen and the workers then help her raise her own workers until the colony becomes mono-specific with just *L. subumbratus* workers (Wheeler and Wheeler 1963). Often nests under rocks and dead wood. Farm subterranean Sternorrhyncha on the roots of plants (Wheeler and Wheeler 1963).

Lasius umbratus (Nylander)
Distribution: Most of North America (Wheeler and Wheeler 1963)
Grassland Sites: AB: Mattheis Ranch (A), Sandy Point Park (A); SSK: Grasslands National Park (PMAE).
Biological Notes: Small (length 3.0–4.0 mm), monomorphic, yellowish-orange ants. Temporary social parasites of *Lasius alienus, L. crypticus*, and *L. neoniger*. Queens invade host colonies, kill the host queen and the workers then help her raise her own workers until the colony becomes mono-specific with just *L. umbratus* workers (Wheeler and Wheeler 1963). Nests can form large mounds when colonies reach a large enough population. Farm subterranean Sternorrhyncha on the roots of plants (Wheeler and Wheeler 1963).

Leptothorax muscorum (Nylander)
Distribution: Most of North America (Mackay and Mackay 2002).
Grassland Sites: AB: Kinsella Ranch (JN); SSK: Grasslands National Park (PMAE).
Biological Notes: Tiny (length 2.0–3.0 mm), monomorphic, dark reddish-brown ants. A common species across North America, it may be a species complex of multiple cryptic species; taxonomic work is in dire need (Fisher and Cover 2007). Often found in forested or shaded areas (Wheeler and Wheeler 1963). Nests are most commonly found in dead wood (Lindgren and McIsaac 2002).

Monomorium minimum (Buckley)
Distribution: Southern Canada, most of the United States and into Mexico (Wheeler and Wheeler 1986).
Grassland Sites: AB: Mattheis Ranch (A), Sandy Point Park (A); SSK: Clearwater Lake (BDCU), Grasslands National Park (R)(PMAE).
Biological Notes: Tiny (length 1.5 mm), monomorphic, black ants. Has very populous, polygynous colonies (Wheeler and Wheeler 1986; Mackay and Mackay 2002). Nest in a wide variety of areas. Feed on a wide range food; including Sternorrhyncha honey-dew, plant secretions, and other invertebrates.

Myrmica americana Weber
Distribution: Southern Canada and most of the United States (Wheeler and Wheeler 1963).
Grassland Sites: AB: Empress Sand Dunes (A), Suffield Military Base (PMAE); SSK: Grasslands National Park (R)(PMAE).
Biological Notes: Medium (length 4.5–6 mm), monomorphic, dark red ants. An aggressive *Myrmica* species, it bites and stings when disturbed (Wheeler and Wheeler 1963). Found almost exclusively in open grasslands (Wheeler and Wheeler 1963). *Myrmica americana* is an opportunistic feeder and has a diet of invertebrates, fruits, plant excretions, and are known to tend Sternorrhyncha (Wheeler and Wheeler 1963; Mackay and Mackay 2002).

Myrmica brevispinosa Wheeler
Distribution: Most of North America (Wheeler and Wheeler 1963).
Grassland Sites: AB: Empress Sand Dunes (A), Suffield Military Base (PMAE); SSK: Grasslands National Park (R)(PMAE), Great Sand Hills (A)
Biological Notes: Medium (3.5–6.0 mm), monomorphic, orange-brown ants. Associated with sandy soils (Ellison *et al*. 2012). Nests under stones, or in cryptic nests often in shaded areas (Mackay and Mackay 2002). Omnivorous, eats insects and plant exudates (Ellison *et al*. 2012).

Myrmica crassirugis Francoeur
Distribution: Western North America (Francoeur 2007).
Grassland Sites: AB: Mattheis Ranch (A); SSK: Grasslands National Park (R)(PMAE), Great Sand Hills (A).
Biological Notes: Medium (length 3.5–5.5 mm), monomorphic, dark red ants. Often found in sandy soils (Francoeur 2007). Omnivorous; has been observed moving insects to their nests, as well as collecting juices from a dropped orange.

Myrmica fracticornis Forel
Distribution: Most of North America (Wheeler and Wheeler 1963)
Grassland Sites: AB: Dinosaur Provincial Park (A), Kinsella Ranch (JN).
Biological Notes: Medium (length 3.5–5.5 mm), monomorphic, dark red ants. Colonies are often polygynous. Often found in wetter areas (Ellison *et al*. 2012). Nest in wood or small irregular shaped mounds. Diet consists of arthropods, fruit, plant secretions, and are known to farm aphids (Newton *et al*. 2011).

Myrmica incompleta Provancher
Distribution: Most of North America (Wheeler and Wheeler 1986)
Grassland Sites: AB: Hay Lakes (A), Sandy Point Park (A).
Biological Notes: Medium (length 4.5–5.5 mm), monomorphic, dark red ants. Often found in wetter areas in organic or clay based soils, rarely sandy soils (Ellison *et al*. 2012). Nest in wood or small irregular shaped mounds. Colonies are often polygynous. Diet consists of arthropods, fruit, plant secretions, and will farm Sternorrhyncha both above and belowground. Host to the guest ant *Formicoxenus provancheri* (Mackay and Mackay 2002).

Myrmica latifrons Stärcke
Distribution: Most of North America (Mackay and Mackay 2002)
Grassland Sites: AB: Kinsella Ranch (JN), Mattheis Ranch (A); SSK: Grasslands National Park (R)(PMAE).
Biological Notes: Medium (length 4.0–5.0 mm), monomorphic, dark red ants. Often found in moist areas and usually more shaded areas (Wheeler and Wheeler 1963; Ellison *et al*. 2012). Nests are small irregular shaped mounds in the soil. Omniovorous, feeds on fruit, nectar and insects (Ellison *et al*. 2012).

Myrmica (undescribed species) code AF-eva by André Francoeur
Distribution: Much of North America (Ellison *et al.* 2012).
Grassland Sites: AB: Dinosaur Provincial Park (A), Empress Sand Dunes (A), Mattheis Ranch (A); SSK: Grasslands National Park (R)(PMAE), Great Sand Hills (A).
Biological Notes: Medium (4.0–5.5 mm), monomorphic (though size can vary between

workers within a nest), brownish-red ants. Nests usually have one main entrance, often with a small mound around it. Observed eating other insects, collecting seeds, and farming Sternorrhyncha at the base of grass stems.

Pogonomyrmex occidentalis (Cresson)
Distribution: Great Plains (Wheeler and Wheeler 1986).
Grassland Sites: AB: Lethbridge (A), Medicine Hat (A)(UASM), Sandy Point Park (A); SSK: Great Sand Hills (A).
Biological Notes: Large (length 6.5–8.0 mm), polymorphic, orangish-red ants. Nests are typically covered in fine gravel, but other materials are sometimes used and form a low cone shape (Wheeler and Wheeler 1986). This species is known to have a painful sting, though is often only aggressive if its nest is disturbed. Harvests seeds from a wide range of plants, but prefer grass seeds, and will also take insects as food (Wheeler and Wheeler 1963).

Solenopsis molesta (Say)
Distribution: Southern Canada, most of the United States and into Mexico (Wheeler and Wheeler 1986).
Grassland Sites: AB: Sandy Point Park (A); SSK: Grasslands National Park (R)(PMAE).
Biological Notes: Tiny (length 1.0–1.7 mm), monomorphic, brown ants. Often called a "thief-ant" because they often nests near colonies of larger ants; where they will periodically dig into the others nests and steal stored food or take larva and eggs (Wheeler and Wheeler 1986). In Alberta often found near *Pogonomyrmex occidentalis* nests. One of the smallest ants present in Alberta and Saskatchewan.

Tapinoma sessile (Say)
Distribution: Most of North America (Wheeler and Wheeler 1986; Mackay and Mackay 2002).
Grassland Sites: AB: Dinosaur Provincial Park (A), Drumheller (UASM), Empress Sand Dunes (A), Hay Lakes (A), Kinsella Ranch (JN), Lethbridge (A), Medicine Hat (A), Mattheis Ranch (A), Suffield Military Base (PMAE), Onefour Station (A), Writing on Stone Provincial Park (A); SSK: Clearwater Lake (BCDU), Delisle (BCDU), Grasslands National Park (R)(PMAE), Great Sand Hills (A), Prelate (BCDU).
Biological Notes: Small (length 2.0–3.0 mm), monomorphic, gray to light brown ants. Colonies are often polygynous (Klotz *et al*. 2008). This species has been known to invade houses in search of food (Klotz *et al*. 2008). Found in a wide range of habitats, has a wide range of nesting habits and is opportunistic in its food exploitation; it will farm Sternorrhyncha (Newton *et al*. 2011), hunt other invertebrates, will exploit plant secretions, and fruit (Wheeler and Wheeler 1963; Wheeler and Wheeler 1986). When crushed, they smell of rotten coconut (Klotz *et al*. 2008).

Temnothorax ambiguus (Emery)
Distribution: Most of North America (Wheeler and Wheeler 1963)
Grassland Sites: AB: Dinosaur Provincial Park (A), Kinsella Ranch (JN); SSK: Grasslands National Park (R)(PMAE).
Biological Notes: Small (length 2.0 mm), monomorphic, yellowish-brown ants. Often found in shaded areas (Wheeler and Wheeler 1963). In Dinosaur Provincial Park, this species is often found in Plains Cottonwood (*Populus* sp.) woodlands. Nests in the soil, with colonies extending into hollow stems of plants (Ellison *et al*. 2012).

Temnothorax rugatulus (Emery)
Distribution: Western North America: southern Alberta south to New Mexico (Wheeler and Wheeler 1986).
Grassland Sites: AB: Mattheis Ranch (A), Kinsella Ranch (JN); SSK: Grasslands National Park (R)(PMAE).
Biological Notes: Small (length 2.0 mm), monomorphic, brown ants. Often nests under stones. In its northern range this species is found in open grasslands but in more southern habitats is also found in woodland areas (Mackay and Mackay 2002). Colonies are often polygynous (Mackay and Mackay 2002).

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References

Berg-Binder, M.C., and Suarez, A.V. 2012. Testing the directed dispersal hypothesis: are native ant mounds (*Formica* sp.) favorable microhabitats for an invasive plant? Oecologia, **169**: 763–772.

Bestelmeyer, B.T., and Wiens, J.A. 2001. Ant biodiversity in semiarid landscape mosaics: the consequences of grazing vs. natural heterogeneity. Ecological Applications, **11**: 1123–1140.

Boulton, A.M., Davies, K.F., and Ward, P.S. 2005. Species richness, abundance, and composition of ground-dwelling ants in northern California grasslands: role of plants, soil, and grazing. Environmental Entomology, **34**: 96–104.

Bradley, G.A. and Hinks, J.D. 1968. Ants, aphids, and Jack Pine in Manitoba. The Canadian Entomologist, **100**: 40–50.

Briese, D.T. 1982. The effect of ants on the soil of a semi-arid saltbush habitat. Insectes Sociaux, **29**: 375–382.

Choate, B., and Drummond, F.A. 2012. Ant diversity and distribution (Hymenoptera: Formicidae) throughout Maine lowbush blueberry fields in Hancock and Washington counties. Environmental Entomology, **41**: 222–232.

Clark, W.H., and Blom, P.E. 2007. Ants of the Idaho National Laboratory. Sociobiology, **49**: 1–117.

Ellison, A.M., Gotelli, N.J., Farnsworth, E.J., and Alpert, G.P. 2012. A Field Guide to the Ants of New England. Yale University Press, New Haven.

Fisher, B.L., and Cover, S.P. 2007. Ants of North America: A Guide to the Genera. University of California Press, Los Angeles.

Folgarait, P.J. 1998. Ant biodiversity and its relationship to ecosystem functioning: a review. Biodiversity and Conservation, **7**: 1221–1244.

Francoeur, A. 1973. Revision taxonomique des espesce nearctiques du groupe *Fusca*, genre *Formica* (Formicidae, Hymenoptera). Memoires de la Société Entomologique du Quebec, **3**: 1–316.

Francoeur, A. 2007. The *Myrmica punctiventris* and *M. crassirugis* species groups in the Nearctic region. *In* Advances in Ant Systematics (Hymenoptera: Formicidae): Homage to E. O. Wilson—50 Years of Contributions, Vol. 80. *Edited by* R.R. Snelling, B.L. Fisher, and P.S. Ward. Memoirs of the American Entomological Institute, pp. 153–185.

French, K., and Major, R.E. 2001. Effect of an exotic Acacia (Fabaceae) on ant assemblages in South African fynbos. Austral Ecology, **26**: 303–310.

Glasier, J.R.N. 2012. Community Ecology of Ants (Hymenoptera: Formicidae) in the Central Sand Hills of Alberta, and a Key to the Ants of Alberta. M.Sc. thesis, University of Alberta, Edmonton.

Glasier, J.R.N., Acorn, J.H., Nielsen, S., Proctor, H. 2013. Ants (Hymenoptera: Formicidae) of Alberta: A key to species based primarily on the worker caste. Canadian Journal of Arthropod Identification No. 22, 4 July, 2013. Available online at http://www.biology.ualberta.ca/bsc/ejournal/ganp_22/ganp_22.html. http://dx.doi.org/10.3752/cjai.2013.22

Gregg, R.E. 1963. The Ants of Colorado. University Colorado Press, Boulder.

Hall, P.W., Catling, P.M., and Lafontaine, J.D. 2011. Insects at risk in the prairie region. *In* Arthropods of Canadian Grasslands, Vol. 2: Inhabitants of a Changing Landscape. *Edited by* K.D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 323–349.

Hansen, L.D., and Klotz, J.H. 2005. The Carpenter Ants of the United States and Canada. Cornell University Press, Ithaca, New York.

Heron, J. 1996. The effect of Grazing on Ant (Hymenoptera: Formicidae) Diversity in the South Okanagan Grasslands. M.Sc. thesis, University of British Columbia, Vancouver.

Heron, J. 2005. Ants of the South Okanagan grasslands, British Columbia. Arthropods of Canadian Grasslands, **11**: 17–22.

Klotz, J., Hansen, L., Pospischil, R., and Rust, M. 2008. Urban Ants of North America and Europe. Cornell University Press, Ithaca, New York.

Lindgren, B.S., and MacIsaac, A.M. 2002. A preliminary study of ant diversity and of ant dependence on dead wood in central interior British Columbia. *In* Symposium Proceedings: Ecology and Management of Dead Wood in Western Services. *Edited by* P.J. Shea, Laudenslayer, W.F., Jr., Valentine, B., Weatherspoon, C.P., and Lisle, T.E. USDA Forest Service Gen. Tech. PSW-GTR-181, SW. Res. Stn., Albany, California. pp. 111–119.

Mackay, W., and Mackay, E. 2002. The Ants of New Mexico (Hymenoptera: Formicidae). The Edwin Mellen Press, Lewiston, New York.

Newton, J.S., Glasier, J., Maw, H.E.L., Proctor, H.C., and Foottit, R.G. 2011. Ants and subterranean Sternorrhyncha in a native grassland in east-central Alberta. The Canadian Entomologist, **143**: 518–523.

Perry, J.C., Mondor, E.B., and Addicott, 2004. An indirect mutualism: ants deter seed predators from ovipositing in yucca fruit. Canadian Journal of Zoology, **82**: 823–827.

Radtke, T.M., Glasier, J.R.N., and Wilson, S.D. 2014. Species composition and abundance of ants and other invertebrates in stands of crested wheatgrass (*Agropyron cristatum*) and native grasslands in the northern Great Plains. Canadian Journal of Zoology, **92**: 49–55.

Robertson, L.N., Kettle, B.A., and Simpson, G.B. 1994. The influence of tillage practices on soil microfauna in a semiarid agroecosystem in northeastern Australia. Agriculture, Ecosystem, and Environment, **48**: 149–152.

Sanders, D., and van Veen, F.J.F. 2011. Ecosystem engineering and predation: the multi-trophic impact of two ant species. The Journal of Animal Ecology, **80**: 569–576.

Savolainen, R., and Deslippe, R. 2001. Facultative and obligate slave making in *Formica* ants. Naturwissenschaften, **88**: 347–350.

Smidt, A.C., Fraser, L.H., Carlyle, C.N., and Bassett, E.R.L. 2012. Does cattle grazing affect ant abundance and diversity in temperate grasslands? Rangeland Ecology Magazine, **65**: 292–298.

Turnbull, C.L., Beattie, A.J., and Hanzawa, F.M. 1983. Seed dispersal by ants in the Rocky Mountains. The Southwestern Naturalist, **28**: 289–293.

Wheeler, G.C., and Wheeler, J. 1963. The Ants of North Dakota. University of North Dakota Press, Grand Forks.

Wheeler, G.C., and Wheeler, J. 1986. The Ants of Nevada. Natural History Museum of Los Angeles County, Los Angeles.

Yates, M., and Andrew, N.R. 2011. Comparison of ant community composition across different land-use types: assessing morphological traits with more common methods. Australian Journal of Entomology, **50**: 118–124.

Chapter 9
Ichneumonidae (Hymenoptera) of the Canadian Prairies Ecozone: A Review

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Abstract. The parasitoid family Ichneumonidae is the largest family in the order Hymenoptera. This chapter provides a checklist of 1,160 ichneumonid species (299 genera) known from the Canadian Prairies Ecozone. The list is primarily drawn from literature records and also includes 35 newly recorded species from the ecozone. The number of species on the list is a vast underestimate of the number of ichneumonid species present, as many genera lack revisions and few biodiversity surveys have been conducted. Most species recorded from this ecozone are only known from the Nearctic region, but are not restricted to the Prairies Ecozone. Little is known about the ecology, habitat requirements, or host associations of most ichneumonid species, with 43% of the species on the checklist lacking any host records. Future research should include revisions of the many genera that have not been studied in the Nearctic region, as well as biodiversity surveys in prairie habitats, rearing of potential host species, and the creation of user-friendly identification resources.

Résumé. Les guêpes parasitoïdes de la famille des Ichneumonidae forment la plus grande famille de l'ordre des hyménoptères. Le présent chapitre dresse la liste des 1 160 espèces de cette famille, réparties en 299 genres, présentes dans l'écozone des prairies. Cette liste, établie principalement à partir de sources documentaires, fait état de 35 nouvelles mentions provenant de l'écozone. Elle sous-estime cependant très largement le nombre d'espèces d'ichneumonidés présentes puisque de nombreux genres n'ont toujours pas fait l'objet d'une révision et que les études sur la biodiversité restent peu nombreuses. La plupart des espèces recensées dans cette écozone ne sont connues que dans la région néarctique, mais ne sont pas limitées à l'écozone des prairies. On sait peu de choses sur l'écologie, les besoins en matière d'habitat ou les hôtes des ichneumonidés, et la liste n'a aucune information à fournir sur les hôtes de 43 % des espèces répertoriées. Les recherches futures devraient inclure des révisions des nombreux genres qui n'ont toujours pas été étudiés dans la région néarctique, l'étude de la biodiversité dans les habitats des prairies, l'élevage d'espèces hôtes possibles et la création de ressources documentaires d'identification facile à utiliser.

Introduction

Ichneumonidae is the largest family within the order Hymenoptera and may be among the largest insect families on earth (Gauld 1991). It consists of at least 24,268 described species (Yu *et al.* 2012) and has an estimated world total of over 100,000 species (Gauld 2002). The family is monophyletic and is one of two families (with Braconidae) that make up the superfamily Ichneumonoidea (Sharkey and Wahl 1992;

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doi: http://dx.doi.org/10.3752/9780968932179.ch9 Species checklist available at http://dx.doi.org/10.5886/5r772nsm
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Belshaw *et al*. 1998). Ichneumonoidea has been hypothesized to be the sister group of Aculeata (Rasnitsyn 1988; Dowton and Austin 1994); more recent studies, however, have not supported this relationship. Instead, strong evidence suggests that the superfamily is sister to Proctotrupomorpha (Heraty *et al.* 2011; Sharkey *et al.* 2012), or to Aculeata + Proctotrupomorpha (Sharanowski *et al.* 2010). According to the most recent taxonomically comprehensive analysis, 38 subfamilies are currently recognized within Ichneumonidae (Quicke *et al.* 2009). Their boundaries and relationships are still highly unresolved, however, and several subfamilies are currently paraphyletic (Quicke *et al.* 2009).

Parasitoids are insects that are free-living as adults, but whose larvae live and feed entirely on or in a single host arthropod, ultimately killing it (Godfray 1994). With the exception of a few species that are predators on spider eggs (Fitton *et al*. 1987) and a very few that may be partly herbivorous (Gauld 1983), all ichneumonids are parasitoids (Gauld and Bolton 1988). Within this basic lifestyle, however, there is a wide range of life histories. Most species parasitize Holometabola, in particular Lepidoptera and Symphyta, but a wide range of hosts is known, including several species that attack Araneae (Fitton *et al.* 1987; Gauld and Bolton 1988). Ichneumonidae species can be classified as either idiobionts (parasitoids that prevent their hosts from developing further) or koinobionts (parasitoids that allow the host to continue to develop) (Askew and Shaw 1986). Within each of these strategies, they can be further classified as ectoparasitoids or endoparasitoids. All host life stages (egg, larval, pupal, and rarely, adult) are prone to attack by different species of Ichneumonidae. Finally, ichneumonids can be primary parasitoids and either obligate or facultative hyperparasitoids (Gauld and Bolton 1988; Gauld 1991).

Some ichneumonid species are highly host specific, whereas others are generalists. In general, koinobionts are thought more likely to be host specialists because of being highly physiologically intertwined with their hosts, whereas idiobionts may have a wider host range (Askew and Shaw 1986; Gauld 1988*a*), but are often specific in a particular niche (e.g., hosts in silk, or hosts in woody material) (Gauld 1988*a*; Godfray 1994).

Summary of Taxonomic and Biodiversity Studies in the Canadian Prairies Ecozone

Despite the abundance, diversity, and ecological importance of Ichneumonidae, there is a dearth of ecological studies or biodiversity surveys on them in general, and a near absence of such studies in the Canadian Prairies. The information contained within this chapter is thus almost entirely drawn from taxonomic studies. In particular, a great many Nearctic groups were revised by H. K. Townes and C. E. Dasch, though many other workers made great contributions to the knowledge of Nearctic species.

A preliminary list of the natural enemies of Canadian agricultural pests was drawn from the literature by Graham (1965), though no localities beyond province were provided. Bradley (1974, 1978) compiled lists of forest Lepidoptera parasitoids in three ichneumonid subfamilies (Ichneumoninae, Metopiinae, Pimplinae) from rearings and museum collections. Although these species were examined in the context of forest pest enemies, many records are from the Prairies Ecozone. Sharkey *et al.* (1987) studied the parasitoids associated with sunflower in Alberta and Saskatchewan. Finnamore (1994) conducted a survey of the Hymenoptera of Wagner Natural Area, a spring fen within the Aspen Parkland Ecoregion, which included an estimated 665 species of Ichneumonidae.

Extensive collecting by E.H. Strickland led to the publication of his checklist of Alberta Ichneumonoidea (1946, 1952), with many records from the Prairies Ecozone. In Manitoba, many ichneumonid species (as well as other taxa such as Carabidae; see Chapter 1, this volume) are known from the collecting efforts of N. Criddle and associates around Aweme.

In this chapter, I provide a checklist of all Ichneumonidae species recorded from the Canadian Prairies Ecozone, with localities and a summary of host records. This list consists primarily of published records, with the addition of 35 new records for the region. I also summarize the biogeographical and ecological patterns of these species in the Canadian Prairies and discuss the gaps in our current knowledge.

Approach

Region

The Canadian Prairies Ecozone extends across the southern portions of Alberta, Saskatchewan, and Manitoba. It includes seven ecoregions, most of which are grassland dominated (Shorthouse 2010). Greater amounts of tree cover are found in the Aspen Parkland Ecoregion, which is a transitional zone between prairie grasslands and boreal forest; in the Cypress Upland Ecoregion; and in the Southwest Manitoba Uplands Ecoregion (Shorthouse 2010). This chapter lists all ichneumonid species that have been recorded from the Prairies Ecozone. Since habitat associations were not given for the vast majority of records, locality was used as the criterion for whether a species should be included in the checklist. When in doubt, I erred on the side of including species. For example, many records are from Waterton Lakes National Park, Alberta, with no further data. Since the park includes the ecologically important Fescue Grassland Ecoregion (Shorthouse 2010), I included these records, although they are equally likely to have come from non-prairie habitats at higher elevations. I also used a relaxed northern border; since the Aspen Parkland Ecoregion has been highly altered by agriculture, and this agricultural land extends beyond what would have historically been parkland habitat and into the boreal, I used the current agricultural limit as an approximate northern boundary. This limit is arbitrary since few species appear to be restricted to the Prairies Ecozone; most species found in the Aspen Parkland Ecoregion have ranges extending into the Boreal Plains Ecozone. I did not include records from the Prairie Provinces (Alberta, Saskatchewan, and Manitoba) that had no locality data beyond province; many of these are undoubtedly from the Prairies Ecozone as well. The Ichneumonidae subfamilies are summarized in Table 1, and a checklist of the Ichneumonidae of the Prairies Ecozone is provided in Table 2.

Literature Review

This checklist consists almost entirely of previously published species records. To obtain the list, I extracted all published records of Ichneumonidae from Alberta, Saskatchewan, and Manitoba from the Taxapad database of Ichneumonoidea (Yu *et al.* 2012). Each reference was examined for locality data, and the list was pruned to include only those species that were recorded from the Prairies Ecozone. In some cases, records were excluded where subsequent revisions rendered them doubtful. For example, many species recorded from the Prairies Ecozone of Alberta by Strickland (1946, 1952) belong to genera that have since been revised by researchers who had access to his collections. I therefore excluded records that are, according to the more recent revisions, well outside the range of the species. In addition, to avoid duplicating records where a subsequent revision almost certainly referred to the same specimen(s) as an earlier revision or description, I included only the most recent revision in Table 2. For non-revisionary work (e.g., Strickland 1946, 1952; Bradley 1974, 1978), all records were included, though this may have resulted in multiple records of the same specimens. I excluded any records that were not identified to the species level. Finally, the checklist contains 113 species that were not part of the Taxapad-generated list (Yu *et al.* 2012). Seventy-eight of these records are from the literature and 35 are newly recorded from the Prairies Ecozone in this publication. With the exception of newly published records from my own work, I did not examine specimens to confirm any of the species identities included herein, as the scope of such a project would be monumental.

Unpublished Records

Unpublished records were extracted from the database of the Wallis-Roughley Museum of Entomology at the University of Manitoba, Winnipeg, Manitoba. These consist of 149 new locality records and include 25 species that had not been previously recorded from the Prairies Ecozone. An additional 103 new locality records, including 10 new species records, are included from a survey of Pimplinae, Poemeniinae, and Rhyssinae in the Aspen Parkland Ecoregion of Alberta (MDS, unpublished). All previously unpublished localities and species records are in bold in Table 2.

Host Records

A list of all recorded hosts for the species included in the checklist was extracted from the Taxapad Ichneumonoidea database (Yu *et al.* 2012), and the number of host species recorded for each ichenumonid species is included in Table 2. This includes all records from throughout the range of the parasitoid, rather than being limited to the Canadian Prairies. The host families and guilds parasitized by each species were summarized by J. Dombroskie (Cornell University Insect Collection). I did not distinguish between primary and secondary hosts; for most hyperparasitoids, records of both are included.

Diversity and Distribution Patterns

Species and localities from 124 publications are recorded in the checklist (Table 2). Thirty-one of these publications are of an ecological or experimental nature; the remaining 93 references consist of revisions, checklists, and compilations of data.

Species from 24 subfamilies of Ichneumonidae are recorded from the Canadian Prairies Ecozone (Table 1). The subfamily Adelognathinae (*Adelognathus*) has been collected in the Aspen Parkland Ecoregion of Alberta (Finnamore 1994; MDS, unpublished) and in Spruce Woods Provincial Park, Manitoba (B. Sharanowski, pers. comm.); however, no specimens have been identified to species. One species from the Palearctic subfamily Collyrinae (*Collyria coxator* (Villers)) was introduced to Swift Current, Saskatchewan, in the 1930s and to Lethbridge, Alberta, in 1960 to control the wheat stem sawfly (*Cephus cinctus* Norton) (Smith 1931, 1961). However, there is no evidence that the species became established at either location (Smith 1961; Shanower and Hoelmer 2004; Wahl *et al*. 2007; Cárcamo and Beres 2013).

Table 1. Summary of Ichneumonidae subfamilies recorded from the Canadian Prairies Ecozone. Abbreviations: K = Koinobiont; I = Idiobiont; En = Endoparasitoid; Ec = Ectoparasitoid; H = Hyperparasitoid.

Subfamily	Biology[1]	Hosts[1]	Nearctic Identification Resources	Genera	Species
Acaenitinae	K, En	Concealed Coleoptera	Townes and Townes 1960	3	5
Anomaloninae	K, En	Lepidoptera, Coleoptera	Dasch 1984	10	64
Banchinae	K, En	Lepidoptera	Townes and Townes 1978 (Banchini and Atrophini); Dasch 1988 (Glyptini)	12	136
Campopleginae	K, En	Lepidoptera (most); also Symphyta, Coleoptera, Raphidioptera	Genera: Townes 1970*b*; many species described by Viereck (1925–1926*a*,*b*); revisions include Walley 1947; Sanborne 1984, 1986*a*,*b*,*c*; Wahl 1987	22	142
Cremastinae	K, En	Concealed Lepidoptera (most); also Coleoptera	Dasch 1979	6	36
Cryptinae	I, Ec (most)	Holometabola (most); also Araneae egg sacs	Genera: Townes 1970*a*; Species: Townes and Townes 1962 (Cryptini); Townes and Gupta 1962 (Hemigasterini); Townes 1983 (some Phygadeuontini); Luhman 1990 (*Endasys*)	58	143
Ctenopelmatinae	K, En	Symphyta (most); also Lepidoptera	Genera: Townes 1970*b*; several genera revised by Barron (1981, 1986, 1990, 1992, 1994, 1997) and Leblanc (1989, 1999)	31	78
Cylloceriinae	K, En	Tipulidae	Dasch 1992	2	3
Diacritinae	Unknown	Unknown	Dasch 1992	1	1
Diplazontinae	K, En	Syrphidae	Dasch 1964	11	45
Eucerotinae	H[2]	Ichneumonoidea	Barron 1976	1	6
Ichneumoninae[3]	K/I, En	Lepidoptera	Heinrich 1960*a*,*b*, 1961*a*,*b*, 1962*a*,*b*,*c*	46	154
Lycorininae	K[4], En?/Ec[4]	Small leaf-rolling Lepidoptera	Gauld and Wahl 2002	1	1
Mesochorinae	K, H	Ichneumonoidea (most); also Tachinidae	Dasch 1971	4	49
Metopiinae	K, En	Lepidoptera	Townes and Townes 1959	10	52
Ophioninae	K, En	Lepidoptera (most); also Scarabaeidae	Nearctic genera: Gauld and Wahl 2002; *Enicospilus* (part): Gauld 1988*b*	3	5
Orthocentrinae	K, En	Mycetophilidae, Sciaridae	Dasch 1992	15	34
Orthopelmatinae	?, En	Cynipidae in galls on *Rubus, Rosa*	Barron 1977	1	3
Pimplinae	K/I, Ec/En	Holometabola (most); also Araneae	Townes and Townes 1960	29	75

Subfamily	Biology[1]	Hosts[1]	Nearctic Identification Resources	Genera	Species
Poemeniinae	I?, Ec	Wood-boring Coleoptera and Hymenoptera	Townes and Townes 1960	4	7
Rhyssinae	I, Ec	Wood-boring Symphyta and possibly Coleoptera	Townes and Townes 1960	3	6
Tersilochinae[3]	K, En	Coleoptera (most); also Symphyta	Genera: Townes 1971; Nearctic species: Horstmann 2010, 2012	3	6
Tryphoninae	K, Ec	Symphyta, Lepidoptera	Genera: Townes 1969; Nearctic species: Mason 1955, 1956, 1959; Townes *et al.* 1992; Townes and Townes 1949*a*,*b*; Loan 1981	21	104
Xoridinae	I, Ec	Wood-boring Coleoptera (most) and possibly Symphyta	Townes and Townes 1960	2	5

[1] Wahl (1993), except where noted.

[2] A summary of the unusual life history of Eucerotinae can be found in Barron (1976).

[3] Several additional species listed from the Prairie Provinces with no localities.

[4] Shaw (2004); early instars are possibly endoparasitic, but are probably concealed ectoparasitoids within the host's anus.

A total of 1,160 species in 299 genera are included in the checklist of Ichneumonidae of the Prairies Ecozone (Table 2). This is a significant underestimate of the true number of species present since many genera have not been revised and a great many species await description. For example, the genus *Ophion* (Ophioninae) consists of 11 described Nearctic species, of which two have been recorded in the literature from Alberta, Saskatchewan, and Manitoba. However, an ongoing taxonomic study of *Ophion*, using morphological and molecular methods, has found a minimum of 21 species in the Prairies Ecozone of Alberta alone (MDS, unpublished). A similar pattern no doubt exists for many genera. Some examples of species-rich genera in desperate need of revision include *Campoplex*, *Diadegma*, and *Hyposoter* (Campopleginae); *Gelis* and *Phygadeuon* (Cryptinae); *Alexeter* and *Mesoleius* (Ctenopelmatinae); *Orthocentrus* (Orthocentrinae); *Netelia* (Tryphoninae); and many others. For genera such as these, this list is clearly inadequate, though it does provide a minimum starting point.

The subfamily Ichneumoninae is among the most diverse ichneumonid subfamilies, with only Cryptinae having a greater number of described species; however, the species list provided here is preliminary. Ichneumoninae species were revised by Heinrich (1960*a*, 1960*b*, 1961*a*, 1961*b*, 1962*a*, 1962*b*, 1962*c*), but he focused on species from northeastern North America and in most cases provided only the province of collection rather than specific localities. I have thus included Strickland's (1946, 1952) species records of Ichneumoninae, but since these were recorded before the publication of Heinrich's synopses, the identifications are tentative.

In addition to the lack of revisions for many taxa, there is a lack of biodiversity studies for the region. For example, Pimplinae, Poemeniinae, and Rhyssinae are among the best known and most easily identified ichneumonid subfamilies; however, a recent survey of these three subfamilies in Alberta found 10 species that had not previously been recorded from the Prairies Ecozone. Nine of these species are new Alberta records and eight are newly recorded from the Prairie Provinces. All of these records are from the Aspen Parkland Ecoregion; a similar pattern would no doubt be seen if a survey were conducted in the prairie grasslands, and this would be greatly magnified for those subfamilies that are less well-known. This study emphasizes the importance of conducting biodiversity surveys and of publishing species records, as many commonly collected and easily identified species may be missing from the published record.

Museum collections are another important yet underutilized source of biodiversity information. Twenty-five species are newly recorded from the Prairies Ecozone from the Wallis-Roughley Museum of Entomology, the only museum in the Prairies region to have databased all of its Ichneumonidae. Databasing specimens and creating publicly available databases of museum specimens is thus a high priority to increase the usability of museum data.

Biogeography

Very few ichneumonid species are restricted to the Canadian Prairies Ecozone. Ninety-seven percent of the species listed in Table 2 (1,124 species) have also been recorded from outside the Prairies Ecozone, all except six having records from outside the three Prairie Provinces (Alberta, Saskatchewan, and Manitoba). Of the remaining 36 species, most (31 species) are known only from the type locality. Within the ecozone, however, little is known about the distribution of most species. Forty-four percent of the species in the checklist (512 species) have been recorded from only a single locality within the Prairies Ecozone (though, as discussed earlier, most are also found outside of this region). Only 6% of the species have been recorded from 10 or more localities within the region.

Most species included in the checklist (75%, 873 species) have a Nearctic distribution, whereas 36 species are restricted to the Nearctic and Neotropical regions. A total of 182 species are Holarctic, with the remainder being distributed across multiple terrestrial ecozones. In several cases, Holarctic species are separated into Nearctic and Palearctic subspecies; few molecular studies have been done to test their conspecificity.

Habitat and Host Associations

While in most cases definitive habitat associations are not given, few species of Ichneumonidae appear to be strongly associated with grassland habitats. Where habitat is indicated, the associations are often with trees or shrubs. Those species with notes that specifically indicate that they have been collected from grasslands or other prairie habitats (e.g., sand dunes, agricultural fields) are marked with an asterisk in Table 2. This does not imply, however, that other species lack this association, as in most cases no habitat association is recorded.

The basic biology of most Ichneumonidae is known at the subfamily or genus level (e.g., Wahl 1993, Table 1). For many species, however, reliable rearing records are lacking. Of the species recorded from this region, 43% (493 species) have no host records, while many of the remaining species have been recorded from only one or two host species. Only 33% of the species in Table 2 have been recorded from three or more host species. While this could be an indication of host specificity, in many cases, it indicates a lack of rearing records, as most rearing studies have been conducted on a limited number of pest species (Askew and Shaw 1986). One or two host records provide useful insight into the biology of the species, but are clearly inadequate to understand the true host range. In addition, literature records are often unrepresentative or incorrect (Askew and Shaw 1986; Mills 1992). For example, the subfamily Diplazontinae is believed to be exclusively associated with Syphidae (Diptera) (Fitton and Rotheray 1982; Klopfstein *et al.* 2011); however, of the 24 diplazontine species included in the checklist that have host records, 17 have been recorded from other families and 16 from non-Diptera.

Of the 667 species with host records, the vast majority (493 species, 74%) have been reared from Lepidoptera, particularly from Tortricidae (189 species), followed by Noctuidae (152) and Geometridae (133). Twenty-eight percent (186 species) are recorded from Hymenoptera, with 77% of these from sawflies (Symphyta). A total of 145 species have been recorded from more than one arthropod order, although, as in the case of Diplazontinae, some of these may be in error.

Future Research

This chapter provides a preliminary checklist of Ichneumonidae of the Canadian Prairies Ecozone. While a useful starting point, the principal message is that Ichneumonidae are incredibly diverse in this region and that we know remarkably little about them. Among the most pressing research needs is an increase in taxonomic studies, particularly for the many genera that have never been properly revised. In addition, most existing revisions were conducted before the advent of molecular techniques; even among those taxa that are relatively well-known, there is great scope for discovery.

In order to understand the roles that ichneumonids play in prairie ecosystems, there is a great need for both biodiversity surveys and ecological studies (including rearing of hosts). These would allow documentation of ichneumonid diversity, as well as habitat and host associations, which would in turn provide insight into host–parasitoid dynamics, biological control of agricultural pests, ichneumonid habitat requirements, impacts of ecological disturbance, and much more.

Finally, a high priority should be placed on creating user-friendly keys and other identification resources, such as online species pages. These would serve to facilitate and encourage studies into the ecology and biodiversity of this important group of parasitoids.

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Table 2. Checklist of Ichneumonidae recorded from the Canadian Prairies Ecozone. Locality references are identified by superscript numbers following each species and are listed following the checklist. Localities marked with [m] were estimated from mapped localities; localities in boldface type are previously unpublished locality records. Species distributions (indicated by superscript abbreviations) and host records are from Yu *et al.* (2012) and are defined following the checklist. Species in bold are newly recorded from the Prairies Ecozone in this publication and those marked with an asterisk have been specifically recorded from grasslands, agricultural fields, sand dunes, or other prairie habitats. Species checklist available at http://dx.doi.org/10.5886/5r772nsm

SUBFAMILY **Species**[a]	**Localities**[b]	**Host Family (No. spp.)** ***Guild/Notes***
ACAENITINAE		
Arotes maurus Rohwer, 1920 [1,N]	AB: Bilby; SK: Fort Pitt	None
Coleocentrus manni Cushman, 1920 [2,N]	AB: Wagner NA	None
Spilopteron formosum (Cresson, 1868) [1,N]	MB: Treesbank	Coleoptera: Cerambycidae (1) *Borers*
Spilopteron franclemonti Townes, 1960 [1,2,N]	AB: Wagner NA; MB: Teulon	None
Spilopteron vicinum (Cresson, 1869)[1,2,N]	MB: Teulon	Coleoptera: Cerambycidae (2) *Borers*
ANOMALONINAE		
Agrypon alaskense (Ashmead, 1902) [3,N]	AB: Southwest[m], MB: South[m]	Lepidoptera: Geometridae, Lycaenidae, Noctuidae (10) *Mostly Geometridae*
Agrypon alpinum (Davis, 1898) [2,4,N]	AB: Edmonton, Elkwater P, Jumping Pound Cr, Orion, Taber, Wabamun, Wagner NA, Waterton; SK: Estevan, Great Deer, Kenosee, Lloydmister, Roche Percée, Saskatoon; MB: Aweme, Binscarth, Glenboro, Keld, Turtle Mt FR, 30 mi N Roblin, 5 mi SW Shilo,Transcona	Lepidoptera: Drepanidae, Erebidae, Geometridae, Hesperiidae, Noctuidae, Notodontidae, Nymphalidae, Sphingidae, Tortricidae (14)
Agrypon anale (Say, 1829) [4,N]	AB: Big Chief Hwy in Waterton Lakes NP, Edmonton, Enilda, Seba Beach; MB: Concord, 5 mi N Minnedosa	Lepidoptera: Drepanidae, Erebidae, Lasiocampidae, Notodontidae (13) *Mostly setose*
Agrypon annulare Dasch, 1984 [2,N,T]	AB: Wagner NA	None
Agrypon carinifer Schmid, 1970 [4,N]	AB: Mountain View, Waterton	None
Agrypon chlamidatum (Provancher, 1886) [4,N]	AB: Edmonton, Elkwater L, Wabamun; MB: Ninette, 5 mi SW Shilo	Lepidoptera: Tortricidae (1) *Leafrollers*
Agrypon clandestinum (Gravenhorst, 1829) [4,H,O]	AB: Elkwater L, Fort MacLeod, Wagner	Hymenoptera: Cynipidae; Lepidoptera: Coleophoridae, Erebidae, Gelechiidae, Geometridae, Micropterigidae, Notodontidae, Tortricidae, Yponomeutidae, Ypsolophidae (34)
Agrypon cushmani Dasch, 1984 [4,N]	AB: Lundbreck, Red Rock Canyon in Waterton P; SK: Birch Cr; MB: Aweme	Lepidoptera: Lycaenidae (3)

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
Agrypon drepanae Dasch, 1984 [2,N,T]	AB: Wagner NA	Lepidoptera: Drepanidae, Geometridae (2) *Loopers*
Agrypon extensor Dasch, 1984 [4,N]	AB: Edmonton; MB: 5 mi SW Shilo	Lepidoptera: Crambidae, Notodontidae (2)
Agrypon hyperetis Dasch, 1984 [4,N]	AB: Wabamun	Lepidoptera: Geometridae (1)
Agrypon melleum (Cresson, 1872) [2,4,N]	AB: Drumheller, Wagner NA; SK: Scout L; MB: 5 mi SW Shilo	Lepidoptera: Tortricidae (7) *Leafrollers*
Agrypon metallicum (Norton, 1863) [4,N]	AB: Pincher; MB: Turtle Mt	Hymenoptera: Tenthredinidae (1) *Leafminers*
Agrypon prismaticum (Norton, 1863) [2,4,5,N]	AB: Derwent, Edmonton, Elk Point, Gull L, Mountain View, Red Deer, Wagner NA, Wainwright, Waterton; SK: Kenosee, Rockglen, Saskatchewan Landing, Saskatoon, Scout L, Willow Bunch, Wood Mt; MB: Aweme, Horton, Sandridge, Spruce Woods FR, Tamarack Bog at 5 mi SW Shilo, Winnipeg	Lepidoptera: Crambidae, Elachistidae, Erebidae, Geometridae, Nolidae, Nymphalidae, Pterophoridae, Tortricidae (21) *Mostly leafrollers*
Agrypon provancheri (Dalla Torre, 1901) [3,5,N]	AB: nr Edmonton[m], nr Waterton[m], S of Lethbridge[m]	Lepidoptera: Geometridae, Noctuidae, Tortricidae (7)
Agrypon schizurae Dasch, 1984 [2,4,N]	AB: Calgary, Edmonton, Wagner NA; SK: Snowden	Lepidoptera: Notodontidae, Sphingidae (4) *Most spp large*
Agrypon validum Dasch, 1984 [4,N]	AB: Edgerton, Irvine, Lethbridge, Morrin; SK: Elbow, Kenosee, Mossbank, Saskatoon, Uren; MB: Aweme, Douglas, Hartney	None
Agrypon varitarsum (Wesmael, 1849) [4,H,O]	AB: Edmonton, Jumping Pound Cr, Wabamun; SK: Elbow	Lepidoptera: Erebidae, Geometridae, Micropterigidae, Oecophoridae, Tortricidae, Yponomeutidae (20) *Mostly leafrollers*
Anomalon reticulatum (Cresson, 1865) [2,4,N,T]	AB: Brant, Brooks, Bow Island, Clymont, Edmonton, Hays, Irvine, Lethbridge, Medicine Hat, Scandia, Wainwright; SK: Dana, Dunblane, Elbow, Great Deer, Moose Jaw, Parkbeg, Prince Albert, Redberry, Saskatoon, Saskatchewan Landing, Strongfield, Swift Current; MB: Aweme, Bald Hills at 13 mi N Glenboro	None
Aphanistes coxatus Hopper, 1981 [4,N]	SK: Prince Albert; MB: Spruce Woods, Treesbank	Lepidoptera: Erebidae, Geometridae, Noctuidae (5) *Mostly loopers*
Aphanistes decurvihastatus Hopper, 1981 [4,N]	MB: Tamarack Bog at 5 mi SW Shilo	None
Aphanistes dreisbachi Hopper, 1981 [4,N]	AB: Edmonton; MB: Ninette	Lepidoptera: Geometridae (1)
Aphanistes energiae Hopper, 1981 [4,N]	AB: Waterton Lakes NP; SK: Glaslyn, Pierceland; MB: Aweme, 3 mi SW Shilo, Spruce Woods, Treesbank	Lepidoptera: Geometridae, Noctuidae (13) *Mostly loopers*

Aphanistes heinrichi Hopper, 1981 [4,N]	MB: Birds Hill, Pine Ridge	Lepidoptera: Geometridae, Noctuidae (4) *Mostly loopers*
Aphanistes hopperi Dasch, 1984 [4,N]	AB: Edmonton	Lepidoptera: Geometridae (4)
Aphanistes manitobae Dasch, 1984 [4,N]	MB: Winnipeg	None
Aphanistes masoni Hopper, 1981 [4,N]	AB: Waterton; MB: Aweme	None
Aphanistes walleyi Hopper, 1981 [4,N]	SK: St. Victor; MB: Ninette	Lepidoptera: Geometridae (1)
Barylypa clavata (Davis, 1898) [4,N]	SK: Tunstall	Lepidoptera: Noctuidae (1)
Barylypa elongata (Davis, 1898) [4,N]	AB: Drumheller, Edmonton, Mayerthorpe; SK: Pelly; MB: Whitemouth	Lepidoptera: Erebidae, Noctuidae (2) *Setose*
Barylypa imitata Dasch, 1984 [4,N]	AB: Calgary; SK: Arcola; MB: Winnipeg	Lepidoptera: Erebidae (1)
Barylypa incompleta Dasch, 1984 [4,N]	AB: Waterton	None
Barylypa sulcata (Provancher, 1886) [4,N]	AB: Calgary, Elkwater, Elkwater L; SK; Fox Valley; MB: Millwood	Lepidoptera: Erebidae, Noctuidae (3)
**Erigorgus ambiguus* (Norton, 1863) [4,6,N]	AB: Calahoo, Grassy L; SK: Earl Grey, Great Sand Hills, Lancer, Rosthern, Saskatoon; MB: Aweme, Otterburne	Lepidoptera: Erebidae, Noctuidae (4) *Mostly cutworms*
Erigorgus aquilonius Dasch, 1984 [4,N]	AB: Jumping Pound Cr	Lepidoptera: Erebidae (5) *Setose*
Erigorgus attenuatus Dasch, 1984 [4,N]	SK: Saskatoon	None
Erigorgus bilineatus Dasch, 1984 [4,N]	AB: Edmonton, Lethbridge; SK: Kenosee, Oxbow; MB: Aweme, Ninette	Lepidoptera: Erebidae (1)
Erigorgus brooksi Dasch, 1984 [4,N]	SK: Willows	None
Erigorgus compressus Dasch, 1984 [4,N]	AB: Edmonton	None
Erigorgus curtus (Norton, 1863) [4,N]	AB: Czar, Drumheller, Edmonton, Grimshaw, Lethbridge, Morrin, Onefour, Waterton; SK: Elbow, Great Sand Hills, Prince Albert	Lepidoptera: Noctuidae (3) *Cutworms*
Erigorgus ferrugineus (Norton, 1863) [4,N]	AB: Edmonton, Ponoka	None
Erigorgus niveus Dasch, 1984 [4,N]	SK: Saskatoon	None
Erigorgus nubilipennis Dasch, 1984 [2,4,N]	AB: Bilby, Wagner NA	None
Erigorgus planus Dasch, 1984 [4,N]	AB: Norton	None
Erigorgus pumilus Dasch, 1984 [4,N]	AB: Lethbridge	None
Erigorgus rotundus (Davis, 1898) [4,N]	AB: Clover Bar; SK: Saskatoon	None
Erigorgus sinuosus Dasch, 1984 [4,N]	SK: Pike L	None
Erigorgus spinosus Dasch, 1984 [4,N]	AB: Calgary, Edmonton, Magrath	None

SUBFAMILY **Species**[a]	**Localities**[b]	**Host Family (No. spp.)** ***Guild/Notes***
Erigorgus stenotus Dasch, 1984 [4,N]	AB: Bilby, Consort, Edmonton, George L, Red Deer, Tofield, Waterton; SK: Attons L at Cut Knife, Elbow, Regina, Saskatoon; MB: Birds Hill, Carberry, Husavik, Killarney, Ninette, Teulon, Winnipeg	Lepidoptera: Tortricidae (1) *Leafrollers*
Erigorgus utahensis Dasch, 1984 [4,N]	AB: Calgary	None
Erigorgus xanthopsis (Ashmead, 1890) [4,N]	AB: Calgary, Derwent, Edmonton, Lethbridge; SK: MacDowell, Saskatoon, Swift Current; MB: Aweme, Ninette, 10 mi S Winnipeg	Lepidoptera: Noctuidae (3)
Habronyx aclerivorus (Rohwer, 1915) [4,N]	AB: 18 mi E Lacombe, Red Deer	Lepidoptera: Geometridae, Pyralidae, Tortricidae (18) *Mostly leafrollers*
Habronyx amoenus Dasch, 1984 [4,N]	AB: Rimbey	Lepidoptera: Geometridae (1)
Habronyx magniceps (Cresson, 1872) [4,N]	MB: Pembina Valley, Thornhill	Lepidoptera: Saturniidae, Sphingidae (6) *Large, most spp social*
Ophionellus foutsi (Cushman, 1922) [2,N]	AB: Wagner NA	Lepidoptera: Galacticidae, Gelechiidae, Olethreutidae, Pyralidae, Tortricidae (7) *Concealed feeders*
**Parania geniculata* (Holmgren, 1857) [4,5,7,8,H]	AB: Aspen Beach, Bilby, Blackfoot Hills, Chedderville, Clymont, Consort, Drumheller, Edgerton, Edmonton, Parkland, Rockyford, Stavely, Wainwright; SK: Attons L, Battle River, Bronson PF, Caron, Cut Knife, Donavon, Dunblane, Dundurn, Elbow, Ft a la Corne, Great Deer, Great Sand Hills, Indian Head, Keppel, Lloydminster, Pike L, Redberry, Saskatoon, Snowden, Sutherland, White Fox; MB: Onah, 2 mi W Stockton, Winnipeg; Midcentral Canada (AB/SK) in sunflower fields	Hymenoptera: Cynipidae; Lepidoptera: Choreutidae, Crambidae, Elachistidae, Erebidae, Galacticidae, Gelechiidae, Geometridae, Lycaenidae, Nolidae, Psychidae, Pyralidae, Sesiidae, Tortricidae (40)
**Parania pulchra* Dasch, 1984 [4,8,N]	AB: Medicine Hat; Midcentral Canada (AB/SK) in sunflower fields	Lepidoptera: Tortricidae (1)
Therion californicum (Cresson, 1879) [4,N,T]	AB: Aden, Edmonton, Elk Island P, Irvine, Lethbridge, Onefour, Scandia; SK: Elbow; MB: Aweme, 2 mi W Stockton, Treesbank	Lepidoptera: Erebidae, Geometridae, Noctuidae, Notodontidae (16)
Therion circumflexum (Linnaeus, 1758) [2,4,5,9,H,O]	AB: Aspen Beach, Clymont, Cypress Hills, Edmonton, Elkwater, George L, Golden Spike, Manyberries, 2 mi E Red Deer, Wagner NA; SK: Attons L, Neilburg, St. Victor, Saltcoats, Saskatoon, Wood Mt; MB: Aweme, **Birtle**, Brandon, Carberry, Horton, International Peace Gardens at Turtle Mt FR, Millwood, 5 mi N Minnedosa, Ninette, 3 mi S Shilo, 1 and 5 mi SW Shilo, Teulon, Winnipeg	Lepidoptera: Erebidae, Geometridae, Lasiocampidae, Noctuidae, Notodontidae, Sphingidae (33)

Therion fuscipenne (Norton, 1863) [2,4,N,T]	AB: Cypress Hills, Green Court, Lethbridge, Red Deer; SK: Cypress Hills PP, Prelate, Prince Albert, Radisson, Rutland; MB: Ninette, Teulon, Winnipeg	Lepidoptera: Erebidae, Noctuidae (10) *Setose*
Therion magnum Dasch, 1984 [4,N]	MB: 5 mi SW Shilo	None
Therion morio (Fabricius, 1781) [2,4,N,T]	AB: Edmonton, Gull L, Wabamun; MB: Aweme, Fort Garry, Teulon	Lepidoptera: Erebidae, Geometridae, Noctuidae, Notodontidae, Nymphalidae, Sphingidae (15) *Mostly setose*
Therion sassacus Viereck, 1917 [2,4,9,10,N,T]	AB: Wagner NA; MB: Aweme, **Riverton**, St. Claude	Lepidoptera: Erebidae, Geometridae, Noctuidae (10) *Mostly setose*
**Trichomma maceratum* (Cresson, 1879) [4,8,N]	AB: Bilby, Waterton; SK: Saskatoon, south in sunflower fields	Lepidoptera: Pyralidae, Tortricidae (6) *Concealed feeders*
BANCHINAE		
Alloplasta piceator (Thunberg, 1824) [5,11,H]	AB: Edmonton	Hymenoptera: Chrysididae, Diapriidae, Ichneumonidae, Vespidae; Lepidoptera: Erebidae, Noctuidae (10)
Alloplasta superba (Provancher, 1874) [5,11,N]	AB: Edmonton, Manyberries, Waterton, Tofield, Twin Butte; SK; Oxbow, St. Victor	Hymenoptera: Pamphiliidae; Lepidoptera: Noctuidae (2)
Apophua simplicipes (Cresson, 1870) [5,9,12,N]	AB: Beauvallon, Blackfoot Hills, Elk Point, Hardisty, Lethbridge, Medicine Hat, Wainwright; SK: Harris, Lebret, Rutland, Saskatoon; MB: **Altona**, Aweme, Clearwater, Ft. Whyte, Sifton	Lepidoptera: Elachistidae, Erebidae, Geometridae, Lasiocampidae, Noctuidae, Nolidae, Notodontidae, Pyralidae, Saturniidae, Tortricidae (26) *Mostly leafrollers*
**Arenetra canadensis* Cresson, 1868 [5,11,13,N]	AB: Cochrane, Edmonton, Lethbridge, Medicine Hat; SK: Saskatoon	Lepidoptera: Noctuidae (2) *Cutworms*
Arenetra criddlei Townes, 1978 [11,N]	MB: Aweme	None
**Arenetra fumipennis* Townes, 1978 [11,N]	AB: Lethbridge	Lepidoptera: Noctuidae (1) *Cutworms*
Arenetra hirsutula Walley, 1931 [11,N]	SK: Saskatoon	None
Arenetra nigrita Cresson, 1870 [11,14,N]	AB: Edmonton, Magrath; SK: Saskatoon	None
**Arenetra rufipes* Cresson, 1870 [5,11,N]	AB: Edmonton, Lethbridge, Medicine Hat; SK: Asquith, Clarkboro, Saskatoon, White Fox	Lepidoptera: Noctuidae (3) *Cutworms*
Banchus apenes Townes, 1978 [11,N]	AB: Medicine Hat	None
**Banchus canadensis* Cresson, 1868 [2,5,11,N]	AB: Edmonton, Lethbridge, Medicine Hat, Wagner NA	None
**Banchus ciliatus* Townes, 1978 [11,N]	AB: Lethbridge; SK: Saskatoon	None

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
**Banchus flavescens* Cresson, 1868 [5,9,11,15,16,17,18,19,N]	AB: Belly River, Bilby, Calgary, Chin, Clyde, Cypress Hills, Edmonton, Elkwater, Elkwater L, Fawcett, Lethbridge, Medicine Hat, Morrin, Scandia, Sedgewick, St. Paul, Tabor, Waterton, Waterton Lakes NP, Winterburn; SK: Aylsham, Earl Grey, Langham, Roche Percee, Saskatoon, Stalwart, White Fox, Young; MB: Arrow River, Aweme, Baldur, Benito, Beulah, Bield, Big Woody, Birtle, Bowsman, Brandon, Dauphin, Durban, Franklin, Grandview, Gilbert Plains, Glenlea, **Grosse Isle**, Hamiota, Horton, Kenville, Laurier, Lenswood, Minitonas, Minnedosa, Neepawa, 20 mi N Roblin, Roblin, Riverton, Russell, Silverton Stn, St. Amelie, Swan River, Thunder Hill, Ukraina, Virden, Whitewater	Lepidoptera: Noctuidae (5)
Banchus hastator (Fabricius, 1793) [11,H]	AB: Edmonton; SK: White Fox	Lepidoptera: Erebidae, Noctuidae (3)
**Banchus inermis* Provancher, 1874 [5,11,N]	AB: St. Paul; SK: Dafoe, Dodsland, Radisson; MB: Aweme, Teulon	Lepidoptera: Noctuidae (1)
Banchus nigroflavus Townes, 1978 [2,11,N]	AB: Edmonton, Chin, St. Paul, Elkwater L, Wagner NA	None
Banchus pallescens Provancher, 1874 [5,11,N]	AB: Edmonton; SK: Wallwort	None
Banchus superbus Cresson, 1865 [11,N]	MB: Aweme	None
Cryptopimpla genalis (Thomson, 1877) [11,N]	AB: Edmonton, Jumping Pound Cr	Lepidoptera: Geometridae (1)
Cryptopimpla quadrilineata (Gravenhorst, 1829) [2,5,11,H]	AB: Bilby, Cochrane, Edmonton, Elkwater, Jumping Pound Cr, Red Deer, Twin Butte, Wagner NA, Waterton; SK: Prince Albert; MB: Birch River, 5 mi W Shilo, Turtle Mt PP	None
Exetastes abdominalis Cresson, 1865 [5,11,N]	AB: Calgary, Edmonton; SK: Dubuc; MB: Aweme	None
**Exetastes albitarsis* Provancher, 1874 [5,11,N]	AB: Cypress Hills, Edmonton, Elkwater, Elkwater L, Red Deer; MB: Teulon	None
**Exetastes angustoralis* Cushman, 1937 [11,N]	SK: Kennedy, Rockglen	Lepidoptera: Noctuidae (1) *Cutworms*
Exetastes brevicornis Cushman, 1937 [11,N]	AB: Calgary; SK: Dafoe, Herschel, Melfort, Roche Percee, Saskatoon, Tyner	None
Exetastes caliginosus (Walley, 1931) [11,N]	AB: Medicine Hat; SK: Dundurn	None
**Exetastes flavus* Cushman, 1937 [11,N]	SK: Great Sand Hills (W of Swift Current)	None
Exetastes fornicator (Fabricius, 1781) [5,11,H,T,O]	AB: Bilby, Calgary, Cooking L, Edmonton, Lethbridge; SK: Earl Grey, Pickthall, Regina, Rockglen, Swift Current, Unity, Val Marie; MB: Aweme	Hymenoptera: Cimbicidae; Lepidoptera: Erebidae, Noctuidae, Sphingidae (10)

**Exetastes illinoiensis* (Walsh, 1873) [5,11,N]	AB: Calgary; SK: Saskatoon	None
**Exetastes illusor* Gravenhorst, 1829 [11,H,O]	AB: Edmonton, St. Paul, Wabamun, Waterton;	Lepidoptera: Crambidae, Erebidae, Geometridae, Pieridae, Noctuidae, Saturniidae (14)
**Exetastes obscurus* Cresson, 1865 [11,N,T]	AB: Lethbridge; MB: Aweme	Lepidoptera: Noctuidae (3) *Cutworms*
Exetastes pectinatus Cushman, 1937 [11,N]	AB: Delia, Waterton; SK: Gull L, White Fox	None
**Exetastes rempeli* Townes, 1978 [11,N]	AB: Medicine Hat, Scandia; SK: Bestville (nr Hazlet), Regina, Secretan, Saskatchewan Landing, Uren, Val Marie	None
Exetastes scutellaris Cresson, 1865 [11,N,T]	AB: Lethbridge	None
Exetastes suaveolens Walsh, 1873 [11,N]	MB: Aweme	Lepidoptera: Noctuidae (1)
**Exetastes syriacus* Schmiedeknecht, 1910 [5,11,H]	AB: Calgary, Chin, Edmonton, Lethbridge, Medicine Hat, Tilley; SK: Great Deer, Saskatoon, Swift Current; MB: Aweme	None
Glypta alberta Dasch, 1988 [12,N]	AB: Cypress Hills, Elkwater P	Lepidoptera: Tortricidae (1) *Leafrollers*
Glypta albifaciens Dasch, 1988 [12,N]	SK: Prince Albert; MB: Spruce Woods	Hymenoptera: Diprionidae; Lepidoptera: Tortricidae (2)
Glypta albilineata Dasch, 1988 [12,N]	AB: Lethbridge	None
Glypta albonotata Dasch, 1988 [12,N]	SK: Lloydminster, Prince Albert; MB: Ft. Garry	Lepidoptera: Tortricidae (5) *Leafrollers*
Glypta borealis Cresson, 1870 [12,N]	MB: Winnipeg	None
Glypta canadensis Cresson, 1870 [12,N]	SK: Saskatoon; MB: 2 mi N of Forrest Stn	Lepidoptera: Tortricidae (1) *Leafrollers*
Glypta caulicola Cushman, 1933 [12,N]	MB: Ninette	Lepidoptera: Gelechiidae, Tortricidae (3) *Stem gall makers*
Glypta cesta Dasch, 1988 [12,N]	MB: Ochre River	Lepidoptera: Tortricidae (2) *Leafrollers*
Glypta conflictanae Dasch, 1988 [12,N]	AB: Bearberry, Caroline, Chief Mt Hwy in Waterton L NP, Cypress Hills, Elkwater P, 1 mi S Elkwater, Vermilion, Red Deer, 5 mi N Star, Waterton Lakes NP at gate; SK: Duck L, Frenchman Butte, Glaslyn, Grassy L, Grenfell, Hillesden, Neilburg, Saskatoon, Sheho; MB: Aweme	Lepidoptera: Erebidae, Geometridae, Lasiocampidae, Noctuidae, Tortricidae (11)
Glypta confusa Dasch, 1988 [12,N]	AB: Twin Butte	None
Glypta convexa Dasch, 1988 [12,N]	AB: Edmonton; SK: Snowden; MB: Ninette	None
Glypta crassa Dasch, 1988 [12,N]	AB: Edmonton	None
Glypta curta Dasch, 1988 [12,N]	AB: 30 mi NE Brooks, Calgary, Cypress Hills, Stettler, Twin Butte; SK: Estevan, Kincaid, Minton, Rockglen, Saskatoon, Welby; MB: Carberry, 5 mi SW Shilo	None

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
Glypta davisii Dalla Torre, 1901 [12,N]	AB: Calgary, Elkwater	None
Glypta diminuta Dasch, 1988 [12,N]	AB: Cowley, Elkwater, Mountain View, Twin Butte, Waterton	None
Glypta divisa Dasch, 1988 [12,N]	AB: George L	None
Glypta dorsiatomanae Dasch, 1988 [12,N]	SK: Scott	Lepidoptera: Tortricidae (1) *Concealed feeders*
Glypta elevata Dasch, 1988 [12,N]	AB: Edmonton	None
Glypta erratica Cresson, 1870 [5,12,N]	AB: Edmonton, Elkwater P, Fawcett, Jumping Pound Cr at 20 mi W Calgary, Lethbridge, Red Deer, St. Paul, Sylvan L, Wabamun; SK: Great Deer, Lake Max, Lanigan, Lloydminster, Saskatoon; MB: Aweme, Gimli, Horton, Ninette, Pilot Mound, 30 mi N Roblin, 5 mi SW Shilo, Spruce Woods, Swan River, Teulon, Virden	Lepidoptera: Geometridae, Lasiocampidae, Nymphalidae, Saturniidae, Tortricidae (28) *Mostly leafrollers*
Glypta flavomaculata Dasch, 1988 [12,N]	SK: Kenosee; MB: Transcona	Lepidoptera: Tortricidae (1) *Leafrollers*
Glypta fumiferanae (Viereck, 1912) [9,12,20,N]	AB: Cypress Hills, Elkwater; SK: Glaslyn; MB: Beausejour, **Glenlea**, Spruce Woods FR	Lepidoptera: Erebidae, Pyralidae, Tortricidae (14) *Mostly concealed conifer feeders*
Glypta fumosa Dasch, 1988 [12,N]	AB: Clymont, Edmonton	None
Glypta fuscata Dasch, 1988 [12,N]	MB: 30 mi N Roblin	None
Glypta inusitata Dasch, 1988 [12,N]	SK: Wood Mt	None
Glypta kukakensis Ashmead, 1902 [12,N]	AB: Edmonton, Elkwater, Elkwater L	Lepidoptera: Noctuidae (1) *Climbing cutworm*
Glypta linearis Dasch, 1988 [12,N]	SK: Tompkins	None
Glypta macilenta Dasch, 1988 [12,N]	MB: Carberry	None
Glypta macra Cresson, 1870 [5,12,N]	AB: Calmar, Edmonton, Stettler, Wainwright; SK: White Fox; MB: Dauphin, 2 mi E Douglas Stn, 9 mi N Forrest Stn, Gladstone, Ninette, 5 mi SW Shilo, Souris	None
Glypta maculata Dasch, 1988 [12,N]	AB: Edmonton, George L; SK: Kenosee P	Lepidoptera: Tortricidae (1) *Leafrollers*
Glypta manitobae Dasch, 1988 [12,N]	MB: 2 mi W Stockton	None
Glypta martini Dasch, 1988 [12,N]	MB: Greenridge	None
Glypta montana Dasch, 1988 [12,N]	SK: Assiniboia	None
Glypta mutica Cushman, 1919 [12,N]	AB: Edmonton, Elkwater L	Hymenoptera: Cephidae; Lepidoptera: Tortricidae (3) *Concealed feeders*

Glypta occidentalis Dasch, 1988 [12,N]	AB: Mountain View	None
Glypta parallela Dasch, 1988 [12,N]	MB: Transcona	None
Glypta prognatha Dasch, 1988 [12,N]	SK: Bienfait, Briercrest, Drinkwater, Estevan, Kandahar, Minton, Outram, Rockglen, Torquay, Willow Bunch; MB: Altona	Lepidoptera: Tortricidae (1) *Concealed feeders*
Glypta pulchripes Cresson, 1870 [12,N]	AB: George L; SK: Kenosee	Lepidoptera: Tortricidae (1) *Leafrollers*
Glypta robusta Dasch, 1988 [12,N]	AB: Edmonton, Elkwater, Elkwater L; MB: Max L in Turtle Mt FR, Transcona	None
Glypta rubripes Cresson, 1870 [12,N]	MB: Transcona	Lepidoptera: Tortricidae (2) *Concealed feeders*
Glypta rufiscutellaris Cresson, 1870 [5,12,H,T]	AB: Edmonton, Elkwater, Lethbridge, Medicine Hat, Onefour, Rainier, Twin Butte; SK: Dafoe, Elbow, Kisbey, Lloydminster, Rose Valley, Snowden; MB: Boissevain, Horton, 5 mi N Minnedosa, Ninette, Spruce Woods FR, Transcona	Lepidoptera: Crambidae, Gelechiidae, Noctuidae, Tortricidae (27) *Mostly leafrollers*
Glypta rufofasciata Cresson, 1870 [12,N]	AB: "Blackfoot Coulee", Calgary, Elkwater Pk, Lethbridge, Manyberries, Scandia, Vermilion, Wainwright; SK: Kandahar, Kelso, Lumsden, Minton, Regina, Roche Percee, Rockglen, Saskatchewan Landing, Saskatoon, Snowden, Val Marie, Willow Bunch; MB: Horton, Spruce Woods FR	Lepidoptera: Momphidae, Tortricidae (12) *Concealed feeders*
Glypta rufula Dasch, 1988 [12,N]	AB: Lethbridge, Blackfoot Hills, Calgary, Drumheller, Hays, Medicine Hat, Scandia; SK: Elbow, Gascoigne, Kennedy, Lisieux, Regina, Rockglen, St. Victor, Saskatoon, Willow Bunch; MB: Aweme, 5 mi SW Shilo	None
Glypta saperdae Dasch, 1988 [12,N]	SK: Prince Albert	Coleoptera: Cerambycidae (1)
Glypta saskatchewan Dasch, 1988 [12,N]	SK: Saskatoon	None
Glypta severa Dasch, 1988 [12,N]	AB:Edmonton; SK: Lloydminster	Lepidoptera: Tortricidae (1) *Leafrollers*
Glypta solida Dasch, 1988 [12,N]	AB: Edmonton	None
Glypta synnomae Dasch, 1988 [12,N]	SK: Saskatoon	Lepidoptera: Tortricidae (1) *Leafrollers*
Glypta tortricis Dasch, 1988 [12,N]	AB: Edmonton; SK: Prince Albert	Lepidoptera: Tortricidae (5) *Leafrollers*
Glypta tricincta Provancher, 1890 [12,N]	MB: Camper, Wasagaming	Lepidoptera: Gelechiidae, Tortricidae (8) *Leafrollers*
Glypta truncata (Provancher, 1883) [12,N]	AB: Edmonton, Wainwright; SK: Prince Albert, Willow Bunch; MB: Dauphin	Lepidoptera: Tortricidae (3) *Concealed feeders*
Glypta varipes Cresson, 1865 [12,N]	AB: Edmonton, Elkwater P, Orion	Lepidoptera: Tortricidae (4) *Concealed feeders*

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
Glypta vulgaris Cresson, 1870 [12,N]	MB: Aweme	Lepidoptera: Crambidae, Gelechiidae, Tortricidae (14) *Concealed feeders*
Helotorus argyresthiae (Walley, 1961) [21,N]	AB: southern AB	Lepidoptera: Argyresthiidae (1) *Stem borer*
Lissonota accusator (Fabricius, 1793) [11,H]	SK: White Fox; MB: Carberry	Lepidoptera: Elachistidae, Gelechiidae, Tineidae, Tortricidae, Sesiidae (6) *Mostly concealed feeders*
Lissonota acrobasidis (Ashmead, 1896) [2,9,11,N]	AB: Jumping Pound Cr, Wagner NA; SK: Kenosee, Snowden; MB: Aweme, Boissevain, Turtle Mt, **Winnipeg**	Lepidoptera: Argyresthiidae, Blastobasidae, Coleophoridae, Gelechiidae, Geometridae, Pyralidae, Sesiidae, Tortricidae (28) *Mostly concealed feeders*
Lissonota amphithyris Townes, 1978 [11,N]	SK: Indian Head	None
**Lissonota brunnea* Cresson, 1868 [2,9,11,14,N]	AB: Edmonton, Magrath, Wagner NA; SK: Glaslyn, Pike L; MB: **Altona**, Aweme, **Rosa**	Lepidoptera: Noctuidae (4) *Stem borers*
Lissonota cephalotes Townes, 1978 [11,N]	AB: Edmonton	Lepidoptera: Tortricidae (2) *Stem borers*
**Lissonota clypeator* (Gravenhorst, 1820) [2,5,9,11,H]	AB: Aspen Beach, Brooks, Calgary, Cameron L Rd in Waterton NP, Castor, Cypress Hills, Drumheller, Edmonton, Elkwater L, Halcourt, High River, Jumping Pound Cr, Lethbridge, Scandia, Stettler, Steveville, Taber, **Tofield**, Vermilion, Wagner NA, Waterton Lakes NP; SK: Adams, Canora, Dana, Meota, Moosomin, F. Qu'Appelle, Kenosee, Redberry, Regina, Saskatoon, Strongfield, Swift Current, Tunstall, White Fox, Willow Bunch, Wood Mt; MB: Aweme, Dauphin, Pilot Mound, Pipestone, Swan River	Lepidoptera: Geometridae, Noctuidae, Notodontidae, Sesiidae, Ypsolophidae (8)
**Lissonota coloradensis* (Cresson, 1870) [2,5,11,N]	AB: Aden, Blackfoot Hills, Calgary, Drumheller, Edmonton, Elkwater L, Jumping Pound Cr, Lethbridge, Manyberries, Red Deer, Scandia, Stettler, Wagner NA, Wainwright, "Blackfoot Coulee"; SK: Bagley, Birch Hills, Dafoe, Dubuc, Earl Grey, Saskatoon, Val Marie, White Fox, Wiseton, Wood Mt; MB: Aweme, Melita, 5 mi N Minnedosa, Roblin, Winnipeg	None
Lissonota conocola Rohwer, 1920 [11,N]	AB: Jumping Pound Cr	Lepidoptera: Pyralidae, Tineidae, Tortricidae (5) *Concealed feeders*

**Lissonota coracina* (Gmelin, 1790) [2,5,9,11,H]	AB: Blackfoot Hills, Castor, Edmonton, Jumping Pound Cr, Lethbridge, Red Deer, Stettler, **Tofield**, Wagner NA, Wainwright; SK: Attons L at Cut Knife, Canora, Estevan, Fort Qu'Apelle, Good Spirit L, Kenosee P, Lebret, Lisieux, Moosomin, Prince Albert, Redberry, Rutland, Saskatoon, White Fox, Wood Mt; MB: Brandon, Dauphin, 9 mi N Forrest, Gladstone, Horton, Husavick, 5 mi N Minnedosa, Max L in Turtle Mt FR, Ninette, Oak L, Pilot Mound, 3 mi S and 5 mi SW Shilo, Turtle Mt, Virden, Whitewater L, 4 mi N Whitewater, Winnipeg	Hymenoptera: Tenthredinidae; Lepidoptera: Crambidae, Notodontidae, Psychidae, Sesiidae, Tortricidae (11) *Mostly concealed feeders*
Lissonota cruralis Townes, 1978 [11,N]	AB: Edmonton, Jumping Pound Cr; SK: Atton L nr Cut Knife, Elbow, Kenosee, Rockglen, St. Victor, Scout L; MB: Aweme, Ninette, 5 mi SW Shilo	None
Lissonota curticauda Townes, 1978 [2,N]	AB: Wagner NA	None
Lissonota dakrumae (Ashmead, 1896) [2,11,N]	AB: Jumping Pound Cr, Lethbridge, Wagner NA; SK: Moosomin; MB: Brandon	Lepidoptera: Batrachedridae, Blastobasidae, Erebidae, Gelechiidae, Pyralidae (5) *Mostly concealed feeders*
Lissonota davisi Townes, 1978 [11,N]	AB: Edmonton	None
Lissonota exigua (Cresson, 1870) [2,11,N]	AB: Wagner NA; MB: 5 mi SW Shilo	None
Lissonota exilis (Cresson, 1870) [2,11,N]	AB: Jumping Pound Cr, Manyberries, Wagner NA; SK: Canora, Good Spirit L, Great Deer, Saskatoon, White Fox; MB: Aweme, Birch River, 6 mi NW Brandon, Dauphin, Pilot Mound, Red Deer River, 3 mi S Shilo, 2 mi W Stockton, Winnipeg	None
Lissonota folii Thomson, 1877 [11,H]	AB: Edmonton; MB: Ninette	Hymenoptera: Cynipidae, Tenthredinidae; Lepidoptera: Erebidae, Gelechiidae, Geometridae, Sesiidae, Tortricidae (21) *Mostly concealed feeders*
Lissonota fulvicornis Townes, 1978 [2,11,N]	AB: Wagner NA; SK: Canora	None
Lissonota infulata Townes, 1978 [11,N]	AB: Onefour; SK: Great Sand Hills	None
Lissonota jacobi (Walley, 1942) [11,N]	AB: Jumping Pound Cr; SK: Elbow, Nisbet PF; MB: Bald Head Hills at 30 mi N Glenboro, Ninette	Lepidoptera: Gelechiidae (2) *Concealed feeders*
Lissonota jaei Townes, 1978 [2,N]	AB: Wagner NA	None
Lissonota laevigata (Cresson, 1870) [2,5,11,N]	AB: Edmonton, Oyen, Vermilion, Wagner NA; SK: Regina; MB: Max L in Turtle Mt FR	None
Lissonota leucoscelis Townes, 1978 [2,N]	AB: Wagner NA, Waterton; SK: Dubuc; MB: Turtle Mt	None

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
Lissonota lirata Townes, 1978 [11,N]	MB: 5 mi SW Shilo	None
Lissonota nigricornis (Provancher, 1873) [2,5,11,N]	AB: Edmonton, Jumping Pound Cr, Wagner NA	Lepidoptera: Tortricidae (1) *Concealed feeders*
Lissonota nigromacra Townes, 1978 [2,11,N]	AB: Jumping Pound Cr, Wagner NA	None
Lissonota occidentalis (Cresson, 1870) [11,N]	SK: Saskatoon, Sutherland	Lepidoptera: Sesiidae (2) *Borers*
Lissonota orophila Townes, 1978 [11,N]	AB: Elkwater L; SK: Val Marie	None
Lissonota parva (Cresson, 1870) [11,N]	AB: Elkwater P; SK: Pike L, Saskatoon; MB: Aweme, Carberry	Lepidoptera: Coleophoridae, Gelechiidae, Pyralidae, Tortricidae (7) *Concealed feeders*
Lissonota pinguicula Townes, 1978 [2,11,N]	AB: Calgary, Edmonton, Tofield, Wagner NA	None
Lissonota punctata (Cresson, 1870) [2,11,N]	AB: Wagner NA; SK: Canora, White Fox; MB: 5 mi W Shilo, Winnipeg	None
Lissonota punctiventrator Aubert, 1977 [2,N]	AB: Wagner NA	Lepidoptera: Tineidae (1)
Lissonota rasilis Townes, 1978 [2,11,N]	AB: Wagner NA; SK: Saskatoon	None
Lissonota reniculellae Townes, 1978 [2,N]	AB: Wagner NA	Lepidoptera: Pyralidae (1) *Concealed conifer feeders*
**Lissonota rubrica* (Cresson, 1870) [11,N]	MB: Transcona	Lepidoptera: Crambidae (1) *Concealed feeders*
**Lissonota scutellaris* (Cresson, 1870) [2,11,N]	AB: Aspen Beach, Edmonton; SK: Willow Bunch; MB: International Peace Gardens in Turtle Mt FR, Pilot Mound, 5 mi SW Shilo, Wasagaming	Lepidoptera: Gelechiidae, Sesiidae (2) *Concealed feeders*
Lissonota sexcincta (Ashmead, 1890) [2,11,N]	AB: Edmonton, Elkwater P, Red Deer, Waterton	Lepidoptera: Gelechiidae (1) *Concealed feeders*
Lissonota stenostoma Townes, 1978 [11,N]	SK: Antelope	None
Lissonota subcalva Townes, 1978 [2,N]	AB: Wagner NA	None
**Lissonota tegularis* (Cresson, 1870) [11,N]	AB: Jumping Pound Cr; SK: White Fox	Lepidoptera: Noctuidae (1)
Lissonota tetrazona Townes, 1978 [2,11,N]	AB: Elkwater, Wagner NA	None
Lissonota uncata Townes, 1978 [11,N]	SK: Cypress Hills	None
Lissonota vidua Townes, 1978 [11,N]	AB: Edmonton, Jumping Pound Cr	None
Lissonota xanthophrys Townes, 1978 [2,11,N]	AB: Jumping Pound Cr, Wagner NA; SK: Elbow, Prince Albert; MB; Ninette	Lepidoptera: Gelechiidae (1) *Concealed feeders*

Meniscomorpha mirabilis (Cresson, 1870) [11,N]	SK: Dundurn, Prince Albert; MB: Aweme, Ninette	Lepidoptera: Gelechiidae, Pyralidae, Tortricidae (7) *Concealed feeders*
Sphelodon phoxopteridis (Weed, 1888) [2,11,N,T]	AB: Edmonton; SK: Avonlea, Saskatoon; MB: 2 mi N Forrest, Swan River	Lepidoptera: Tortricidae (6) *Concealed feeders*
Syzeuctus elegans (Cresson, 1870) [11,N]	MB: 2 mi W Stockton	Lepidoptera: Notodontidae, Pyralidae (5) *Leafrollers*
Syzeuctus epischniae Cushman, 1926 [11,N]	AB: Calgary, Lethbridge	Lepidoptera: Pyralidae (1) *Concealed feeders*
Syzeuctus eximius Walley, 1934 [11,N,T]	SK: Rockglen; MB: Aweme	None
CAMPOPLEGINAE		
Bathyplectes bryanti (Viereck, 1925) [22,N]	AB: Bilby	None
**Bathyplectes curculionis* (Thomson, 1887) [23,24,H,O]	AB: Manyberries, Milk River, Orion, Sterling, Cranford	Coleoptera: Curculionidae (6)
Bathyplectes exiguus (Gravenhorst, 1829) [5,H]	AB: Lethbridge	Coleoptera: Curculionidae; Hymenoptera: Vespidae; Lepidoptera: Tischeriidae (6) *Mostly concealed feeders*
Callidora surata Tigner, 1969 [25,N]	AB: Glenwood	None
Campoctonus carinatus (Provancher, 1879) [26,N]	AB: Elk Island; SK: Saskatoon; MB: Whitewater	None
Campoletis argentifrons (Cresson, 1864) [5,22,N,T]	AB: Edmonton; SK: Saskatoon	Hymenoptera: Tenthredinidae; Lepidoptera: Crambidae, Noctuidae, Nymphalidae, Plutellidae, Tortricidae (20)
**Campoletis atkinsoni* (Viereck, 1925) [5,6,22,27,N]	AB: Calahoo, Calgary, Edmonton, Lethbridge, Wainwright; SK: Rosthern, Saskatoon	Lepidoptera: Noctuidae (1) *Cutworms*
Campoletis atypica (Viereck, 1925) [28,N]	AB: Edmonton	None
Campoletis australis (Viereck, 1903) [5,N]	AB: Lethbridge	Lepidoptera: Noctuidae (1) *Cutworms*
Campoletis clavata (Provancher, 1875) [22,N]	SK: Saskatoon	Lepidoptera: Crambidae, Noctuidae, Tortricidae (4)
Campoletis distincta (Provancher, 1882) [14,29,N]	AB: Edmonton; SK: south	None
Campoletis diversa (Viereck, 1925) [22,N]	AB: Waterton	None
Campoletis flavicincta (Ashmead, 1890) [5,N,T,O]	AB: Lethbridge, Red Deer, Edmonton	Lepidoptera: Crambidae, Gelechiidae, Noctuidae, Pieridae, Sphingidae (25)
Campoletis imperfecta (Viereck, 1925) [22,N]	SK: Saskatoon; MB: Carberry	None
Campoletis intermedia (Viereck, 1925) [5,22,N]	AB: Lethbridge; MB: Teulon	None

SUBFAMILY **Species**[a]	**Localities**[b]	**Host Family (No. spp.)** ***Guild/Notes***
Campoletis julia (Viereck, 1925) [22,N]	AB: Waterton Lakes	Lepidoptera: Choreutidae (1) *Concealed feeders*
Campoletis kingi (Viereck, 1925) [22,N]	SK: Saskatoon	None
Campoletis linearis (Viereck, 1925) [22,N]	SK: Saskatoon	None
Campoletis lipomerus (Viereck, 1925) [22,N]	SK: Saskatoon	None
Campoletis nigricoxa (Viereck, 1925) [22,N]	AB: Bilby	None
Campoletis nigripes (Cresson, 1864) [5,N]	AB: Cypress Hills, Lethbridge, Medicine Hat, Vermilion	None
Campoletis nigriscaposa (Viereck, 1925) [22,N]	SK: Saskatoon	None
**Campoletis oxylus* (Cresson, 1864) [22,N]	MB: Aweme	Diptera: Syrphidae; Lepidoptera: Noctuidae (13)
Campoletis parasignata (Walley, 1927) [30,N]	SK: Indian Head	None
Campoletis patsuiketorum (Viereck, 1917) [5,22,N]	AB: Edmonton, Vermilion; SK: Saskatoon	Lepidoptera: Crambidae, Pyralidae, Tortricidae (5) *Concealed feeders*
Campoletis plena (Provancher, 1875) [22,N]	AB: Cowley	None
Campoletis pyralidis Walley, 1970 [31,N]	SK: Kinistino	Lepidoptera: Gelechiidae, Pyralidae (11)
Campoletis septentrionalis (Viereck, 1925) [22,N]	AB: Brooks, Waterton	Lepidoptera: Noctuidae (1) *Cutworms*
Campoletis tibialis (Viereck, 1925) [14,N]	AB: Cochrane	None
Campoletis tibiator (Cresson, 1864) [5,N]	AB: Lethbridge, Edmonton	Lepidoptera: Noctuidae, Plutellidae, Pyralidae (4)
Campoplex crassatus (Viereck, 1925) [7,N]	SK: Indian Head	Lepidoptera: Tortricidae (4) *Concealed feeders*
Campoplex erythromerus Viereck, 1925 [5,N]	AB: Edmonton	None
Campoplex fusiformis (Provancher, 1874) [14,N]	AB: Edmonton	None
Campoplex hexagonalis (Viereck, 1925) [22,N]	AB: Lethbridge	None
Campoplex infumatus (Provancher, 1874) [14,N]	AB: Lethbridge	Lepidoptera: Tortricidae (1) *Concealed feeders*
Campoplex mellipes (Provancher, 1883) [5,22,N]	AB: Cypress Hills, Edmonton; SK: Saskatoon	Lepidoptera: Gelechiidae, Tortricidae (4) *Concealed feeders*
Campoplex tortricidis Cushman, 1915 [14,N]	AB: Edmonton	Lepidoptera: Tortricidae (3) *Concealed feeders*
Casinaria canadensis Walley, 1947 [2,N]	AB: Wagner NA	None
Casinaria eupitheciae Viereck, 1912 [2,N]	AB: Wagner NA	Lepidoptera: Geometridae (5)

Casinaria forcipata Walley, 1947 [2,14,32,N]	AB: Blackfoot Hills, Cochrane, Wagner NA; SK: Saskatoon	Lepidoptera: Geometridae, Lasiocampidae, Erebidae (11) *Mostly loopers*
Casinaria genuina (Norton, 1863) [2,32,N]	AB: Wagner NA; SK: Great Sand Hills (W Swift Current)	Hymenoptera: Diprionidae; Lepidoptera: Erebidae, Noctuidae (5) *Mostly setose*
Casinaria limenitidis (Howard, 1889) [2,32,N]	AB: Wagner NA; MB: Aweme, Winnipeg	Lepidoptera: Erebidae, Geometridae, Lasiocampidae, Notodontidae, Nymphalidae (13) *Mostly setose*
Casinaria petiolaris (Gravenhorst, 1829) [32,H]	SK: Regina, Uren	Lepidoptera: Erebidae, Geometridae, Nymphalidae (4)
Casinaria scabriformis Viereck, 1912 [14,N]	AB: Cypress Hills	Diptera: Chloropidae; Lepidoptera: Geometridae (2)
Casinaria semiothisae Walley, 1941 [33,N]	SK: Nipawin, Prairie River, Ushta Siding	Lepidoptera: Geometridae (4) *Loopers*
**Cymodusa distincta* (Cresson, 1864) [34,N]	AB: Edmonton; SK: Elbow	None
Cymodusa melanocera Viereck, 1925 [34,N,T]	MB: Carberry	None
**Cymodusa partis* (Viereck, 1925) [34,N]	AB: Elkwater, Lethbridge, Norton, Onefour, Orion; MB: Carberry	None
**Cymodusopsis aristoteliae* Viereck, 1912 [35,N]	AB: Lethbridge	Lepidoptera: Crambidae, Gelechiidae (2) *Concealed feeders*
Cymodusopsis latifacies Sanborne, 1986 [35,N]	SK: Saskatoon	None
Cymodusopsis variabilis Sanborne, 1986 [35,N]	AB: Elkwater, Onefour, Waterton; SK: Elbow, Saskatoon	Lepidoptera: Plutellidae (1) *Concealed feeders*
**Diadegma insulare* (Cresson, 1865) [5,9,36,37,38,39,H,T,O,Oc]	AB: nr Lethbridge; SK: Aylsham, Melfort, Saskatoon, Watson; MB: **Franklin**, **Glenlea**, **LaSalle**, **Minnedosa**, **Winnipeg**	Lepidoptera: Crambidae, Gelechiidae, Plutellidae (5) *Concealed feeders*
**Diadegma openangorum* (Viereck, 1917) [5,8,N]	AB: Edmonton; midcentral Canada (AB/SK) in sunflower fields	Lepidoptera: Pyralidae (2) *Concealed feeders*
Diadegma stenosomum (Viereck, 1925) [40,N]	SK: Willow Bunch	Lepidoptera: Gelechiidae, Oecophoridae (3) *Concealed feeders*
Diadegma trachas (Viereck, 1925) [22,N]	AB: Cochrane	None
Dusona annexa (Förster, 1868) [2,H]	AB: Wagner NA	None
Dusona bellula (Dalla Torre, 1901) [2,41,N]	AB: Bilby, Wagner NA	Lepidoptera: Geometridae (1) *Loopers*
Dusona canadensis (Walley, 1940) [42,N]	AB: Cochrane	Lepidoptera: Noctuidae (1) *Concealed feeders*
Dusona crassicornis (Provancher, 1886) [2,42,N]	AB: Edmonton, Wagner NA	Lepidoptera: Erebidae (1) *Setose*
Dusona deceptor (Walley, 1940) [42,N]	SK: Earl Grey	Lepidoptera: Geometridae (2) *Loopers*
Dusona diversa (Norton, 1863) [9,42,N]	AB: Edmonton, **Wabamun**; SK: Saskatoon; MB: Aweme, **Glenlea**	Lepidoptera: Geometridae (1) *Loopers*

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
Dusona downesi (Viereck, 1925) [2,42,N]	AB: Wagner NA, Waterton	Lepidoptera: Noctuidae (1)
Dusona fossata (Viereck, 1926) [42,N]	AB: Bilby; MB: Aweme	None
Dusona glauca (Norton, 1863) [2,5,42,N]	AB: Gull L, Red Deer, Wagner NA	Lepidoptera: Geometridae (2) *Loopers*
Dusona insolita (Walley, 1940) [14,42,N]	AB: Edmonton; MB: Aweme	None
Dusona laminata (Walley, 1940) [42,N]	MB: Teulon	None
Dusona laticincta (Cresson, 1865) [5,42,N]	AB: Bilby, Calgary, Edmonton, Lethbridge, Waterton; SK: Radison, Saskatoon; MB: Aweme, Transcona	Lepidoptera: Noctuidae (1) *Cutworms*
Dusona lobata (Walley, 1940) [42,N]	MB: Aweme	Lepidoptera: Geometridae (2) *Loopers*
Dusona major (Cresson, 1879) [5,N]	AB: Waterton	Lepidoptera: Geometridae, Notodontidae (2)
Dusona minor (Provancher, 1879) [2,5,42,H]	AB: Cypress Hills, Edmonton, Lethbridge, Wagner NA	Hymenoptera: Diprionidae Lepidoptera: Geometridae (3) *Conifer feeders*
Dusona occidentalis (Davis, 1898) [2,N]	AB: Wagner NA	None
Dusona pectoralis (Walley, 1940) [2,42,N]	AB: Edmonton, Wagner NA	Lepidoptera: Geometridae (1) *Loopers*
Dusona petiolator (Fabricius, 1804) [2,5,H,O]	AB: Edmonton, Wagner NA	Lepidoptera: Geometridae (8) *Loopers*
Dusona scalaria (Provancher, 1886) [2,42,N]	AB: Edmonton, Wagner NA	None
Dusona seamansi (Viereck, 1925) [2,5,42,N]	AB: Edmonton, Wagner NA, Waterton; MB: Aweme	Lepidoptera: Tortricidae (1) *Leafrollers*
Dusona semirufa (Provancher, 1882) [42,N]	MB: Transcona	Lepidoptera: Notodontidae (1)
Dusona signata (Viereck, 1925) [42,N]	SK: Earl Grey; MB: Aweme, Transcona	None
Dusona stricklandi (Viereck, 1925) [42,N]	AB: Waterton	None
Dusona vara (Walley, 1940) [2,5,N]	AB: Edmonton, Wagner NA	None
Dusona varicoxa (Viereck, 1926) [2,5,42,N]	AB: Calgary, Edmonton, Wagner NA	Lepidoptera: Geometridae (1) *Loopers*
Dusona vicina (Provancher, 1874) [2,N]	AB: Wagner NA	Lepidoptera: Geometridae (2) *Loopers*
Dusona villosa (Norton, 1863) [5,N]	AB: Calgary	Lepidoptera: Geometridae (1) *Loopers*
Dusona vitticollis (Norton, 1863) [2,5,N]	AB: Edmonton, Wagner NA	Lepidoptera: Geometridae, Lasiocampidae (4) *Mostly loopers*
Dusona wyomingensis (Viereck, 1906) [5,41,43,N]	AB: Edmonton, Waterton; SK: Saskatoon	Lepidoptera: Noctuidae (1)
Echthronomas ochreofrons Cushman, 1924 [44,N]	SK: St. Louis, Cut Knife	Lepidoptera: Erebidae (2) *Bristly lichen feeders*

Enytus eureka (Ashmead, 1890) [14,N]	AB: Edmonton	Lepidoptera: Coleophoridae, Gelechiidae, Pyralidae, Tortricidae (13) *Concealed feeders*
Enytus montanus (Ashmead, 1890) [9,H]	MB: **Kenville**, **Roblin**, **Swan River**	Lepidoptera: Pyralidae, Tortricidae (12) *Concealed feeders*
Enytus oculus (Viereck, 1925) [45,N]	AB: nr Calgary	Lepidoptera: Geometridae (1) *Loopers*
Hyposoter annulipes (Cresson, 1864) [5,43,N]	AB: Calgary, Lethbridge, Waterton	Lepidoptera: Crambidae, Coleophoridae, Erebidae, Gelechiidae, Lasiocampidae, Noctuidae, Nymphalidae, Pieridae, Pyralidae, Tortricidae (34)
Hyposoter asper (Viereck, 1925) [22,N]	AB: Waterton Lakes	None
Hyposoter degrysei (Viereck, 1925) [22,N]	SK: Indian Head	None
Hyposoter erythrinus (Viereck, 1925) [22,N]	SK: St. Louis	None
Hyposoter exiguae (Viereck, 1912) [22,N,T,Oc]	SK: Kinistino	Lepidoptera: Erebidae, Geometridae, Noctuidae, Nymphalidae, Pieridae, Sphingidae (24)
Hyposoter fugitivus (Say, 1835) [9,N,T]	MB: **Gladstone**, **Piney**	Lepidoptera: Erebidae, Geometridae, Hesperiidae, Lasiocampidae, Limacodidae, Lycaenidae, Megalopygidae, Noctuidae, Notodontidae, Nymphalidae, Pyralidae, Saturniidae (31)
Hyposoter occidentali (Viereck, 1925) [22,N]	AB: Waterton Lakes	Lepidoptera: Pterophoridae (1) *Concealed feeders*
Hyposoter popofensis (Ashmead, 1902) [5,N]	AB: Edmonton	None
Hyposoter rivalis (Cresson, 1872) [9,10,N]	MB: Carman, **Gladstone**, Oak Bluff, St. Claude	Lepidoptera: Erebidae (8) *Setose*
Olesicampe alaskensis (Ashmead, 1902) [5,N]	AB: Edmonton	None
Olesicampe banffensis (Viereck, 1925) [22,N]	MB: Transcona	None
Olesicampe lata (Viereck, 1925) [22,N]	MB: Winnipeg	None
Olesicampe patula (Viereck, 1925) [22,N]	MB: Winnipeg	None
Olesicampe typica (Viereck, 1925) [5,N]	AB: Edmonton	None
Phobocampe bicingulata (Gravenhorst, 1829) [29,H]	Southern AB, Southern SK	Lepidoptera: Geometridae, Noctuidae (9)
Phobocampe clisiocampae (Weed, 1903) [46,N]	AB: sites in parkland and Peace River area	Lepidoptera: Erebidae, Geometridae, Lasiocampidae, Notodontidae, Saturniidae, Sphingidae (16)

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
Phobocampe confusa (Thomson, 1887) [29,H]	Southern AB, Southern SK	None
Phobocampe flavipes (Provancher, 1874) [9,22,N]	MB: Winnipeg	Lepidoptera: Erebidae, Geometridae, Noctuidae (10)
Pyracmon ctenicerae Barron & Walley, 1983 [47,N]	SK: Asquith	Coleoptera: Elateridae (1)
Pyracmon hyalinus (Provancher, 1874) [14,N]	AB: Edmonton	Lepidoptera: Tortricidae (3) *Concealed feeders*
Pyracmon sepiellus (Holmgren, 1860) [2,H]	AB: Wagner NA	Coleoptera: Artematopodidae (1)
Rhimphoctona aldrichi (Davis, 1898) [48,N]	AB: Edmonton	Coleoptera: Cerambycidae, Curculionidae (2) *Borers*
Rhimphoctona brevicauda (Sanborne, 1986) [48,N]	AB: Bilby	None
Rhimphoctona longicauda Horstmann, 1980 [48,N]	AB: Calgary, Edmonton, Villeneuve	None
Rhimphoctona macdunnoughi (Viereck, 1925) [48,N]	AB: Edmonton	None
Rhimphoctona macrocephala (Provancher, 1874) [14,N]	AB: Edmonton	Coleoptera: Cerambycidae (1)
Rhimphoctona vancouverensis (Harrington, 1894) [48,N]	AB: Drumheller; SK: Elbow	None
Scirtetes canadensis (Wally, 1944) [9,N]	MB: **Winnipeg**	Lepidoptera: Noctuidae (2)
Sinophorus caradrinae (Viereck, 1912) [49,N]	AB: Lethbridge, Medicine Hat; SK: Saskatoon, Swift Current	Lepidoptera: Noctuidae, Tortricidae (3)
Sinophorus constrictus Sanborne, 1984 [49,N]	AB: Waterton	None
Sinophorus costalis (Thomson, 1887) [49,H]	AB: Edmonton, Waterton	Lepidoptera: Elachistidae, Noctuidae (2)
Sinophorus erectus Sanborne, 1984 [49,N]	AB: Twin Butte	None
Sinophorus eruficinctus (Walkley, 1958) [49,N]	AB: Drumheller, Stettler; SK: Lisieux, Regina, Rockglen, Willow Bunch	Lepidoptera: Noctuidae (3)
Sinophorus heliothidis Sanborne, 1984 [49,N]	SK: Tyner	Lepidoptera: Noctuidae (1)
Sinophorus infimus Sanborne, 1984 [49,N]	AB: Oyen	None
Sinophorus masoni Sanborne, 1984 [49,N]	AB: Waterton	None
Sinophorus megalodontis Sanborne, 1984 [49,N]	AB: Delburne	Hymenoptera: Pamphiliidae (2) *Web-spinning sawflies*

Sinophorus nitidus (Brischke, 1880) [49,H,O]	AB: Calgary, Edmonton, Gleichen; SK: Elbow, Great Sand Hills, Swift Current	Lepidoptera: Tortricidae (2) *Conifer shoot borers*
Sinophorus orientis Sanborne, 1984 [49,N]	AB: Three Creeks	Lepidoptera: Geometridae (1) *Loopers*
Sinophorus platycephalus Sanborne, 1984 [49,N]	SK: Elbow	None
Sinophorus relativus (Viereck, 1905) [49,N,T]	MB: Shilo	Lepidoptera: Tortricidae (1) *Conifer shoot borers*
Sinophorus sabulus Sanborne, 1984 [49,N]	SK: Tunstall	None
**Sinophorus sulcatellus* (Viereck, 1925) [5,49,N]	AB: Calgary, Coaldale, Drumheller, Edmonton, Elkwater, Glenwood, Lethbridge, Lost River, Manyberries, Medicine Hat, Milk River, Orion, Oyen, Pearce, Rainier, Red Deer, Three Hills, Waterton, Winnifred; SK: Buchanan, Estevan, Great Deer, Regina, Rosthern, Rutland, Saskatoon, Stoughton, Strongfield, Swift Current, Torquay, Tunstall, White Fox; MB: Brandon, Minnedosa	Coleoptera: Cerambycidae; Lepidoptera: Crambidae (2)
**Sinophorus teratis* (Weed, 1887) [49,H]	AB: Edmonton, Jumping Pond Cr, Calgary, Kinsella, Stettler, Wainwright, Waterton	Lepidoptera: Crambidae, Erebidae, Geometridae, Pyralidae, Tortricidae (9) *Mostly concealed feeders*
Sinophorus townesorum Sanborne, 1984 [49,N]	AB: Oldman River, Lethbridge	Lepidoptera: Notodontidae (2)
**Sinophorus tumidus* Sanborne, 1984 8,N	Midcentral Canada (AB/SK) in sunflower fields	Lepidoptera: Pyralidae (1)
Sinophorus validus (Cresson, 1864) [5,49,N]	AB: Edmonton, Jumping Pound Cr, Lethbridge, Waterton; MB: Aweme	Hymenoptera: Ichneumonidae, Coleophoridae; Lepidoptera: Crambidae, Erebidae, Geometridae, Lasiocampidae, Noctuidae, Notodontidae, Pyralidae, Tortricidae (32)
Sinophorus vericulus Sanborne, 1984 [49,N]	AB: Jumping Pound Cr (20 mi W Calgary); SK: Tangleflags	Lepidoptera: Noctuidae (1) *Loopers*
Tranosema carbonellum (Thomson, 1887) [50,H]	AB: Edmonton	Hymenoptera: Argidae (1)
Tranosemella coxalis (Brischke, 1880) [5,H]	AB: Edmonton	Lepidoptera: Geometridae, Noctuidae, Nolidae, Tortricidae (5)
Venturia canescens (Gravenhorst, 1829) [5,51,W]	AB: Lethbridge; Throughout Nearctic, indoors, attacking caterpillars on stored products	Lepidoptera: Erebidae, Crambidae, Gelechiidae, Noctuidae, Pyralidae, Tineidae, Tortricidae, Yponomeutidae (22) *Mostly concealed feeders*
Venturia finlaysonae Wahl, 1987 [51,N]	MB: Whitemouth	Lepidoptera: Pyralidae (1)
Venturia scitula Wahl, 1987 [51,N]	MB: Morris, Treesbank	None
Xanthocampoplex orbitalis (Walley, 1944) [2,5,N]	AB: Edmonton, Wagner NA	None

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
CREMASTINAE		
Cremastus albertensis Dasch, 1979 [52,N]	SK: Saskatoon	None
Cremastus canadensis Dasch, 1979 [52,N]	MB: Brandon	None
Cremastus cressoni Kerrich, 1959 [52,N]	AB: Calgary	None
Cremastus dorcaschemae Cushman, 1920 [52,N]	MB: Brandon	Coleoptera: Cerambycidae (1) *Borers*
Cremastus flavopictus Dasch, 1979 [52,N,T]	SK: Saskatoon; MB: Ninette	None
Cremastus gallaecola Cushman, 1917 [52,N]	AB: Medicine Hat	Lepidoptera: Gelechiidae (1) *Stem gall makers*
Cremastus hyalinipennis (Cresson, 1872) [52,N]	SK: Elbow	Lepidoptera: Noctuidae (1)
Cremastus incompletus (Provancher, 1875) [5,52,N]	AB: Aden, Coaldale, Cypress Hills, Drumheller, Edmonton, Elkwater, Irvine, Jumping Pound Cr, Lethbridge, Magrath, Manyberries, Medicine Hat, Milk River, Morrin, Steveville, Taber, Wayne; SK: Attons L, Duck L, Elbow, Grenfell, Lloydminster, Parkbeg, Prince Albert, Redberry, Roadene, Saskatoon, Swift Current, Tompkins; MB: Aweme, Carberry, Ninette, Pierson, 3 mi S Shilo, Tamarack Bog at 5 mi SW Shilo, Vita, Wawanesa, Winnipeg	Diptera: Tephritidae (1)
Cremastus mordellistenae Cushman, 1917 [52,N]	AB: Edmonton, Lethbridge, Medicine Hat; SK: Saskatoon; MB: Aweme, Brandon	Coleoptera: Mordellidae (3)
Cremastus nordi Townes, 1965 [52,N]	SK: Indian Head	Coleoptera: Cerambycidae (1) *Borers*
Cremastus politus Dasch, 1979 [52,N]	SK: Elbow	None
Cremastus protractus Cushman, 1935 [52,N]	AB: Onefour; SK: Swift Current	Lepidoptera: Coleophoridae (1)
Neleothymus pusillus Dasch, 1979 [52,N]	AB: Edmonton, Ponoka	None
Nothocremastus mellipes (Provancher, 1875) [52,N]	SK: White Fox	None
Pristomerus baumhoferi Cushman, 1930 [52,N]	SK: Great Sand Hills, Saskatchewan Landing	Lepidoptera: Coleophoridae, Cosmopterigidae, Gelechiidae, Tortricidae (6) *Concealed feeders*
Pristomerus coracinus Dasch, 1979 [52,N]	AB: Clymont	None

Pristomerus euryptychiae Ashmead, 1896 [7,52,N,T]	SK: Indian Head, Saskatoon	Coleoptera: Curculionidae; Lepidoptera: Cosmopterigidae, Elachistidae, Gelechiidae, Nymphalidae, Pyralidae, Tortricidae (22) *Mostly stem borers*
Pristomerus laticeps Cushman, 1920 [52,N]	MB: Ninette	None
**Pristomerus spinator* (Fabricius, 1804) [5,43,52,53,N,T,Oc]	AB: Brooks, Burdett, Calgary, "Cameron Ranch", Cassils, Chin, Clarinda, Cochrane, Cypress Hills, Edmonton, Elkwater P, Glenwood, Gull L, Jumping Pound Cr, Lethbridge Manyberries, Medicine Hat, Morrin, Onefour, Orion, Oyen, Picture Butte, Red Deer, Rosebud, Scandia, Stavely, Taber, Tofield, Vermilion, Wardlow, Wild Horse, Winnifred; SK: Antelope L, Consul, Dollard, Duck L, Dunblane, Earl Grey, Elbow, Estevan, Garrick, Great Deer, Great Sand Hills, Indian Head, Kenosee P, Moose Jaw, Moosomin, Nipawin, Parkbeg, Regina, Roadene, Roche Percee, Rosetown, Saskatoon, Strongfield, Swift Current; MB: Aweme, Treesbank	Lepidoptera: Crambidae, Erebidae, Gelechiidae, Noctuidae, Pieridae, Pyralidae, Tortricidae (28)
Temelucha chilonis (Cushman, 1935) [14,52,N]	AB: Edmonton, Wabamun	Lepidoptera: Crambidae (2) *Concealed feeders*
Temelucha cookii (Weed, 1888) [52,N]	AB: Rosemary	Lepidoptera: Tortricidae (2) *Concealed feeders*
Temelucha crepera Dasch, 1979 [52,N]	AB: Calgary; SK: Saskatoon	None
Temelucha cymosa Dasch, 1979 [52,N]	AB: Edmonton	None
Temelucha dakotae Dasch, 1979 [52,N]	MB: 9 mi N Forrest Stn	None
Temelucha forbesi (Weed, 1887) [52,N]	SK: Saskatoon; MB: Aweme, Ninette	Coleoptera: Cerambycidae; Lepidoptera: Coleophoridae, Gelechiidae, Tortricidae (18) *Mostly concealed feeders*
Temelucha fuscalata Dasch, 1979 [52,N]	SK: Birch Hills	None
Temelucha inflata Dasch, 1979 [52,N]	SK: Redberry, Uren, Saskatoon	None
Temelucha platynotae (Cushman, 1917) [52,N]	AB: Lethbridge, Onefour; SK: Estevan, Great Sand Hills, Kenosee, Swift Current, Uren; MB: Aweme, Treesbank	Lepidoptera: Choreutidae, Gelechiidae, Momphidae, Pyralidae, Tortricidae (21) *Concealed feeders*
Temelucha recta (Provancher, 1874) [52,N]	MB: Dauphin, Morris	Lepidoptera: Tortricidae (1) *Concealed feeders*
Temelucha rhyacioniae (Cushman, 1930) [52,N]	AB: Coaldale, Onefour; SK: Elbow, Moosomin, Pike L, Rosetown, Saskatoon; MB: Ninette, 5 mi SW Shilo	Lepidoptera: Coleophoridae, Tortricidae (8) *Concealed feeders*
Temelucha undulata Dasch, 1979 [52,N]	SK: Bounty, Elbow	Lepidoptera: Gelechiidae (1) *Concealed feeders*
Trathala angulosa Dasch, 1979 [52,N]	SK: Great Sand Hills	None

SUBFAMILY **Species**[a]	**Localities**[b]	**Host Family (No. spp.)** ***Guild/Notes***
Trathala delicata (Cresson, 1872) [7,52,N]	SK: Clemenceau, Elbow, Indian Head, Snowden, White Fox; MB: Ninette, 5 mi SW Shilo	Lepidoptera: Elachistidae, Gelechiidae, Pyralidae, Tortricidae (14) *Concealed feeders*
Trathala enigmatica Dasch, 1979 [52,N]	SK: Indian Head	Lepidoptera: Gelechiidae, Gracillariidae, Tortricidae (7) *Concealed feeders*
Trathala granulata (Davis, 1898) [52,N]	SK: Saskatoon	Coleoptera: Cerambycidae, Cleridae, Curculionidae, Trogossitidae; Hymenoptera: Cynipidae (7) *Mostly wood borers*
Trathala oregona Dasch, 1979 [2,52,N]	AB: Wagner NA; MB: Ninette	None
CRYPTINAE		
Aclastus flagellatus (Davis, 1897) [5,N]	AB: Medicine Hat, Edmonton	None
Aclastus micator (Gravenhorst, 1807) [14,H]	AB: Edmonton	Araneae: Amaurobiidae, Linyphiidae; Coleoptera: Curculionidae; Diptera: Anthomyiidae; Lepidoptera: Tortricidae (7)
Acrolyta nigricapitata (Cook & Davis, 1891) [5,N]	AB: Edmonton	Hymenoptera: Braconidae; Lepidoptera: Limacodidae, Noctuidae (5)
Acroricnus stylator (Thunberg, 1824) [54,55,H]	AB: Waterton[m]	Hymenoptera: Megachilidae, Sphecidae, Vespidae (12)
Agrothereutes abbreviatus (Fabricius, 1794) [9,55,H]	AB: Bilby, Drumheller, Edmonton; SK: Nipawin; MB: **Franklin**	Hymenoptera: Cimbicidae, Diprionidae, Tenthredinidae; Lepidoptera: Coleophoridae, Incurvariidae, Lasiocampidae, Notodontidae, Psychidae, Saturniidae, Tortricidae, Zygaenidae (40)
Agrothereutes cimbicivorus (Cushman, 1924) [5,55,N]	AB: Edmonton, Drumheller	Hymenoptera: Cimbicidae (1)
Agrothereutes lophyri (Norton, 1869) [55,N]	MB: Aweme, Hamiota	Hymenoptera: Diprionidae (8) *Conifer sawflies*
Agrothereutes mandator (Linnaeus, 1758) [55,H]	AB: Edmonton	Hymenoptera: Cimbicidae, Diprionidae; Lepidoptera: Erebidae, Noctuidae, Tortricidae (14)
Apsilops bicolor (Cushman, 1927) [55,N]	AB: Wabamun; SK: Pike L, Regina; MB: Aweme	Lepidoptera: Crambidae (1) *Aquatic stem borer*
Apsilops sericatus (Viereck, 1925) [5,55,N]	AB: Edmonton, Wabamun	Lepidoptera: Crambidae (2) *Grass stem borers*
**Aptesis fastigata* Townes, 1962 [56,N]	AB: Edmonton, Waterton	None

**Aptesis gracilis* Townes, 1962 [56,N]	AB: Wabamun	None
Aptesis segnis (Provancher, 1877) [14,56,N]	AB: Edmonton; SK: Regina	Hymenoptera: Tenthredinidae (1) *Leafminers*
Aritranis freemani (Townes, 1962) [55,N]	AB: Lethbridge	None
Atractodes angustipennis Forster, 1876 [14,H]	AB: Edmonton	None
Atractodes brevissimus (Dalla Torre, 1902) [14,N]	AB: Edmonton	None
Bathythrix eurypyga Townes, 1983 [2,N]	AB: Wagner NA	None
Bathythrix sericea (Provancher, 1875) [57,H]	AB: Edmonton	None
Bathythrix triangularis (Cresson, 1868) [2,N]	AB: Wagner NA	Hymenoptera: Braconidae, Diprionidae, Ichneumonidae (31)
Buathra dorsicarinata (Pratt, 1945) [55,N]	AB: Cochrane	Lepidoptera: Geometridae (2) *Loopers*
Buathra laborator (Thunberg, 1824) [5,55,H]	AB: Bilby, Calgary, Chin, Cochrane, Cowley, Cypress Hills, Drumheller, Edmonton, Glenwood, High River, Lethbridge, Onefour, St. Paul, Wabamun, Waterton, Welling; SK: 10 mi W Moose Jaw, Regina, Saskatoon, Willow Bunch; MB: Bird's Hill, Teulon	Lepidoptera: Geometridae, Lasiocampidae, Noctuidae (6)
Caenocryptus erasus (Townes, 1962) [55,N]	AB: Lethbridge	None
Ceratophygadeuon brevacus (Townes, 1944) [2,57,N]	AB: Wagner NA; SK: Redberry, Rush L	None
Ceratophygadeuon crassidens Townes, 1983 [2,N]	AB: Wagner NA	None
Ceratophygadeuon limatulus Townes, 1983 [2,N]	AB: Wagner NA	None
Ceratophygadeuon perditus (Provancher, 1886) [2,N]	AB: Wagner NA	None
Ceratophygadeuon provancheri (Walkley, 1958) [2,57,N]	AB: Wagner NA; SK: Regina	None
Ceratophygadeuon rugifer Townes, 1983 [2,57,N]	AB: Wabamun, Wagner NA	None
Charitopes mellicornis (Ashmead, 1890) [57,N]	SK: Lloydminster	Neuroptera: Hemerobiidae (1)
**Compsocryptus resolutus* (Cresson, 1879) [5,55,N]	AB: Cypress Hills, Red Rock Canyon (Waterton NP)	None

SUBFAMILY **Species**[a]	**Localities**[b]	**Host Family (No. spp.)** ***Guild/Notes***
Cryptus albitarsis (Cresson, 1864) [5,9,55,N,T]	AB: Brooks, Calgary, Cassils, Chin, Drumheller, Duchess, Edmonton, Elkwater, Elkwater L, Lethbridge, Manyberries, Medicine Hat, Scandia, Waterton, Welling; SK: Dodsland, Maple Cr, Qu'Appelle, Regina, Rockglen, Saskatoon, White Fox, Willow Bunch, Rosthern, Swift Current; MB: Aweme, **Franklin**, **Souris**, Spruce Woods, Transcona, Teulon	Lepidoptera: Crambidae, Erebidae, Noctuidae, Nymphalidae, Pyralidae, Sesiidae, Tortricidae (12)
Cryptus luctuosus Cresson, 1864 [55,H]	AB: Calgary, High River, Lethbridge; SK: Love	Hymenoptera: Cimbicidae (2)
**Cryptus minimus* Pratt, 1945 [14,55,N]	AB: Edmonton, Gleichen, Lethbridge, Taber, Waterton; SK: Big Muddy, Saskatoon	None
Cryptus mutatus Pratt, 1945 [55,N]	AB: Waterton	None
**Cryptus persimilis* Cresson, 1864 [14,55,N]	AB: Cypress Hills, Edmonton, Irvine, Medicine Hat; SK: Estevan, Regina, Secretan, Uren, Weyburn; MB: Aweme, Transcona	None
Cryptus ruralis Pratt, 1945 [14,55,N]	AB: Lethbridge; SK: Minton, Weyburn; MB: Aweme	None
Cubocephalus alacris (Cresson, 1864) [5,9,56,N]	AB: Edmonton, Red Deer; MB: **Franklin**	Hymenoptera: Tenthredinidae; Lepidoptera: Tortricidae (2)
Cubocephalus annectus Townes, 1944 [56,N]	AB: Bilby	None
Cubocephalus annulatus (Cresson, 1864) [9,14,56,N]	AB: Edmonton, Elkwater L; MB: **Swan River**	Coleoptera: Buprestidae (1)
Cubocephalus atriclunis Townes & Gupta, 1962 [56,N]	MB: 5 mi W Shilo	None
Cubocephalus baldaufii (Dalla Torre, 1902) [56,N]	SK: Willow Bunch	None
Cubocephalus contractus Townes & Gupta, 1962 [56,N]	AB: Edmonton	None
Cubocephalus dreisbachi Townes, 1962 [56,N]	AB: Bilby	None
Cubocephalus hebes Townes, 1962 [56,N]	SK: Sutherland	None
Cubocephalus hirtipes Townes, 1962 [56,N]	AB: Pincher	None
Cubocephalus inhabilis (Provancher, 1877) [56,N]	AB: Edmonton; SK: Saskatoon	None

Cubocephalus occidentalis (Provancher, 1875) [5,56,N]	AB: Wabamun, Edmonton	Coleoptera: Curculionidae (1) *Stem borer*
Cubocephalus prolixus Townes & Gupta, 1962 [56,N]	MB: McCreary	None
Demopheles corruptor (Taschenberg, 1865) [126,H]	AB: Edmonton	Coleoptera: Cerambycidae, Curculionidae Hymenoptera: Crabronidae (4)
Diaglyptidea lavoiei (Provancher, 1882) [14,N]	AB: Vermilion	None
Dichrogaster crassa (Provancher, 1882) [5,9,57,N]	AB: Lethbridge; SK: Moosomin; MB: **Sanford**, **Winnipeg**	Neuroptera: Chrysopidae, Hemerobiidae Lepidoptera: Geometridae, Tortricidae (9)
Dichrogaster nigriceps Townes, 1983 [2,N]	AB: Wagner NA	None
Dichrogaster schimitscheki (Fahringer, 1935) [2,57,H]	AB: Wagner NA; SK: Lloydminster	Diptera: Tachinidae (1)
Echthrus adillae Davis, 1895 [55,N]	AB: Calgary, Waterton Lakes NP;	Lepidoptera: Sesiidae (1) *Borers*
Echthrus niger Cresson, 1868 [5,55,N]	AB: Edmonton, Waterton Lakes NP; MB: Aweme	Coleoptera: Cerambycidae (2) *Borers*
Endasys aurantifex Luhman, 1990 [58,N]	AB: Elkwater	None
Endasys aurigena Luhman, 1990 [58,N]	SK: Atton's L at Cut Knife	None
Endasys bicolorescens Luhman, 1990 [58,N]	AB: Waterton	None
Endasys chrysoleptus Luhman, 1990 [58,N]	AB: nr Edmonton[m]	None
Endasys hexamerus Luhman, 1990 [58,N]	AB: Pincher	None
Endasys michiganensis Luhman, 1990 [58,N]	AB: approx Cypress Hills[m]	None
Endasys monticola (Dalla Torre, 1902) [58,N]	SK: nr Regina[m]	None
Endasys mucronatus (Provancher, 1879) [14,58,N]	AB: nr Edmonton	Hymenoptera: Argidae (2)
Endasys nemati Luhman, 1990 [58,N]	AB: Elkwater P	Hymenoptera: Tenthredinidae (1)
Endasys pubescens (Provancher, 1874) [5,58,N]	AB: Drumheller, nr Edmonton, Elkwater; SK: Cypress Hills	Hymenoptera: Diprionidae, Tenthredinidae (5) *Mostly conifer sawflies*
Endasys xanthostomus Luhman, 1990 [58,N]	AB: nr Edmonton[m]	None
Ethelurgus dorsatus Townes, 1983 [2,N]	AB: Wagner NA	None
Ethelurgus fuscidens Townes, 1983 57,N	AB: Edmonton	None
Ethelurgus opacus Townes, 1983 [2,N]	AB: Wagner NA	None

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
Gambrus apicatus (Provancher, 1874) [55,N]	SK: Dundurn, Redberry	None
Gambrus canadensis (Provancher, 1875) [5,9,46,55,N]	AB: Edmonton, Waterton, parkland region; SK: Attons L (near Cut Knife), Pike L, 5 mi E Swift Current; MB: Aweme, **Swan River**, Teulon	Coleoptera: Curculionidae; Lepidoptera: Erebidae, Hesperiidae, Lasiocampidae, Noctuidae, Pieridae, Saturniidae, Tortricidae (13)
Gambrus ultimus (Cresson, 1864) [9,N,T,Oc]	MB: **Franklin**	Coleoptera: Curculionidae; Hymenoptera: Ichneumonidae, Tenthredinidae; Lepidoptera: Erebidae, Gelechiidae, Hesperiidae, Lasiocampidae, Noctuidae, Pieridae, Psychididae, Pyralidae, Tortricidae (32)
Gelis drassi (Riley, 1892) [5,9,N]	AB: Lethbridge; MB: **Glenlea**, **Gnadenthal**	Araneae: Gnaphosidae (1)
Gelis tenellus (Say, 1835) [9,N,T,Oc]	MB: **Swan River**, **Winnipeg**	Hymenoptera: Braconidae, Diprionidae, Ichneumonidae, Pteromalidae, Tenthredinidae; Lepidoptera: Bucculatricidae, Coleophoridae, Cosmopterigidae, Erebidae, Lasiocampidae, Notodontidae, Nymphalidae, Papilionidae, Pyralidae, Saturniidae, Tortricidae, Yponomeutidae; Neuroptera: Chrysopidae (64)
Glyphicnemis californica (Cresson, 1879) [59,N]	SK: Grenfell	None
Glyphicnemis mandibularis (Cresson, 1864) [5,N]	AB: Edmonton	None
Helcostizus yukonensis (Ashmead, 1890) [5,57,N]	AB: Edmonton	Coleoptera: Cerambycidae (1) *Borers*
Hemiteles amboniger Townes, 1983 [2,N]	AB: Wagner NA	None
Hoplocryptus albicollaris (Cresson, 1872) [55,N]	MB: Minnedosa	Lepidoptera: Crambidae (1) *Stem borer*
Hoplocryptus imitator (Provancher, 1877) [5,55,N]	AB: Clymont, Lethbridge	Hymenoptera: Megachilidae (2)
Hoplocryptus linnae (Townes, 1962) [55,N]	AB: Edmonton; SK: White Fox	None
Hoplocryptus notatus (Provancher, 1874) [5,55,N]	AB: Edmonton, Lethbridge	Hymenoptera: Megachilidae, Tenthredinidae, Vespidae (6)
Idiolispa analis (Gravenhorst, 1807) [5,55,H,O]	AB: Cypress Hills; SK: Attons L at Cut Knife, Pickthall; MB: Aweme	Araneae: Lycosidae; Coleoptera: Cerambycidae; Hymenoptera: Diprionidae, Lepidoptera: Erebidae (7)

Ischnus inquisitorius (Müller, 1776) [5,55,H]	AB: Calgary, Consort, Edmonton, Lacombe, Red Deer, Saint Paul, Sylvan L, Waterton Lakes NP; SK: Glaslyn, Kenosee L, Saskatoon; MB: Aweme	Hymenoptera: Ichneumonidae; Lepidoptera: Elachistidae, Erebidae, Geometridae, Lasiocampidae, Tortricidae (21) *Mostly concealed feeders*
Ischnus latus (Provancher, 1874) [14,55,N]	AB: Edmonton	None
Listrognathus albomaculatus (Cresson, 1864) [5,55,N]	AB: Edmonton, Medicine Hat, Waterton	Lepidoptera: Crambidae, Tortricidae (1) *Concealed feeders*
Listrognathus nigrescens Townes, 1962 [55,N]	AB: Waterton	None
Listrognathus paludatus (Cresson, 1872) [55,N]	MB: Aweme	Lepidoptera: Notodontidae (1)
Lysibia mandibularis (Provancher, 1875) [2,5,N]	AB: Edmonton, Wagner NA	Hymenoptera: Braconidae Lepidoptera: Cosmopterigidae, Erebidae, Gracillaridae, Tortricidae (11)
Lysibia tenax Townes, 1983 [2,H]	AB: Wagner NA	Hymenoptera: Braconidae (2)
Mastrus aciculatus (Provancher, 1886) [5,N]	AB: Cochrane, Lethbridge, Edmonton	Hymenoptera: Braconidae, Diprionidae, Ichneumonidae; Lepidoptera: Gelechiidae, Geometridae, Notodontidae, Tortricidae (19)
Mastrus laplantei Mason, 1968 [60,N]	MB: Spruce Woods FR	Hymenoptera: Braconidae, Diprionidae, Tenthredinidae; Lepidoptera: Geometridae, Tortricidae (15)
Medophron latus Townes, 1983 [57,N]	AB: Cooking L; SK: Redberry, Regina	None
Megacara hortulana (Gravenhorst, 1829) [2,H,O]	AB: Wagner NA	Diptera: Agromyzidae, Muscidae; Hymenoptera: Cynipidae; Lepidoptera: Plutellidae, Tineidae (9)
Megacara impressa Townes, 1983 [2,N]	AB: Wagner NA	None
Megacara vagans (Gravenhorst, 1829) [2,H]	AB: Wagner NA	Diptera: Anthomyiidae, Tachinidae; Hymenoptera: Ichneumonidae; Lepidoptera: Noctuidae, Nymphalidae, Tortricidae (7)
Megaplectes monticola (Gravenhorst, 1829) [56,H]	AB: Edmonton; MB: Aweme, Douglas	Lepidoptera: Notodontidae, Pieridae (2)
Meringopus asymmetricus (Pratt, 1945) [14,55,N]	AB: Blackfoot Hills, Calgary, Consort, Cypress Hills, Vermilion, Waterton; SK: Great Deer, Saskatchewan Landing, Saskatoon	None
Meringopus calescens (Gravenhorst, 1829) [5,55,H,O]	AB: Calgary, Cypress Hills, Waterton, Waterton Lakes	Hymenoptera: Sphecidae; Lepidoptera: Saturniidae (3)

SUBFAMILY **Species**[a]	**Localities**[b]	**Host Family (No. spp.)** ***Guild/Notes***
Meringopus genatus (Pratt, 1945) [14,55,N]	AB: Cochrane, Foremost, Lethbridge, Waterton, Waterton Lakes: SK: Katepwa L nr Indian Head	Lepidoptera: Lasiocampidae (2) *Setose*
Meringopus relativus (Cresson, 1879) [5,55,N]	AB: Calgary, Foremost, Waterton	Lepidoptera: Sesiidae (1) *Borers*
Meringopus tejonensis (Cresson, 1879) [14,N]	AB: Lethbridge	Lepidoptera: Noctuidae, Sesiidae (2)
Mesoleptus declivus (Provancher, 1886) [14,N]	AB: Edmonton	Diptera: Sciomyzidae (3) *Aquatic snail parasitoids*
**Mesostenus albinotatus* Gravenhorst, 1829 [55,H]	AB: Edmonton	Lepidoptera: Pyralidae (1) *Concealed feeders*
**Mesostenus gracilis* Cresson, 1864 [5,8,9,N,T]	AB: Lethbridge; MB: **Swan River**; midcentral Canada (AB/SK) in sunflower fields	Lepidoptera: Pyralidae, Tortricidae (13) *Concealed feeders*
Mesostenus liogaster Townes, 1962 [55,N,T]	SK: Pickthall	None
Mesostenus melanurus Cushman, 1929 [55,N]	AB: Calgary	None
**Mesostenus sicarius* Townes, 1962 [55,N,T]	AB: Lethbridge	None
Mesostenus thoracicus Cresson, 1864 [5,55,N]	AB: Edmonton; MB: Aweme	Lepidoptera: Crambidae, Pyralidae (12) *Concealed feeders*
Messatoporus rufiventris Cushman, 1929 [5,55,N]	AB: Medicine Hat	Hymenoptera: Pompilidae (1)
Oresbius albicoxus (Provancher, 1875) [14,56,N]	AB: Edmonton, Tofield	Hymenoptera: Tenthredinidae (1)
Oresbius parallelus (Townes, 1962) [56,N]	MB: Aweme	Hymenoptera: Tenthredinidae (1)
Oresbius tsugae (Cushman, 1939) [56,N]	AB: Edmonton	Hymenoptera: Diprionidae (1)
Pachysomoides fulvus (Cresson, 1864) [55,N]	AB: Medicine Hat	Hymenoptera: Vespidae (7)
Parmortha circumcincta (Provancher, 1879) [14,56,N]	AB: Edmonton	Hymenoptera: Tenthredinidae (1)
Parmortha parvula (Gravenhorst, 1829) [5,9,56,H]	AB: Lethbridge; SK: Cut Knife; MB: **Swan River**	Hymenoptera: Cynipidae, Tenthredinidae (4)
Phygadeuon aciculatus Provancher, 1882 [5,N]	AB: Edmonton	Lepidoptera: Tortricidae (1)
Phygadeuon fumator Gravenhorst, 1829 [9,61,62,H]	MB: Beausejour, Glenlea, Grunthal, **La Broquerie**, **Narcisse**, **Seven Sisters**, **Steinbach**, Whitemouth, Winnipeg, Kleefeld	Coleoptera: Cerambycidae; Diptera: Anthomyiidae, Muscidae; Lepidoptera: Erebidae, Noctuidae (8)
Phygadeuon ovalis Provancher, 1875 [9,N]	MB: **Glenlea**	None

Phygadeuon subfuscus Cresson, 1864 [5,9,N]	AB: Lethbridge, Edmonton; MB: **Birtle**, **Swan River**	Diptera: Tachinidae (4)
Pleolophus coriaceus Townes, 1962 [56,N]	AB: Edmonton	None
Pleolophus indistinctus (Provancher, 1886) [56,N]	AB: Prince Albert	Hymenoptera: Diprionidae, Tenthredinidae (15)
Pleolophus rubrocinctus (Provancher, 1874) [5,56,N]	AB: Edmonton, Wabamun, Waterton	None
Polyaulon bimaculatus (Ashmead, 1890) [2,N]	AB: Wagner NA	None
Polyaulon erythropa (Ashmead, 1890) [57,N]	SK: Antelope L	None
**Polytribax crotchii* (Cresson, 1879) [5,56,N]	AB: Edmonton, Gull L	None
Pygocryptus brevicornis (Brischke, 1881) [2,H]	AB: Wagner NA	Lepidoptera: Erebidae (1)
Rhembobius abdominalis (Provancher, 1874) [2,5,56,N,Oc]	AB: Bilby, Edmonton, Saint Paul, Wabamun, Wagner NA; SK: Regina	Diptera: Syrphidae (2)
Schenkia graminicola (Gravenhorst, 1829) [14,56,H]	AB: Edmonton	Hymenoptera: Cynipidae; Lepidoptera: Zygaenidae (3)
Schenkia iridescens (Cresson, 1864) [56,N]	AB: Wabamun	None
Sphecophaga vesparum (Curtis, 1828) [2,H,Oc]	AB: Wagner NA	Hymenoptera: Vespidae; Lepidoptera: Pyralidae (14) *Mostly Vespidae*
Stilpnus gagates (Gravenhorst, 1807) [5,H,T]	AB: Lethbridge	Diptera: Anthomyiidae, Fanniidae (3)
Sulcarius nigricornis (Thomson, 1884) [2,H]	AB: Wagner NA	Diptera: Anthomyiidae (1)
Trychosis cyperia Townes, 1962 [55,N]	AB: Cypress Hills, Edmonton, Oldman River nr Lethbridge	Araneae: Thomisidae (1)
Trychosis latidens Townes, 1962 [55,N]	AB: Onefour	None
Trychosis montivaga (Provancher, 1877) [5,55,N]	AB: Edmonton, Lethbridge, Wabamun; SK: Waldheim; MB: Aweme	None
Trychosis semirubra Townes, 1944 [55,N]	AB: Edmonton	None
Xenolytus bitinctus (Gmelin, 1970) [5,W]	AB: Edmonton	Lepidoptera: Gelechiidae, Geometridae, Tineidae (5)
Xiphulcus floricolator (Gravenhorst, 1807) [57,H]	SK: Lloydminster	Hymenoptera: Braconidae, Cynipidae, Tenthredinidae; Lepidoptera: Elachistidae Psychidae, Tineidae, Tortricidae; Neuroptera: Chrysopidae (10)
Xiphulcus parallelus Townes, 1983 [57,N]	AB: Duchess	None
Xylophrurus bicolor Cushman, 1919 [5,55,N]	AB: Calgary	Coleoptera: Buprestidae, Cerambycidae (3)
Xylophrurus nubilipennis (Cresson, 1864) [55,N]	SK: Saskatoon	Coleoptera: Buprestidae, Cerambycidae (5)

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
Zoophthorus gigas (Provancher, 1886) [5,N]	AB: Edmonton	None
CTENOPELMATINAE		
Absyrtus arealis Cushman, 1924 [14,N]	AB: Edmonton	None
Alexeter canaliculatus (Provancher, 1874) [5,9,N]	AB: **Edmonton**, Red Deer	None
Alexeter difficilis (Davis, 1897) [29,N]	AB: Southwest	None
Alexeter luteifrons (Cresson, 1868) [5,N]	AB: Edmonton	None
Alexeter notatus Davis, 1897 [5,N]	AB: Waterton	None
Anisotacrus popofensis (Ashmead, 1902) [5,N]	AB: Edmonton	None
Campodorus picens (Davis, 1897) [5,N]	AB: Red Deer	None
Ctenopelma crassicorne Walley, 1941 [63,N]	AB: Edmonton	Hymenoptera: Pamphiliidae (1)
Ctenopelma croceum Walley, 1941 [5,63,N]	AB: Edmonton, Elkwater L; MB: Turtle Mt	None
Ctenopelma nigricorne (Provancher, 1886) [5,N]	AB: Edmonton	None
Ctenopelma ruficeps Barron, 1981 [63,N]	AB: Edmonton; SK: Pike L	None
Ctenopelma sanguineum (Provancher, 1875) [5,63,N]	AB: Cypress Hills, Edmonton	None
Euryproctus bituminosus Davis, 1897 [5,N]	AB: Edmonton	None
Euryproctus ramis Davis, 1897 [5,N]	AB: Edmonton, Lethbridge	None
Hadrodactylus coxatus Davis, 1897 [5,N]	AB: Edmonton, Red Deer	None
Hadrodactylus femoratus (Davis, 1897) [5,N]	AB: Edmonton, Lethbridge	None
Hadrodactylus seminiger (Provancher, 1874) [5,9,N]	AB: Edmonton, **Fawcett**, St. Paul	None
Hadrodactylus tibialis (Ashmead, 1902) [5,N]	AB: Edmonton	None
Himerta annulata (Davis, 1895) [5,64,N]	AB: Calgary, Edmonton, George L, Jumping Pound Cr, Red Deer; SK: Rockglen, Brooks	None
Himerta atra (Cushman, 1924) [5,64,N]	AB: Bilby, Edmonton, George L, Wabamun; SK: Redberry	None
Himerta bicolorata Leblanc, 1989 [64,N]	AB: Drumheller, George L, Gull L, Jumping Pound Cr (20 mi W Calgary), Red Deer; SK: Great Sand Hills, Saskatoon	None

Himerta carinata Leblanc, 1989 [64,N]	AB: Edmonton, Fawcett, Waterton	Hymenoptera: Tenthredinidae (1)
Himerta epicnemia Leblanc, 1989 [64,N]	AB: Bilby, Calgary, Carstairs, Demmitt, Drumheller, Edmonton, Elkwater P, George L, Jumping Pound Cr (20mi W Calgary), Waterton NP; SK: Broadview, Elbow, Prince Albert, Rockglen, St. Victor, Saskatoon; MB: Southwest[m]	Hymenoptera: Cimbicidae (1)
Himerta foxleei Leblanc, 1989 [64,N]	AB: Red Deer	None
Himerta lineola Leblanc, 1989 [64,N]	AB: Edmonton; MB: Ninette	None
Himerta pumila Leblanc, 1989 [64,N]	SK: Willow Bunch	None
Himerta rubiginosa (Cresson, 1879) [5,N]	AB: Calgary, Edmonton	None
Homaspis albipes Davis, 1897 [65,N]	AB: Waterton; SK: 23 km E White	Hymenoptera: Pamphiliidae (1)
Homaspis slossonae Cushman, 1922 [65,N]	SK: Resource, Wadena; MB: Winnipeg	Hymenoptera: Pamphiliidae (2)
Hypamblys albopictus (Gravenhorst, 1829) [66,H]	AB: Winnipeg	Hymenoptera: Diprionidae, Tenthredinidae (16)
Hypamblys conformis (Walley, 1933) [5,N]	AB: Edmonton	None
Lamachus lophyri Ashmead, 1898 [9,N]	MB: **Riverton**	Hymenoptera: Diprionidae (4)
Lamachus ruficoxalis (Cushman, 1919) [9,67,N]	MB: Aweme, **Strathclair**, **Winnipeg**	Hymenoptera: Diprionidae (1)
Lathrolestes aquilus Barron, 1994 [68,N]	AB: Jumping Pound Cr (20 mi W Calgary), Mountain View at Waterton Lakes NP, Waterton	None
Lathrolestes bulbus Barron, 1994 [68,N]	AB: Edmonton	None
Lathrolestes carinatus Barron, 1994 [68,N]	AB: Jumping Pound Cr (20 mi W Calgary)	None
Lathrolestes caudatus (Thomson, 1883) [5,68,N]	AB: Edmonton, Jumping Pound Cr (20 mi W Calgary), Wabamun	None
Lathrolestes luteolator (Gravenhorst, 1829) [68,69,H,Oc]	AB: Edmonton, George L, Jumping Pound Cr (20 mi W Calgary)	Hymenoptera: Argidae, Tenthredinidae (10)
Lathrolestes nigricollis (Thomson, 1883) [70,H]	AB: Edmonton	Hymenoptera: Tenthredinidae (2)
Lathrolestes pictus Cushman, 1933 [68,N]	AB: Edmonton	None
Lathrolestes protrusus Barron, 1994 [68,N]	SK: Elbow, Rockglen	None
Lathrolestes thomsoni Reshchikov, 2010 [71,N]	AB: Edmonton	Hymenoptera: Tenthredinidae (1)
Lathrolestes truncatus (Provancher, 1888) [5,68,N]	AB: Bilby, Cowley, Edmonton, Elkwater, Jumping Pound Cr (32 km W Calgary), Waterton, Waterton L NP; SK: St. Victor; MB: Aweme	Hymenoptera: Tenthredinidae (1)
Mesoleius insidiosus (Cresson, 1864) [5,N]	AB: Cypress Hills, Edmonton, Red Deer	None

SUBFAMILY **Species**[a]	**Localities**[b]	**Host Family (No. spp.)** ***Guild/Notes***
Mesoleius submarginatus (Cresson, 1868) [5,N]	AB: Edmonton	None
Mesoleius tarsalis (Cresson, 1868) [5,N]	AB: Red Deer	None
Mesoleius tenthredinis Morley, 1912 [72,H]	MB: Treesbank	Hymenoptera: Diprionidae, Tenthredinidae (2)
Mesoleptidea decens (Cresson, 1868) [14,N]	AB: Edmonton	None
Oetophorus pleuralis (Cresson, 1864) [73,N]	AB: Wabamun, Edmonton; SK: Attons L, Cut Knife, Bapaume, Great Sand Hills (W Swift Current), Elbow; MB: Ninette, Duck Mt FR	Hymenoptera: Tenthredinidae (1)
Opheltes glaucopterus (Linnaeus, 1758) [5,9,43,H]	AB: Calgary, Edmonton; MB: Aweme, **Franklin**	Hymenoptera: Cimbicidae; Lepidoptera: Erebidae, Lasiocampidae, Sphingidae (13)
Otlophorus carbonarius (Gravenhorst, 1829) [74,H]	AB: Edmonton	Araneae: Tetragnathidae (1)
Pantorhaestes xanthostomus (Gravenhorst, 1829) [5,N]	AB: Edmonton, Lethbridge	Hymenoptera: Tenthredinidae (2)
Perilissus araius Burks, 1952 [75,N]	AB: Jumping Pound Cr (32 km W Calgary); MB: Bald Head Hills (21 km N Glenboro), Shilo (tamarack bog),	Lepidoptera: Erebidae (1)
Perilissus coloradensis (Ashmead, 1896) [75,N]	SK: Attons L (Cut Knife), Great Sand Hills (W Swift Current)	None
Perilissus concolor (Cresson, 1864) [75,N]	AB: Drumheller; SK: Kenosee; MB: Ninette	Hymenoptera: Tenthredinidae (1)
Perilissus decoloratus (Cresson, 1864) [5,9,75,N]	AB: **Bilby**, Edmonton, George L, Jumping Pound Cr (32 km W Calgary), Lundbreck, Red Deer; SK: Big River, Cut Knife, Prince Albert; MB: Ninette, Morton	None
Perilissus discolor (Cresson, 1864) [75,N]	AB: Jumping Pound Cr (32km W Calgary); SK: Great Sand Hills; MB: Shilo (tamarack bog)	Hymenoptera: Tenthredinidae (1)
Phobetes striatus (Davis, 1897) [5,N,T]	AB: Edmonton	Hymenoptera: Tenthredinidae (1)
Phobetes uniformis (Provancher, 1874) [5,N]	AB: Edmonton	Hymenoptera: Cimbicidae (1)
Protarchus mellipes (Provancher, 1886) [76,N]	AB: Edmonton	Hymenoptera: Cimbicidae (1)
Protarchus sorbi (Ratzeburg, 1844) [76,H]	AB: Edmonton	Hymenoptera: Cimbicidae (5)
Protarchus testatorius (Thunberg, 1822) [76,H]	AB: Cameron L	Hymenoptera: Cimbicidae (7)
Rhinotorus ovalis (Davis, 1897) [2,N]	AB: Wagner NA	Hymenoptera: Tenthridinidae (1)
Rhorus clapini (Provancher, 1876) [77,N]	SK: nr Lloydminster, nr Regina, nr Fort Qu'Appelle; MB: nr Riding Mt P[m]	Hymenoptera: Cimbicidae (2)

Rhorus pilosus (Davis, 1897) [77,N]	SK: nr N Battleford; MB: nr Boissevain, nr Portage la Prairie[m]	None
Rhorus tristis Provancher, 1886 [9,N]	SK: **Duck Mt**	Hymenoptera: Argidae, Tenthredinidae (4)
Rhorus varifrons (Cresson, 1868) [5,77,N]	AB: Cochrane, Edmonton, Red Deer, nr Waterton[m], 3 central localities[m]; SK: nr Saskatoon[m], S of Saskatoon[m]	Hymenoptera: Diprionidae, Tenthredinidae (11)
Scolobates auriculatus (Fabricius, 1804) [2,5,H]	AB: Edmonton, Wagner NA	Hymenoptera: Argidae, Tenthredinidae; Lepidoptera: Sphingidae (11)
Scopesis gesticulator (Thunberg, 1824) [5,H]	AB: Edmonton, Red Deer	None
Sympherta fucata (Cresson, 1868) [5,9,N]	AB: Cypress Hills, Edmonton, **Wabamun**	None
Syndipnus conformis (Holmgren, 1857) [78,H]	SK: Attons L at Cut Knife	None
Syndipnus lateralis (Gravenhorst, 1829) [78,N]	AB: Bilby	Hymenoptera: Tenthredinidae (2)
Syndipnus rubiginosus Walley, 1940 [78,H]	SK: Sutherland	Hymenoptera: Tenthredinidae (2)
Synoecetes festivus (Cresson, 1864) [5,9,N]	AB: Edmonton, **Fawcett**	None
Synomelix obesa (Davis, 1897) [14,N]	AB: Edmonton	None
Trematopygus semirufus (Cresson, 1864) [2,5,N]	AB: Edmonton, Wagner NA	None
Xenoschesis cinctiventris (Ashmead, 1896) [5,N]	AB: Edmonton	None
Xenoschesis nitida Walley, 1935 [5,N]	AB: Edmonton	None
CYLLOCERIINAE		
Allomacrus arcticus (Holmgren, 1880) [79,H]	AB: Cameron L Rd in Waterton NP	None
Cylloceria borealis (Roman, 1925) [79,H]	AB: Gull L; SK: Prince Albert	None
Cylloceria melancholica (Gravenhorst, 1820) [5,9,79,H]	AB: Aspen Beach, Bilby, Clymont, Drumheller, Edmonton, Egremont, Elkwater L, Elkwater P, Gull L, Jumping Pound Cr, Lethbridge, Manyberries, Stettler, Wabamun, Wainwright, Waterton; SK: Birch Hills, Canora, Dubuc, Estevan, Gull L, Holbein, Kandahar, Kenosee, Lebret, Prince Albert, Redberry, Regina, Saskatoon, 5 mi E Swift Current; MB: Aweme, Boissevain, Carberry, Dauphin, **Franklin**, Glenboro, Hodgson, Horton, Millwood, 5 mi N Minnedosa, Ninette, Oak L, Pilot Mound, Roblin, 5 mi SW Shilo, Souris, 3 mi W Stockton, **Swan River**	Hymenoptera: Pamphiliidae, Tenthredinidae; Lepidoptera: Crambidae, Pyralidae, Tortricidae (5)
DIACRITINAE		
Diacritus muliebris (Cresson, 1868) [14,N]	AB: Edmonton	None

SUBFAMILY **Species**[a]	**Localities**[b]	**Host Family (No. spp.)** ***Guild/Notes***
DIPLAZONTINAE		
Diplazon bradleyi Dasch, 1964 2,80,N	AB: Wagner NA; MB: 5 mi SW Shilo	None
Diplazon deletus (Thomson, 1890) [2,H]	AB: Wagner NA	None
Diplazon hyperboreus (Marshall, 1877) [2,H]	AB: Wagner NA	None
**Diplazon laetatorius* (Fabricius, 1781) [5,9,80,81,W]	AB: Aspen Beach, Bilby, Cypress Hills, Edmonton, Elkwater L, Medicine Hat, Milk River, Lethbridge, Onefour, Rockyford, Scandia, Standard, Wabamun; SK: Assiniboia, Belle Plaine, Chaplin, Elbow, Estevan, Kandahar, Maple Cr, Minton, Moosomin, Pike L, Redberry, Regina, Rockglen, Rutland, Saskatoon, Swift Current, Val Marie, south; MB: Boissevain, Brandon, Douglas, **Glenlea**, **Morris**, Ninette, Russell, **Sanford**, Shilo, **Swan River**, Turtle Mt FR, Virden, Wawanesa, Whitewater L, **Winnipeg**	Coleoptera: Chrysomelidae, Curculionidae; Diptera: Anthomyiidae, Muscidae, Syrphidae; Hymenoptera: Diprionidae, Pamphiliidae; Lepidoptera: Crambidae, Elachistidae, Erebidae, Gelechiidae, Noctuidae, Plutellidae (74)
Diplazon orbitalis (Cresson, 1865) [2,80,H,T]	AB: Bilby, Edmonton, High River, Wabamun, Wagner NA; SK: Swift Current	Diptera: Syrphidae (3)
Diplazon pectoratorius (Thunberg, 1824) [5,80,H,T,O]	AB: Bilby, Edmonton, Gull L, Red Deer, Sylvan L, Wabamun, Waterton	Coleoptera: Curculionidae; Diptera: Syrphidae, Tachinidae; Hymenoptera: Tenthredinidae; Lepidoptera: Noctuidae, Tortricidae (17) *Mostly Syrphidae*
Diplazon scutellaris (Cresson, 1868) [5,80,N,T]	AB: Medicine Hat	Diptera: Syrphidae; Lepidoptera: Noctuidae (5) *Mostly Syrphidae*
Diplazon tetragonus (Thunberg, 1824) [2,5,80,H,O]	AB: Bilby, Consort, Edmonton, Sylvan L, Wabamun, Wagner NA; SK: Antelope L, Snowden, Willow Bunch; MB: Aweme, 5 mi SW Shilo	Coleoptera: Curculionidae Diptera: Syrphidae (16) *Mostly Syrphidae*
Diplazon tibiatorius (Thunberg, 1824) [5,80,H,T]	AB: Bilby, Calgary, Clymont, Edmonton, Lethbridge	Coleoptera: Curculionidae; Diptera: Syrphidae (9) *Mostly Syrphidae*
Enizemum ornatum (Gravenhorst, 1829) [80,H,O]	AB: Bilby, Calgary, Edmonton; SK: Cookson, Indian Head	Diptera: Syrphidae; Lepidoptera: Noctuidae (13) *Mostly Syrphidae*
Enizemum petiolatum (Say, 1835) [5,80,N]	AB: Consort, Edmonton, Vermilion	Diptera: Syrphidae
Fossatyloides gracilentus (Holmgren, 1858) [2,80,H]	AB: Edmonton, Wagner NA; SK: Saskatoon, White Fox	None
Homotropus nigritarsus (Gravenhorst, 1829) [5,80,H]	AB: Bilby, Calgary, Duchess, Edmonton, Lethbridge, Medicine Hat, Onefour, Waterton; SK: Dunblane, Moosomin, Saskatoon; MB: Aweme	Diptera: Syrphidae; Lepidoptera: Lasiocampidae (4) *Mostly Syrphidae*

Homotropus pacificus (Cresson, 1879) [2,N,T]	AB: Wagner NA	Diptera: Syrphidae, Tachinidae (5) *Mostly Syrphidae*
Homotropus pallipes (Gravenhorst, 1829) [2,80,H,T]	AB: Edmonton, Wagner NA Cameron L Rd in Waterton NP	Diptera: Cecidomyiidae, Syrphidae; Lepidoptera: Tortricidae (5) *Mostly concealed feeders*
Homotropus signatus (Gravenhorst, 1829) [2,5,9,80,H]	AB: Brooks, Cooking L, Duchess, Edmonton, Lethbridge, Wagner NA; SK: Moosomin, Regina, Saskatoon; MB: Treesbank, Ninette, **Starbuck**	Diptera: Anthomyiidae, Syrphidae; Lepidoptera: Tortricidae (14) *Mostly Syrphidae*
Homotropus vitreus (Dasch, 1964) [80,H]	AB: Blackfoot Hills, Duchess, Edmonton, Lethbridge	None
Phthorima compressa (Desvignes, 1856) [80,H]	AB: Aspen Beach, Pincher	Diptera: Syrphidae (2)
Promethes melanaspis (Thomson, 1890) [80,H]	AB: Edmonton	None
Promethes sulcator (Gravenhorst, 1829) [2,5,80,H,O]	AB: Edmonton, Wagner NA; SK: Saskatoon; MB: Ninette, Treesbank	Diptera: Anthomyiidae, Syrphidae; Lepidoptera: Pieridae, Plutellidae, Tortricidae (11)
Sussaba aciculata (Ruthe, 1859) [2,H]	AB: Wagner NA	None
Sussaba dorsalis (Holmgren, 1858) [2,9,80,H]	AB: **Bilby**, **Edmonton**, Elkwater, Wagner NA; SK: Regina; MB: Assiniboine River nr Treesbank	Diptera: Anthomyiidae, Syrphidae; Lepidoptera: Choreutidae (4)
Sussaba pulchella (Holmgren, 1858) [2,5,80,H,O]	AB: Calgary, Edmonton, Gull L, Lethbridge, Medicine Hat, Onefour, Patricia, Pincher Cr, Shaughnessy, Tilley, Wagner NA, Waterton; SK: Cypress Hills, Great Sand Hills, Saskatoon, Swift Current	Coleoptera: Bruchidae; Diptera: Anthomyiidae, Chloropidae, Syrphidae; Lepidoptera: Crambidae, Noctuidae (12)
Sussaba punctiventris (Thomson, 1890) [2,H]	AB: Wagner NA	None
Sussaba rohweri (Brues, 1908) 80,N,T	AB: Iron Springs, Lethbridge; SK: Moosomin	Diptera: Syrphidae; Lepidoptera: Oecophoridae (2)
Syrphoctonus albopictus (Davis, 1895) 2,80,N	AB: Edmonton, Wagner NA	Diptera: Anthomyiidae, Syrphidae (2)
Syrphoctonus columbiensis (Dasch, 1964) 80,N	AB: Lethbridge, Wabamun	None
Syrphoctonus fraudulentus (Dasch, 1964) 80,N	AB: Edmonton, Consort	None
Syrphoctonus laevis Brues, 1908 80,N	AB: Bilby	None
Syrphoctonus maculifrons (Cresson, 1865) 5,80,N,T,Oc	AB: Calgary, Edmonton, High River, Lethbridge; SK: Regina, Saskatoon, Willow Bunch	Diptera: Syrphidae (6)
Syrphoctonus minimus (Cresson, 1864) [2,N]	AB: Wagner NA	None
Syrphoctonus nudus (Dasch, 1964) [80,H]	AB: Edmonton	None

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
Syrphoctonus pectoralis (Provancher, 1874) [2,5,H]	AB: Edmonton, Wagner NA	None
Syrphoctonus pleuralis (Cresson, 1868) [5,80,N]	AB: Bilby, Edmonton	Diptera: Syrphidae (3)
Syrphoctonus quadrangularis (Dasch, 1964) [2,80,N]	AB: Edmonton, Wagner NA	None
Syrphoctonus robustus Davis, 1895 [5,80,N]	AB: Bilby, Edmonton	None
Syrphoctonus tarsatorius (Panzer, 1809) [80,H,O]	AB: Bilby	Diptera: Syrphidae (16)
Syrphophilus bizonarius (Gravenhorst, 1829) [2,9,14,80,H,O]	AB: **Cooking L**, Edmonton, Wagner NA; SK: Cypress Hills	Coleoptera: Curculionidae; Diptera: Anthomyiidae, Syrphidae (9) *Mostly Syrphidae*
Syrphophilus ichneumonoides (Provancher, 1874) [2,5,9,N]	AB: **Edmonton**, Wagner NA, Vermilion	None
Syrphophilus tricinctorius (Thunberg, 1824) [80,H,O]	AB: Waterton; SK: Saskatoon	Diptera: Syrphidae; Lepidoptera: Tortricidae (4) *Mostly Syrphidae*
Syrphophilus tricinctus (Ashmead, 1902) [2,80,H]	AB: Wagner NA, Waterton	None
Tymmophorus erythrozonus (Forster, 1850) [2,5,80,H]	AB: Cooking L, Edmonton, Wagner NA; MB: Shilo	Diptera: Syrphidae (2)
Tymmophorus fasciventris Dasch, 1964 [2,N]	AB: Wagner NA	None
Woldstedtius citropectoralis (Schmiedeknecht, 1926) [2,H]	AB: Wagner NA	Coleoptera: Curculionidae; Diptera: Syrphidae (5) *Mostly Syrphidae*
Woldstedtius flavolineatus (Gravenhorst, 1829) [5,80,H,T,O,Oc]	AB: Edmonton, Lethbridge	Diptera: Syrphidae; Lepidoptera: Coleophoridae, Crambidae, Erebidae, Tortricidae (28) *Mostly Syrphidae*
EUCEROTINAE		
Euceros congregatus Barron, 1976 [82,N]	AB: Jumping Pound Cr (20 mi W Calgary), Wabamun; MB: Aweme	None
Euceros decorus Walley, 1932 [2,82,N]	AB: Wagner NA; MB: Aweme, Spruce Woods FR, Treesbank	Hymenoptera: Diprionidae, Ichneumonidae, Tenthredinidae (3)
Euceros digitalis Walley, 1932 [82,N]	AB: Edmonton, Lundbreck; SK: Cut Knife	Lepidoptera: Erebidae (1)

Euceros frigidus Cresson, 1869 [82,N]	MB: Aweme	Hymenoptera: Diprionidae, Ichneumonidae; Lepidoptera: Geometridae (15) *Mostly conifer feeders*
Euceros sanguineus Davis, 1897 [82,N]	AB: Edmonton, Waterton; SK: Attons L, Cut Knife	None
Euceros semiothisae Barron, 1976 [82,N]	AB: Glendon, Lunbreck; SK: Prince Alberta; MB: Treesbank	Hymenoptera: Ichneumonidae; Lepidoptera: Erebidae, Geometridae, Noctuidae (20) *Mostly loopers on conifers*
ICHNEUMONINAE		
Anisobas texensis (Ashmead, 1890) [14,N]	AB: Edmonton	Lepidoptera: Lycaenidae (2)
Anisopygus americanus Heinrich, 1961 [83,N]	SK: Cypress Hills	Lepidoptera: Notodontidae (2)
Aoplus confirmatus (Cresson, 1877) [5,N]	AB: Waterton	Lepidoptera: Pyralidae (1)
Aoplus ruficeps (Gravenhorst, 1829) [5,14,83,H]	AB: Edmonton, Red Deer	Lepidoptera: Geometridae, Noctuidae (5) Mostly loopers
Aoplus torpidus (Wesmael, 1857) [83,84,H]	AB: Edmonton, Gull L	Lepidoptera: Geometridae (1) *Loopers*
Aoplus velox (Cresson, 1864) [14,N]	AB: Drumheller, Edmonton	Lepidoptera: Geometridae, Notodontidae (4) *Mostly loopers*
Asthenolabus agilis (Cresson, 1877) [2,N]	AB: Wagner NA	None
Asthenolabus canadensis (Cresson, 1877) [5,N]	AB: Edmonton	None
Asthenolabus scutellatus (Provancher, 1875) [5,N]	AB: Edmonton	None
Coelichneumon ater (Cresson, 1864) [5,N]	AB: Edmonton	None
Coelichneumon deliratorius (Linnaeus, 1758) [85,H]	SK: Great Deer; MB: Aweme	Hymenoptera, Lepidoptera: Diprionidae, Erebidae, Geometridae, Noctuidae, Notodontidae, Nymphalidae, Sphingidae, Tortricidae (14)
Coelichneumon eximius (Stephens, 1835) [5,83,H]	AB: nr Calgary[m], Edmonton, nr Lethbridge[m]	Lepidoptera: Erebidae, Geometridae, Noctuidae, Notodontidae (8)
Coelichneumon histricus (Cresson, 1867) [5,N]	AB: Cypress Hills	None
Coelichneumon maurus (Cresson, 1864) [5,83,N]	AB: Edmonton, Waterton; SK: Indian Head	Lepidoptera: Noctuidae (1) *Cutworms*
Coelichneumon neocretatus Heinrich, 1960 9,86,H	SK: Pike L; MB: **Swan River**	None

SUBFAMILY **Species**[a]	**Localities**[b]	**Host Family (No. spp.)** ***Guild/Notes***
Coelichneumon orpheus (Cresson, 1864) [5,83,N]	AB: Edmonton; MB: Aweme	Lepidoptera: Erebidae, Noctuidae (4) *Mostly setose*
Conocalama manitobae Heinrich, 1962 [87,N]	MB: Aweme	None
Conocalama occidentalis (Cresson, 1868) [88,N]	AB: Calgary, Waterton; MB: Aweme	Lepidoptera: Sphingidae (1)
Conocalama quebecensis (Provancher, 1874) [83,N]	SK: Prince Albert; MB: Aweme	Lepidoptera: Saturniidae (1)
Cratichneumon pilosulus (Provancher, 1875) [5,N]	AB: Edmonton	None
Cratichneumon popofensis Ashmead, 1902 [14,N]	AB: Edmonton	None
Cratichneumon promptus (Cresson, 1877) [5,83,N]	AB: Edmonton; MB: Treesbank	Lepidoptera: Geometridae (1) *Loopers*
Cratichneumon pteridis Townes, 1944 [83,N]	MB: 2 localities in SW corner[m]	Lepidoptera: Geometridae, Notodontidae (4) *Mostly loopers*
Cratichneumon rubricus (Provancher, 1882) [9,N]	MB: **Glenlea**	None
Cratichneumon scitulus (Cresson, 1864) [5,N]	AB: Edmonton	Lepidoptera: Pyralidae (1) *Concealed feeders*
Cratichneumon unifasciatorius (Say, 1825) [83,N]	AB: nr Calgary[m]	Lepidoptera: Erebidae, Noctuidae, Saturniidae, Sesiidae (11) *Mostly setose*
Cratichneumon vescus (Provancher, 1877) [5,9,83,N]	AB: Edmonton, **Gull L**, Red Deer, Vermilion, **Wabamun**; MB: Southwest[m]	Lepidoptera: Geometridae, Noctuidae (2)
Cratichneumon viator (Scopoli, 1763) [83,H]	Several localities in southwest SK and southeast MB	Hymenoptera: Diprionidae, Ichneumonidae;Lepidoptera: Erebidae, Geometridae, Lasiocampidae, Noctuidae, Pieridae (28)
Ctenichneumon caeruleops Heinrich, 1961 [89,N]	SK: Saskatoon	None
Ctenichneumon excultus (Cresson, 1867) [14,N]	AB: Calgary	None
Ctenichneumon punctiscuta Heinrich, 1961 [89,N]	MB: Aweme	None
Ctenichneumon syphax (Cresson, 1864) [14,N]	AB: Drumheller	None
Cyclolabus lobatus Heinrich, 1962 [90,N]	AB: Edmonton	Lepidoptera: Geometridae (1) *Loopers*

Cyclolabus signatus (Provancher, 1874) [14,N]	AB: Cochrane, Edmonton	None
Dentilabus rufipes (Provancher, 1875) [83,N]	AB: Fawcett	Lepidoptera: Geometridae (3) *Loopers*
Diadromus helvolus (Cresson, 1867) [2,14,N]	AB: Edmonton, Wagner NA	Lepidoptera: Tortricidae (2) *Concealed feeders*
Diadromus marginatus (Provancher, 1886) [5,N]	AB: Lethbridge	None
Diadromus subtilicornis (Ashmead, 1890) [9,H]	MB: **Swan River**	Coleoptera: Cerambycidae; Lepidoptera: Acrolepiidae, Noctuidae, Pyralidae (4)
Diphyus allapsus (Cresson, 1865) [5,N]	AB: Edmonton	None
Diphyus animosus (Cresson, 1864) [9,14,N]	AB: **Bilby**, Calgary, Edmonton, Lethbridge	None
Diphyus apiculatus (Walkley, 1958) [5,N]	AB: Edmonton, Lethbridge, Red Deer	Lepidoptera: Noctuidae (1) *Cutworms*
Diphyus comes (Cresson, 1864) 9,N	AB: **Edmonton**	Lepidoptera: Coleophoridae, Noctuidae (3)
Diphyus discus (Cresson, 1864) [5,91,N]	AB: Calgary; MB: Husavick	None
**Diphyus euxoae* Heinrich, 1969 [5,9,13,N]	AB: Calgary, Edmonton, Lethbridge, **Wabamun**	Lepidoptera: Noctuidae (3) *Cutworms*
Diphyus hudsonicus (Cresson, 1877) [5,N]	AB: Cochrane, Edmonton	None
Diphyus macilentus (Cresson, 1865) [14,N]	AB: Edmonton	None
Diphyus nuncius (Cresson, 1877) [5,N]	AB: Calgary	Lepidoptera: Noctuidae (2) *Cutworms*
Diphyus ormenus (Cresson, 1864) [5,N]	AB: Edmonton, Red Deer, St. Paul	None
Diphyus populorum (Heinrich, 1961) [83,89,N]	AB: Calgary; SK: Roche Percee	Lepidoptera: Noctuidae (1)
Diphyus provancheri (Cushman, 1925) [5,N]	AB: Edmonton	None
Diphyus robustus (Cresson, 1867) [5,N]	AB: Edmonton	None
Diphyus rubellus (Cresson, 1865) [5,N]	AB: Calgary, Edmonton, Lethbridge	None
Diphyus subfuscus (Cresson, 1864) [5,9,92,N]	AB: Calgary, **Edmonton**, Lethbridge	Lepidoptera: Noctuidae (3) *Cutworms*
Dirophanes gaspesianus Provancher, 1882 [14,N]	AB: Edmonton	Lepidoptera: Geometridae, Tortricidae (2) *Conifer feeders*
Dirophanes hariolus (Cresson, 1867) [9,N]	MB: **Stead**	Hymenoptera: Diprionidae; Lepidoptera: Tortricidae (10) *Mostly Tortricidae*
Ectopimorpha hiulcops Heinrich, 1961 [89,N]	SK: Weyburn	None
Ectopimorpha luperinae Cushman, 1931 [9,N]	MB: **Portage**	Lepidoptera: Noctuidae (1)
Ectopimorpha wilsoni (Cresson, 1864) [9,N]	MB: **Dauphin**	None
Eutanyacra improvisa (Cresson, 1867) [5,89,N]	AB: Edmonton; AB, SK: "Transition zone"	Lepidoptera: Noctuidae (5)

SUBFAMILY **Species**[a]	**Localities**[b]	**Host Family (No. spp.)** ***Guild/Notes***
Eutanyacra suturalis (Say, 1835) [5,9,N,T]	AB: Calgary, Drumheller, Lethbridge, Edmonton; MB: **Altona**, **Lenswood**, **Swan River**	Lepidoptera: Noctuidae (8) *Cutworms*
Eutanyacra trivittata Heinrich, 1961 [9,N]	MB: **Glenlea**	None
Exephanes terminalis (Provancher, 1874) [5,N]	AB: Edmonton	None
Heterischnus huardi (Provancher, 1875) [5,93,N]	AB: Edmonton	Lepidoptera: Pterophoridae (1)
Homotherus porcelariae Heinrich, 1961 [83,94,N]	MB: Treesbank, Sprucewoods, five localities in south MB[m]	Lepidoptera: Geometridae (4) *Loopers*
Hoplismenus morulus (Say, 1829) [5,9,83,95,N]	AB: Bilby, nr Calgary[m], Edmonton, Red Deer; SK: nr Prince Albert[m]; MB: **Swan River**, **Winnipeg**	Lepidoptera: Nymphalidae (6) *Spiny*
Hoplismenus rutilus (Cresson, 1864) [84,N]	SK: Saskatoon; MB: Beulah	None
Hybophorellus townesi Heinrich, 1956 [84,N]	SK: Secretan, Swift Current	None
Hypomecus quadriannulatus (Gravenhorst, 1829) [14,H,O]	AB: Edmonton	Lepidoptera: Geometridae, Noctuidae (7) *Mostly loopers*
Ichneumon ambulatorius Fabricius, 1775 [14,H]	AB: Medicine Hat; MB: Birtle	Lepidoptera: Noctuidae (9)
Ichneumon annulatorius Fabricius, 1775 [5,N]	AB: Cochrane, Edmonton	Lepidoptera: Coleophoridae, Noctuidae (2)
Ichneumon artemis (Viereck, 1902) [85,N]	AB: Waterton L	None
Ichneumon atrox Cresson, 1877 [85,N]	MB: Aweme	None
Ichneumon bimembris Provancher, 1877 [5,83,N]	AB: Cochrane; MB: Aweme	None
**Ichneumon canadensis* Cresson, 1867 [5,9,17,N]	AB: Edmonton; MB: **Altona**, Glenlea, **Grosse Isle**	Lepidoptera: Erebidae, Noctuidae (3)
Ichneumon centrator Say, 1825 [83,N]	SK: nr Lloydminster; MB: 2 localities in southwest[m]	Lepidoptera: Erebidae (1) *Setose*
Ichneumon cervulus Provancher, 1875 [5,N]	AB: Edmonton	None
Ichneumon cessatorops Heinrich, 1956 [85,N]	AB: Edmonton	None
Ichneumon chasmodops Heinrich, 1961 [85,N]	MB: Aweme, Dauphin L	Lepidoptera: Sesiidae (1) *Borers*
Ichneumon creperus Cresson, 1867 [5,9,83,N]	AB: Edmonton; SK: 1 locality in southeast[m]; MB: **Franklin**	Lepidoptera: Noctuidae (1) *Cutworms*
Ichneumon devinctor Say, 1825 [5,83,N]	AB: Edmonton; SK: 1 locality in southeast[m]; MB: 1 locality in southwest[m]	Lepidoptera: Cossidae, Hepialidae, Sesiidae (5) *Borers*
Ichneumon dioryctriae Heinrich, 1961 [83,N]	AB: 1 locality in southeast; SK: nr Prince Albert, 1 locality in southwest[m]	Lepidoptera: Pyralidae (3) *Concealed feeders*

Ichneumon eurypus Heinrich, 1961 [9,N]	MB: **Swan River**	None
Ichneumon faciens Davis, 1898 [5,N]	AB: Edmonton	None
Ichneumon feralis Cresson, 1867 [5,9,N]	AB: **Bilby**, Edmonton	Lepidoptera: Geometridae, Hepialidae, Noctuidae (4)
Ichneumon feriens Heinrich, 1961 [85,N]	AB: Midnapore; MB: Aweme	None
Ichneumon gestuosus Cresson, 1877 [5,N]	AB: Edmonton	Lepidoptera: Tortricidae (1) *Concealed feeders*
Ichneumon gracilicornops Heinrich, 1961 [85,N]	AB: Edmonton	None
Ichneumon hippisleyae Heinrich, 1961 [85,N]	MB: Dauphin L	None
Ichneumon inurbanus Cresson, 1867 [5,N]	AB: Calgary, Edmonton	None
Ichneumon lachrymans Provancher, 1875 [5,N]	AB: Cypress Hills, Edmonton	Lepidoptera: Erebidae, Geometridae, Nymphalidae (3)
Ichneumon laetus Brulle, 1846 [5,9,N]	AB: **Bilby**, Calgary, Edmonton, Red Deer; MB: **Winnipeg**	Lepidoptera: Crambidae, Erebidae, Noctuidae (8)
Ichneumon longulus Cresson, 1864 [5,9,N]	AB: **Bilby**, Calgary, Edmonton, Lethbridge	Lepidoptera: Noctuidae (1) *Cutworms*
Ichneumon maius Cresson, 1867 [5,N]	AB: Edmonton	Lepidoptera: Erebidae (2) *Setose lichen feeders*
Ichneumon microferiens Heinrich, 1961 [85,N]	AB: Edmonton, Wabamun; MB: Aweme	None
Ichneumon nigrovariegatus (Provancher, 1874) [14,N]	AB: Edmonton	None
Ichneumon parvus Cresson, 1864 [5,N]	AB: Edmonton	None
Ichneumon pedalis Cresson, 1864 [5,N]	AB: Calgary, Edmonton	None
Ichneumon pictifrons Cresson, 1864 [5,N]	AB: Edmonton	None
Ichneumon placidus Provancher, 1875 [5,N]	AB: Edmonton, Lethbridge	None
Ichneumon pseudowinkleyi Heinrich, 1961 [85,N]	MB: Dauphin L	None
Ichneumon putus Cresson, 1877 [5,N]	AB: Edmonton	Lepidoptera: Geometridae (1) *Loopers*
Ichneumon subdolus Cresson, 1867 [5,N]	AB: Calgary	Lepidoptera: Noctuidae (1)
Ichneumon suburbanus Heinrich, 1961 [85,N]	AB: Calgary; MB: Ninette	None
Ichneumon uncinatus Cresson, 1877 [5,N]	AB: Edmonton	None
Ichneumon ultimus Cresson, 1877 [9,N]	MB: **Swan River**	Lepidoptera: Erebidae (1)
Ichneumon versabilis Cresson, 1877 83, N	SK: nr Regina[m]	Lepidoptera: Lycaenidae, Nymphalidae, Sesiidae (4)
Limerodops belangeri (Cresson, 1877) [14,N]	AB: Edmonton	Lepidoptera: Noctuidae (1) *Cutworms*

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
Melanichneumon absconditus (Provancher, 1886) [14,N]	AB: Vermilion	None
Melanichneumon flavicarina Heinrich, 1961 [83,84,N]	MB: Treesbank	Lepidoptera: Geometridae (1) *Loopers*
Neotypus coreensis Uchida, 1930 [5,H]	AB: Edmonton	Lepidoptera: Lycaenidae (2)
Neotypus nobilitator (Gravenhorst, 1807) [14,H,O]	AB: Edmonton	Hymenoptera: Ichneumonidae; Lepidoptera: Lycaenidae, Sphingidae (10)
Netanyacra dacotae Heinrich, 1968 [96,N]	AB: Lethbridge	None
Obtusodonta manitobae Heinrich, 1962 [87,N]	AB: Calgary; MB: Winnipeg	None
Obtusodonta obscuricolor (Heinrich, 1961) [94,N]	SK: White Fox	None
Orgichneumon calcatorius (Thunberg, 1824) [83,H]	SK: nr Prince Albert[m]	Lepidoptera: Erebidae, Tortricidae (6) *Mostly setose*
Oronotus vincibilis (Cresson, 1867) [97,N]	SK: Indian Head	Lepidoptera: Plutellidae, Pterophoridae (2) *Concealed feeders*
Patrocloides montanus (Cresson, 1864) [5,83,N]	AB: Edmonton, Red Deer, Waterton several south and central localities; MB: 1 locality in southwest	Lepidoptera: Geometridae, Noctuidae, Tortricidae (9) *Mostly loopers*
Patrocloides perluctuosus (Provancher, 1877) [5,N]	AB: Cypress Hills	Lepidoptera: Noctuidae, Tortricidae (7) *Conifer feeders*
Phaeogenes arcticus Cushman, 1920 [2,5,N]	AB: Edmonton, Vermilion, Wagner NA	Hymenoptera: Diprionidae; Lepidoptera: Tortricidae (3) *Conifer feeders*
Phaeogenes cacoeciae Viereck, 1924 [5,20,N]	AB: Edmonton; SK: Glaslyn	Lepidoptera: Tortricidae (2) *Concealed feeders*
Phaeogenes hebe (Cresson, 1867) [14,N]	AB: Edmonton	None
Platylabops pecki Heinrich, 1961 [84,N]	SK: White Fox	None
Platylabus clarus (Cresson, 1867) [14,N]	AB: Edmonton	Lepidoptera: Geometridae (3) *Loopers*
Platylabus foxleei Heinrich, 1962 [83,N]	AB: Waterton Lakes NP	Lepidoptera: Geometridae (1) *Loopers*
Platylabus imitans Heinrich, 1962 [83,N]	AB: 1 locality in southwest	Lepidoptera: Geometridae (4) *Loopers*
Platylabus luteatae Heinrich, 1962 [83,N]	AB: Edmonton	Lepidoptera: Geometridae (1) *Loopers*

Platylabus rubricapensis Provancher, 1882 [14,N]	AB: Edmonton	None
Pristicerops bakeri (Davis, 1898) [14,83,N]	AB: Breton, Vermilion	Lepidoptera: Geometridae (2) *Loopers*
Pristiceros lascivus (Cresson, 1867) [83,N]	SK: Fort-à-la-Corne	Lepidoptera: Geometridae (1) *Loopers*
Protichneumon effigies Heinrich, 1961 [86,N]	MB: Russell	None
Protichneumon grandis (Brulle, 1846) [5,9,N]	AB: Calgary, Edmonton; MB: **Winnipeg**	Lepidoptera: Saturniidae (1)
Rubicundiella deuteromelas Heinrich, 1962 [2,N]	AB: Wagner NA	None
Rubicundiella perturbatrix Heinrich, 1962 [9,N,Oc]	MB: **Altona**	Hymenoptera: Diprionidae; Lepidoptera: Crambidae, Erebidae, Noctuidae (6)
Rubicundiella simplicior Heinrich, 1961 [84,N]	SK: Tyner	Lepidoptera: Noctuidae, Sesiidae (3)
Spilichneumon bronteus (Cresson, 1864) [9,14,N]	AB: Cypress Hills, Medicine Hat; MB: **Glenlea**	None
Spilichneumon inconstans (Cresson, 1864) [5,83,N]	AB: Calgary, Cypress Hills, Edmonton, Lethbridge; SK, MB: across southern part[m]	Lepidoptera: Coleophoridae, Noctuidae (3)
Spilichneumon nubivagus (Cresson, 1867) [5,N]	AB: Calgary, Cochrane, Cypress Hills	Lepidoptera: Noctuidae (1)
**Spilichneumon superbus* (Provancher, 1886) [5,6,9,13,83,N,Oc]	AB: Calahoo, Edmonton, Lethbridge; MB: **Birtle**, **Swan River**; Across southern AB, SK, MB[m]	Lepidoptera: Noctuidae (8) *Cutworms*
Spilichneumon taos (Cresson, 1877) [9,N,T]	MB: **Altona**, **Roland**, **Rosa**	None
Stenichneumon culpator (Schrank, 1802) [5,9,H]	AB: **Bilby**, Edmonton, **Wabamun**, Vermilion; MB: **Winnipeg**	Lepidoptera: Erebidae, Lasiocampidae, Noctuidae, Nymphalidae, Pieridae (9)
Stenichneumon pallidipennis (Viereck, 1902) [5,N]	AB: Cypress Hills, Edmonton, Medicine Hat	None
Stenobarichneumon saundersii (Cresson, 1877) [5,N]	AB: Edmonton	None
Syspasis tauma (Heinrich, 1951) [83,H]	SK: nr Prince Albert; MB: 2 localities nr Dauphin[m]	Lepidoptera: Erebidae, Geometridae, Tortricidae (3)
Thyrateles instabilis (Cresson, 1867) [5,N]	AB: Edmonton, Lethbridge	Lepidoptera: Nymphalidae, Pieridae (5)
Thyrateles lugubrator (Gravenhorst, 1807) [5,9,83,N,Oc]	AB: Calgary, Edmonton, Lethbridge; MB: **Domain**, **Minnedosa**, **Winnipeg**; Across southern AB, SK, MB[m]	Lepidoptera: Noctuidae, Nymphalidae (5) *Mostly spiny*
Thyrateles mormonus (Cresson, 1877) [5,83,N]	AB: Cypress Hills, Edmonton, Red Deer	Lepidoptera: Notodontidae, Nymphalidae (3) *Setose or spiny*
Thyrateles procax (Cresson, 1877) [83,N]	SK: nr Regina; MB: several localities in south[m]	Lepidoptera: Erebidae, Nymphalidae (3) *Setose or spiny*

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
Tricholabus citatus (Provancher, 1877) [5,N]	AB: Edmonton	None
Tricholabus nortonii (Cresson, 1867) [5,83,N]	AB: Edmonton; MB: 2 southern localities[m]	Lepidoptera: Erebidae (1)
Trogus fulvipes Cresson, 1868 [5,97,98,N]	AB: Waterton; MB: Aweme; Across southern AB, SK, MB: across southern Canada[m]	Lepidoptera: Papilionidae (6)
Trogus lapidator (Fabricius, 1787) [99,H,O]	AB: Buck Mt, Drumheller, Nevis, Waterton NP	Lepidoptera: Nymphalidae, Papilionidae (8)
Virgichneumon subcyaneus (Cresson, 1864) [83,N]	MB: nr Brandon, west of Brandon	Hymenoptera: Tenthredinidae; Lepidoptera: Erebidae (5) *Mostly setose*
Virgichneumon texanus (Cresson, 1877) [5,N]	AB: Red Deer	None
Vulgichneumon brevicinctor (Say, 1825) [5,17,N]	AB: Edmonton; MB: Glenlea	Lepidoptera: Crambidae, Erebidae, Geometridae, Noctuidae, Notodontidae (16)
LYCORININAE		
Lycorina albomarginata (Cresson, 1870) [91,N]	MB: Aweme	Lepidoptera: Gelechiidae, Pyralidae, Tortricidae (7) *Concealed feeders*
MESOCHORINAE		
Astiphromma alsium Dasch, 1971 [100,N]	AB: George L	None
Astiphromma cordatum Dasch, 1971 [100,N]	AB: George L	None
Astiphromma exitiale Dasch, 1971 [2,N]	AB: Wagner NA	None
Astiphromma leucogrammum (Holmgren, 1860) [100,H]	MB: Gilbert Plains, Minitonas	Hymenoptera: Braconidae, Ichneumonidae, Tenthredinidae; Lepidoptera: Geometridae (7)
Astiphromma perditum Dasch, 1971 [100,N]	MB: Ninette	None
Astiphromma splenium (Curtis, 1833) [2,5,9,100,H]	AB: Cooking L, Edmonton, Elkwater, George L, Wabamun, Wagner NA; SK: Calder; MB: Ninette, **Swan River**	Hymenoptera: Braconidae, Diprionidae, Ichneumonidae; Lepidoptera: Erebidae, Geometridae, Lasiocampidae, Noctuidae (33)
Cidaphus occidentalis Cushman, 1924 [2,5,9,100,101,N]	AB: Bilby, Edmonton, Elkwater P, Wagner NA; SK: Broadview, Esterhazy, Prince Albert, White Fox; MB: **Franklin**, **Swan River**	None
Mesochorus agilis Cresson, 1865 [100,H,T]	AB: Bilby, Edmonton, Elkwater L, George L, Lethbridge, Onefour, Waterton Lakes NP; SK: Great Sand Hills, Swift Current, Saskatoon, White Fox; MB: 5 mi SW Shilo	Coleoptera: Curculionidae; Hymenoptera: Braconidae, Ichneumonidae; Lepidoptera: Erebidae (5)

Mesochorus americanus Cresson, 1872 [2,9,100,H]	AB: Edmonton, Wagner NA; SK: Yorkton, near Swift Current[m]; MB: Dauphin, **Lenswood**, 5 mi SW Shilo	Hymenoptera: Braconidae; Lepidoptera: Bucculatricidae, Crambidae, Erebidae, Geometridae, Noctuidae, Pieridae, Sphingidae (27)
Mesochorus applanatus Dasch, 1971 [100,N]	AB: Edmonton	Hymenoptera: Tenthredinidae; Lepidoptera: Geometridae (4)
Mesochorus areolatus Provancher, 1883 [2,100,N]	AB: Wagner NA; SK: White Fox	None
Mesochorus bellus Dasch, 1971 [100,N]	MB: Aweme	None
Mesochorus calais Viereck, 1917 [2,100,N]	AB: Edmonton, Wagner NA; SK: Attons L, Swift Current	None
Mesochorus coronatus Dasch, 1971 [100,N]	AB: George L; MB: Aweme	None
Mesochorus cupreatus Dasch, 1971 [2,100,N]	AB: Wagner NA; SK: Saskatoon; MB: 5 mi SW Shilo	None
**Mesochorus curvulus* Thomson, 1886 [2,100,102,H,T]	AB: Elkwater L, Lethbridge, Wagner NA; MB: Brandon, Glenlea	Coleoptera: Chrysomelidae; Hymenoptera: Braconidae; Lepidoptera: Crambidae, Geometridae, Noctuidae, Pieridae (11)
Mesochorus deletus Dasch, 1971 [2,100,N]	AB: Wabamun, Wagner NA	None
Mesochorus dentatus Dasch, 1971 [100,N]	AB: Edmonton	Hymenoptera: Argidae (1)
Mesochorus dimidiatus Holmgren, 1860 [100,H]	AB: Bilby	Hymenoptera: Diprionidae, Ichneumonidae; Tenthredinidae; Lepidoptera: Notodontidae (10)
Mesochorus discitergus (Say, 1835) [100,H,T,A,O]	AB: Gleichen, Moon L; MB: Gull L	Hymenoptera: Braconidae; Lepidoptera: Bucculatricidae, Erebidae, Geometridae (82) *Mostly Braconidae*
Mesochorus dreisbachi Dasch, 1971 [2,100,N]	AB: Edmonton, George L, Jumping Pond Cr (20 mi W Calgary), Wagner NA	None
Mesochorus erythraeus Dasch, 1971 [100,N]	AB: Edmonton	Lepidoptera: Geometridae (1)
Mesochorus exsertus Dasch, 1971 [2,100,N]	AB: Edmonton, Elkwater L, Wagner NA, Wayne; SK: Saskatoon	Hymenoptera: Cimbicidae, Ichneumonidae (2)
Mesochorus foersteri Dasch, 1971 [100,N]	AB: Bilby; SK: Estevan; MB: Teulon	None
Mesochorus fuliginatus Dasch, 1971 [100,N]	AB: Onefour; SK: Saskatoon	Coleoptera: Chrysomelidae (1)
Mesochorus gemellus Holmgren, 1860 [100,H]	AB: Cochrane	Hymenoptera: Braconidae; Lepidoptera: Crambidae, Gelechiidae, Geometridae, Lasiocampidae, Lycaenidae, Tortricidae (21)

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
Mesochorus giberius (Thunberg, 1822) [2,14,100,H,T,O]	AB: Buffalo Cr, Duffield, Edmonton, Nampa, Ponoka, Wagner NA, Waterton Lakes NP; MB: Ninette, 5 mi SW Shilo, Spruce Woods FR, Turtle Mt	Coleoptera: Chrysomelidae; Diptera: Tachinidae; Hymenoptera: Braconidae, Ichneumonidae, Tenthredinidae; Lepidoptera: Gelechiidae, Noctuidae, Notodontidae, Psychidae, Saturniidae, Tortricidae (43)
Mesochorus hesperus Dasch, 1971 [100,N]	AB: Elkwater L	None
Mesochorus inaequidens Dasch, 1971 [100,N]	AB: Edmonton	None
Mesochorus incultus Dasch, 1971 [100,N,T]	SK: Kindersley	Lepidoptera: Erebidae, Geometridae, Noctuidae (12) *Mostly conifer loopers*
Mesochorus longiscutatus Dasch, 1971 [2,100,N]	AB: Bilby, Cochrane, Edmonton, Elkwater, Wagner NA	Lepidoptera: Ypsolophidae (1) *Concealed feeders*
Mesochorus maleficus Dasch, 1971 [100,N]	AB: Edmonton	None
Mesochorus masoni Dasch, 1971 [100,N]	AB: Beaver Mines, Ferry Saskatchewan S of Stony Plain, Hayter, Provost, Red Deer Ranger Stn, Rivercours; SK: Canora, Cloan, Humboldt, Imperial; MB: Crandall, Hamiota, Mulvihill, Shoal L	Hymenoptera: Diprionidae, Ichneumonidae, Tenthredinidae (7) *Mostly conifer sawflies*
Mesochorus ottawaensis (Harrington, 1892) [2,100,N]	AB: Bilby, George L, Lethbridge, Wagner NA; MB: Transcona	None
Mesochorus peltatus Dasch, 1971 [100,N]	AB: Edmonton, Elkwater P	None
**Mesochorus perniciosus* Viereck, 1911 [2,14,53,100,N]	AB: Calgary, Coaldale, Cypress Hills, Drumheller, Edmonton, Glenwood, Jumping Pound Cr, L Newell, Lethbridge, Manyberries, Medicine Hat, Milk River, Oyen, Picture Butte, Rosebud, Scandia, Tilley, Vauxhall, Wagner NA, Waterton Lakes NP, Wild Horse; SK: Antelope L, Attons L at Cut Knife, Battle River, Cadillac, Consul, Dunblane, Estevan, Great Deer, Great Sand Hills, Indian Head, Minton, Parkbeg, Regina, Saskatoon, Swift Current, Tompkins; MB: Aweme, Brandon, Morris	Hymenoptera, Lepidoptera: Braconidae, Crambidae, Geometridae, Yponomeutidae (5)
Mesochorus personatus Dasch, 1971 [100,N]	AB: Edmonton	Lepidoptera: Geometridae (1) *Loopers*
Mesochorus prolatus Dasch, 1971 [100,N]	AB: Edmonton	None
Mesochorus tachinae Ashmead, 1898 [100,N]	AB: Edmonton, Elk Island P	Diptera, Lepidoptera: Tachinidae, Erebidae, Geometridae (15) *Mostly conifer loopers and Tachinidae*
Mesochorus unicarinatus Dasch, 1971 [100,N]	MB: Max L in Turtle Mt FR	Diptera, Lepidoptera: Tachinidae, Geometridae (2)

Mesochorus uniformis Cresson, 1872 [100,N,T,O]	AB: Belly River Ranger Stn, Edmonton, Lethbridge, Winfield; SK: Barrier River, Indian Head, Saskatoon	Hymenoptera, Lepidoptera: Braconidae, Diprionidae, Elachistidae, Erebidae, Geometridae, Noctuidae, Sphingidae, Tortricidae (21) *Mostly conifer feeders*
Mesochorus validus Dasch, 1971 [100,N]	AB: Orion	None
Mesochorus varianus Dasch, 1971 [100,N]	AB: George L, Lethbridge	Hymenoptera: Ichneumonidae (1)
Mesochorus vittator (Zetterstedt, 1838) [9,100,H,T]	AB: Bilby, Burdett, Calgary, Cameron L at Waterton L NP, Edmonton, Elkwater, George L, Lethbridge, Lost River, Onefour, Rosemary, Stavely, 21 mi S Walsh, Winfield; SK: Dunblane, Great Deer, Moose Mt P, Prince Albert, Saskatoon, Swift Current, Watrous; MB: Aweme, Brandon, 5 mi SW Shilo, **Starbuck**, **Swan River**	Hymenoptera: Braconidae, Ichneumonidae; Lepidoptera: Bucculatricidae, Choreutidae, Erebidae, Gelechiidae, Geometridae, Noctuidae, Nolidae, Pieridae, Plutellidae (78) *Mostly conifer loopers*
Stictopisthus argaleus Dasch, 1971 [100,N]	SK: Saskatoon	Lepidoptera: Crambidae, Tortricidae, Yponomeutidae (4) *Concealed feeders*
Stictopisthus bilineatus (Thomson, 1886) [100,N,T,A]	AB: Lethbridge, Manyberries, Onefour; SK: Great Deer, Saskatoon	Diptera: Muscidae; Hymenoptera: Braconidae; Lepidoptera: Crambidae, Gracillariidae, Nolidae, Plutellidae (9)
Stictopisthus crenatus Dasch, 1971 [100,N]	AB: Edmonton, Elkwater L	Lepidoptera: Gracillariidae (1) *Concealed feeders*
Stictopisthus flaviceps (Provancher, 1879) [100,N]	AB: Edmonton	Lepidoptera: Gracillariidae, Tortricidae, Yponomeutidae (5) *Concealed feeders*
Stictopisthus lanceolatus Dasch, 1971 [100,N]	AB: Edmonton, Rockyford; SK: Cypress Hills	Hymenoptera: Braconidae; Lepidoptera: Gelechiidae, Tortricidae (4) *Mostly concealed feeders*
METOPIINAE		
Bothromus bicolor Walley, 1966 [103,N]	AB: Jumping Pd Cr 20 mi W Calgary	None
Bothromus gibbus Townes & Townes, 1959 [103,104,105,N]	AB: Gull L, nr Brooks, Westward Ho (Mountain View)	Lepidoptera: Geometridae (1) *Loopers*
Carria dreisbachi Townes & Townes, 1959 [104,105,N]	SK: Saskatoon; MB: 1 locality in southwest[m]	Lepidoptera: Tortricidae (3) *Concealed feeders*
Chorinaeus aequalis Townes & Townes, 1959 [104,N]	AB: Edmonton	Lepidoptera: Elachistidae, Tortricidae (3) *Concealed feeders*
Chorinaeus excessorius Davis, 1897 [105,N]	MB: 2 localities (southwest and southeast)[m]	Lepidoptera: Geometridae, Tortricidae (8) *Mostly concealed feeders*

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
Chorinaeus funebris (Gravenhorst, 1829) [104,105,H]	AB: Edmonton[m]; MB: Deepdale	Lepidoptera: Elachistidae, Gelechiidae, Geometridae, Heterobathmiidae, Pyralidae, Tortricidae, Yponomeutidae, Ypsolophidae (25) *Concealed feeders*
Chorinaeus subcarinatus Holmgren, 1858 [105,H]	AB: 1 locality in southeast; SK: nr Prince Albert[m]	Lepidoptera: Elachistidae, Geometridae, Tortricidae, Yponomeutidae (14) *Mostly conifer loopers*
Exochus albifrons Cresson, 1868 [2,5,104,105,N]	AB: Blackfoot Hills, Wagner NA, nr Wainwright[m], Waterton; SK: Kinistino, several locations in parkland[m]; MB: Agassiz, across southern MB[m]	Lepidoptera: Gelechiidae, Erebidae, Tortricidae (15) *Mostly concealed feeders*
Exochus annulicrus Walsh, 1873 [104,105,N]	AB: Edmonton[m]	Lepidoptera: Tortricidae (2) *Concealed feeders*
Exochus armillosus Townes & Townes, 1959 [104,105,N]	AB: Edmonton	Lepidoptera: Pyralidae (2) *Concealed feeders*
Exochus atriceps Walsh, 1873 [104,N]	MB: Aweme	Lepidoptera: Tortricidae (2) *Concealed feeders*
Exochus brutus Townes & Townes, 1959 [104,N]	AB: Chin; SK: Mossbank	None
Exochus bryanti Townes & Townes, 1959 [2,N]	AB: Wagner NA	None
Exochus canidens Townes & Townes, 1959 [2,104,N]	AB: Edmonton, Wagner NA	None
Exochus cnemidotus Townes & Townes, 1959 [2,104,105,N]	AB: Wagner NA, Waterton[m]	Lepidoptera: Tortricidae (1) *Leafrollers*
Exochus denotatus Townes & Townes, 1959 [2,N]	AB: Wagner NA	Lepidoptera: Tortricidae (1) *Leafrollers*
**Exochus flavifrontalis* Davis, 1897 [2,104,105,N]	AB: Edmonton[m], Lethbridge[m], Wagner NA	None
Exochus megadon Townes & Townes, 1959 [2,N]	AB: Wagner NA	Lepidoptera: Tortricidae (1) *Leafrollers*
Exochus mesodon Townes & Townes, 1959 [2,N]	AB: Wagner NA	None
Exochus mitratus Gravenhorst, 1829 [5,104,H]	AB: Lethbridge; MB: Aweme	Hymenoptera: Cynipidae; Lepidoptera: Noctuidae, Pyralidae, Tortricidae, Yponomeutidae (6) *Mostly concealed feeders*

Exochus nigripalpis Thomson, 1887 [2,104,105,H]	AB: Edmonton[m], Wagner NA	Lepidoptera: Hesperiidae, Tortricidae (17) *Concealed feeders*
Exochus ostentatus Davis, 1897 [2,104,N]	AB: Edmonton, Wagner NA	None
Exochus peroniae Townes & Townes, 1959 [2,N]	AB: Wagner NA	Lepidoptera: Tortricidae (6) *Concealed feeders*
Exochus pictus Holmgren, 1858 [5,H]	AB: Edmonton	Hymenoptera: Tenthredinidae; Lepidoptera: Crambidae (2)
Exochus pleuralis Cresson, 1864 [9,14,105,N]	AB: Edmonton; MB: nr Brandon[m], **Spruce Woods FR**	Lepidoptera: Bucculatricidae, Gelechiidae, Tortricidae (9) *Concealed feeders*
Exochus signifer Townes & Townes, 1959 [2,N]	AB: Wagner NA	Lepidoptera: Gelichiidae (2) *Concealed feeders*
Exochus spilotus Townes & Townes, 1959 [2,N]	AB: Wagner NA	Lepidoptera: Pyralidae (2) (*Concealed feeders*
Exochus transversus Townes & Townes, 1959 [104,105,N]	SK: Saskatoon	Lepidoptera: Gelechiidae (1) *Concealed feeders*
Exochus turgidus Holmgren, 1858 [104,105,H]	SK: nr Saskatoon[m], Sutherland	Lepidoptera: Pyralidae, Tortricidae (10) *Concealed conifer feeders*
Exochus washingtonensis (Davis, 1897) [2,104,N]	AB: Edmonton, Wagner NA	Lepidoptera: Tortricidae (1) *Concealed feeders*
Hypsicera cuneata Townes & Townes, 1959 [2,N]	AB: Wagner NA	None
Hypsicera femoralis (Geoffroy, 1785) [14,W]	AB: Edmonton	Coleoptera: Anobiidae; Lepidoptera: Tortricidae (2)
Metopius edwardsii Cresson, 1879 [104,N]	AB: Edmonton	None
Metopius errantia Davis, 1897 [105,N]	MB: Pine Ridge	Lepidoptera: Geometridae (1) *Loopers*
Metopius pollinctorius (Say, 1835) [5,104,105,N]	AB: Lloydminster, Wainwright; SK: Southeast[m]	Lepidoptera: Noctuidae, Notodontidae, Saturniidae (11)
Periope aethiops (Cresson, 1868) [104,N]	AB: Tofield	None
Spudaeus indigus (Davis, 1897) [5,104,105,N]	AB: Fawcett, Wainwright, southwest[m], southeast[m]; MB: Aweme, southwest[m]	Lepidoptera: Noctuidae (2)
Spudaeus scaber (Gravenhorst, 1829) [5,104,H]	AB: Cypress Hills, Waterton	Hymenoptera: Ichneumonidae; Lepidoptera: Noctuidae (3)
Triclistus brunnipes (Cresson, 1879) 104,N	SK: Roche Percee; MB: Transcona	None
Triclistus crassus Townes & Townes, 1959 [45,104,105,H]	AB: nr Calgary, Cochrane, Lethbridge[m]; SK: nr Prince Albert[m], 2 locations in south[m]	Lepidoptera: Geometridae (2) *Loopers*

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
Triclistus emarginalus (Say, 1829) [2,5,104,105,N]	AB: Cochrane, Edmonton[m], Wagner NA; MB: south of Winnipeg[m]	Lepidoptera: Bucculatricidae, Choreutidae, Crambidae, Geometridae, Gracillariidae, Nolidae, Pyralidae, Tortricidae (27) *Mostly concealed feeders*
Triclistus evexus Townes & Townes, 1959 [104,105,N]	AB: Manyberries, Brooks; SK: Indian Head	Lepidoptera: Pyralidae, Tortricidae (2) *Concealed feeders*
Triclistus pallipes Holmgren, 1873 [104,105,H,O]	AB: Edmonton; SK: nr Lloydminster[m], southwest[m]	Lepidoptera: Crambidae, Geometridae, Tortricidae, Yponomeutidae (16) *Concealed feeders*
Triclistus podagricus (Gravenhorst, 1829) [2,104,105,H]	AB: Edmonton, Wagner NA; SK: Saskatoon[m]	Lepidoptera: Choreutidae, Elachistidae, Gelechiidae, Gracillariidae, Pyralidae, Tortricidae (22) *Concealed feeders*
Triclistus pygmaeus (Cresson, 1864) [2,H,O]	AB: Wagner NA	Lepidoptera: Crambidae, Tortricidae, Yponomeutidae (7) *Concealed feeders*
Trieces arcuatus Townes & Townes, 1959 [105,106,N]	MB: Pine Ridge	Lepidoptera: Erebidae (1) *Loopers*
Trieces confusus Walley, 1969 [105,106,N]	MB: Ninette, Pierson, 5 mi SW Shilo, southwest[m]	Lepidoptera: Elachistidae (1) *Concealed feeders*
Trieces epinotiae Walley, 1969 [105,106,N]	MB: Assiniboine River at Treesbank, southwest[m]	Lepidoptera: Tortricidae (3) *Concealed feeders*
Trieces integer Townes & Townes, 1959 [104,N]	SK: Saskatoon	None
Trieces onitis (Davis, 1897) [105,106,N]	MB: Baldur, southwest	Lepidoptera: Elachistidae, Pyralidae, Tortricidae (7) *Concealed feeders*
Trieces sapineus Townes & Townes, 1959 2,[105,106,N]	AB: Aspen Beach, Wagner NA	Lepidoptera: Yponomeutidae (1) *Concealed feeders*
Trieces teres Townes & Townes, 1959 [104,N]	MB: Aweme	None
OPHIONINAE		
Enicospilus purgatus (Say, 1835) [5,107,N,T,Oc]	AB: Calgary, Lethbridge; MB: Winnipeg	Diptera: Tephritidae; Lepidoptera: Crambidae, Drepanidae, Erebidae, Noctuidae, Notodontidae, Saturniidae (19)
Enicospilus texanus (Ashmead, 1890) [91,N,T]	MB: Aweme	Lepidoptera: Apatelodidae, Saturniidae (12) *Setose or spiny*

Ophion bilineatus Say, 1829 [108,N,T]	MB: Winnipeg	Lepidoptera: Erebidae, Noctuidae, Notodontidae, Saturniidae (14) *Mostly cutworms*
Ophion idoneus Viereck, 1905 [29,109,N]	AB: Calgary, Edmonton, Erskine, George L, Lacombe, Pigeon L, Rochon Sands PP, Sherwood Park, Spruce Grove, Winfield, Wyndham-Carseland PP; SK: Saskatoon; MB: Brandon, Winnipeg, south	Lepidoptera: Noctuidae (1)
Thyreodon atricolor (Olivier, 1811) [29,N]	MB: South	Lepidoptera: Sphingidae (2)
ORTHOCENTRINAE		
Aniseres latus Dasch, 1992 [79,H]	AB: Edmonton	None
Aniseres pallipes Forster, 1871 [79,H]	AB: Edmonton, Jumping Pound Cr	Diptera: Mycetophilidae (3) *Fungus gnats*
Aperileptus albipalpus (Gravenhorst, 1829) [79,H]	AB: Edmonton, Jumping Pound Cr, Milk River; SK: Bredenbury, Elbow, Snowden, White Fox	Diptera: Mycetophilidae (5) *Fungus gnats*
Catastenus femoralis Forster, 1871 [79,H]	AB: Waterton Lakes NP at 1,300m	None
Dialipsis dissimilis Dasch, 1992 [79,H]	AB: Edmonton, Cameron L Rd in Waterton NP	None
Entypoma robustum Forster, 1871 [79,H]	AB: Aspen Beach	Diptera: Mycetophilidae (3) *Fungus gnats*
Eusterinx bispinosa (Strobl, 1901) [79,H]	AB: Edmonton, Jumping Pound Cr	Diptera: Keroplatidae (1) *Bioluminescent fungus gnat*
Eusterinx inaequalis Rossem, 1981 [79,H]	SK: Rockglen, Scout L	None
Eusterinx oligomera Forster, 1871 [79,H]	AB: Aspen Beach, Battle River; SK: Alton L, Saskatoon, White Fox	None
Eusterinx subdola Forster, 1871 [79,H]	AB: Elkwater L	None
Eusterinx tenuicincta (Forster, 1871) [79,H]	AB: Elkwater P, George L	None
Eusterinx trifasciata (Ashmead, 1899) [79,H]	AB: Jumping Pound Cr	None
Gnathochorisis crassulus (Thomson, 1888) [79,H]	AB: Edmonton	None
Helictes borealis (Holmgren, 1857) [79,H]	AB: Jumping Pound Cr (15 mi E Calgary); MB: Ninette	None
Helictes paucus Dasch, 1992 [79,N]	AB: Elkwater Pk, Jumping Pound Cr, Waterton, Waterton L NP at 1300m	None
Hyperacmus crassicornis (Gravenhorst, 1829) [79,H,O]	AB: Jumping Pound Cr	Lepidoptera: Yponomeutidae (1) *Concealed feeder*
Megastylus impressor Schiødte, 1838 [79,H]	AB: Edmonton, Jumping Pound Cr	Diptera: Keroplatidae (1) *Fungus gnats*
Megastylus orbitator Schiødte, 1838 [79,H]	AB: Edmonton, Jumping Pound Cr, Lundbreck, Onefour, Tofield; SK: Bredenbury, Elbow, Saskatoon	Diptera: Keroplatidae; Hymenoptera: Tenthredinidae (3)
Megastylus similis Dasch, 1992 [79,H]	MB: Brandon	None

SUBFAMILY **Species**[a]	**Localities**[b]	**Host Family (No. spp.)** ***Guild/Notes***
Orthocentrus frontator (Zetterstedt, 1838) [5,H]	AB: Red Deer	Hymenoptera: Diprionidae (1) *Conifer sawflies*
Pantisarthrus lubricus Forster, 1871 [79,H]	AB: Aspen Beach, Edmonton, Cameron L Rd in Waterton NP, Waterton	Diptera: Mycetophilidae (1) *Fungus gnats*
Plectiscidea collaris (Gravenhorst, 1829) [14,79,H]	AB: Aspen Beach, Bilby, Cameron L Rd in Waterton NP, Edmonton, Elkwater L, George L, Jumping Pound Cr, Mountain View, Twin Butte, Waterton; SK: Attons L, Cypress Hills, Moosomin, Nipawin, Saskatoon; MB: Horton, Ninette, Ninga, 5 mi SW Shilo, 2 mi W Stockton	Diptera: Mycetophilidae (3) *Fungus gnats*
Plectiscidea communis Forster, 1871 [79,H]	AB: Cowley	None
Plectiscidea inflata Dasch, 1992 [79,N]	AB: Jumping Pound Cr	None
Plectiscidea prolata Dasch, 1992 [79,N]	AB: Jumping Pound Cr	None
Proclitus bicolor Dasch, 1992 [79,N]	AB: Cameron L Rd in Waterton NP, Edmonton	None
Proclitus extensor Dasch, 1992 [79,N]	AB: Elkwater L	None
Proclitus foveatus Dasch, 1992 [79,N]	AB: Edmonton; MB: 5 mi SW Shilo	None
Proclitus fulvicornis Forster, 1871 [14,79,H]	AB: Edmonton, Elkwater L, Jumping Pound Cr; SK: Elbow, White Fox; MB: Ninette	None
Proclitus paganus (Haliday, 1838) [79,H]	AB: Waterton Lakes NP	Diptera: Bolitophilidae (1) *Fungus gnats*
Proclitus praetor (Haliday, 1838) [79,H]	AB: Edmonton	Diptera: Mycetophilidae (5) *Fungus gnats*
Symplecis breviuscula Roman, 1923 [79,H]	AB: Jumping Pound Cr	Diptera: Diadocidiidae (1) *Fungus gnats*
Symplecis glabra Dasch, 1992 [79,H]	MB: Ninette	None
Symplecis invisitata Rossem, 1981 [79,H]	AB: Waterton Lakes NP at 4,300'	None
ORTHOPELMATINAE		
Orthopelma californicum Ashmead, 1890 [2,N]	AB: Wagner NA	Hymenoptera: Cynipidae (3) *Gall makers*
Orthopelma mediator (Thunberg, 1824) [5,110,H]	AB: Medicine Hat; "Throughout N. America"	Diptera: Cecidomyiidae; Hymenoptera: Cynipidae, Tenthredinidae; Lepidoptera: Noctuidae, Saturniidae (24) *Gall makers*

Orthopelma occidentale Ashmead, 1890 [5,110,N]	AB: Edmonton; AB, MB, SK: Numerous locations across prairie and parkland region[m]	Hymenoptera: Cynipidae (13) *Gall makers*
PIMPLINAE		
Acrodactyla degener (Haliday, 1838) [1,2,H]	AB: Edmonton, Lethbridge, Wagner NA	Araneae: Linyphiidae, Theridiidae
Acrodactyla quadrisculpta (Gravenhorst, 1820) [5,109,H,O,Au]	AB: Lethbridge, **Pigeon L**	Araneae, Lepidoptera: Araneidae, Tetragnathidae, Elachistidae, Gracillariidae (8)
Acropimpla alboricta (Cresson, 1870) [1,5,9,105,109,N]	AB: Calgary, **Cooking L**, Edmonton, **George L**, **Pembina PP**, southeast[m]; MB: **Glenlea**	Hymenoptera: Braconidae; Lepidoptera: Crambidae, Gracillariidae, Lasiocampidae, Noctuidae, Psychidae, Pyralidae, Tortricidae (19) *Mostly concealed feeders*
Acrotaphus wiltii (Cresson, 1870) [1,N]	MB: Aweme	Araneae: Araneidae (2)
Alophosternum foliicola Cushman, 1933 [105,111,N]	MB: Birds Hill PP, nr Winnipeg[m]	Coleoptera: Chrysomelidae; Hymenoptera: Tenthredinidae; Lepidoptera: Erebidae, Gracillariidae, Incurvariidae (11) *Mostly concealed feeders*
Apechthis annulicornis (Cresson, 1870) [5,109,N]	AB: Edmonton, **George L**, **Pembina PP**	Lepidoptera: Erebidae, Geometridae, Papilionidae, Pieridae, Tortricidae (8)
Apechthis ontario (Cresson, 1870) [5,109,N]	AB: **Edmonton**, **George L**, Lethbridge, **Pembina PP**, **Pigeon L**	Hymenoptera: Ichneumonidae; Lepidoptera: Erebidae, Geometridae, Noctuidae, Pyralidae, Tortricidae (21) *Mostly conifer feeders*
Apechthis picticornis (Cresson, 1870) [1,2,5,105,109,N]	AB: Edmonton, Elkwater P, **George L**, Lethbridge **Pembina PP**, **Pigeon L**, Wagner NA, Waterton; SK: nr Regina[m]; MB: Aweme	Lepidoptera: Erebidae, Geometridae, Pyralidae, Tortricidae (9) *Mostly concealed feeders*
Clistopyga canadensis Provancher, 1880 [1,2,109,H]	AB: **Edmonton**, Wagner NA; SK: Cut Knife, Swift Current	Lepidoptera: Lasiocampidae (1) *Setose*
Clistopyga maculifrons Cushman 1921 [2,109,N]	AB: **George L**, Wagner NA	None
Delomerista borealis Walkley, 1960 [2,H]	AB: Wagner NA	None
Delomerista diprionis Cushman, 1939 [5,112,N]	AB: Edmonton; MB: Aweme, Sand Hills	Hymenoptera: Diprionidae (10) *Conifer sawflies*
Delomerista longicauda Kasparyan 1973 [109,H]	AB: **George L**	None
Delomerista mandibularis (Gravenhorst, 1829) [109,112,H]	AB: **Edmonton**, **George L**, **Pigeon L**; SK: Conquest	Hymenoptera: Tenthredinidae; Lepidoptera: Lasiocampidae (2)

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) ***Guild/Notes***
Delomerista masoni Gupta, 1982 [109,N]	AB: **Edmonton**	None
Delomerista novita (Cresson 1870) [5,109,H]	AB: Edmonton, **Pigeon L**	Coleoptera: Curculionidae; Hymenoptera: Diprionidae; Lepidoptera: Erebidae, Pyralidae, Tortricidae (6) *Mostly concealed feeders*
Delomerista townesorum Gupta, 1982 [109,112,N]	AB: **George L**, **Pigeon L**; SK: Regina, Saskatoon	None
Dolichomitus cephalotes (Holmgren, 1860) [1,5,H]	AB: Hardisty, Wainwright; SK: Vawn	Coleoptera: Cerambycidae; Hymenoptera: Xiphydriidae (4) *Wood borers*
Dolichomitus imperator (Kriechbaumer, 1854) [1,5,109,H]	AB: Edmonton, **George L**, Vermilion, Wabamun, Waterton Lakes NP; MB: Onah	Coleoptera: Buprestidae, Cerambycidae, Curculionidae; Lepidoptera: Sesiidae (24) *Wood borers*
Dolichomitus messor (Gravenhorst, 1829) [1,H]	SK: Indian Head; MB: Aweme	Coleoptera: Buprestidae, Cerambycidae, Curculionidae; Hymenoptera: Tenthredinidae; Lepidoptera: Cossidae, Pyralidae, Sesiidae, Tortricidae (29) *Mostly wood borers*
Dolichomitus populneus (Ratzeburg, 1848) [1,H]	SK: Earl Grey	Coleoptera: Buprestidae, Cerambycidae, Curculionidae; Lepidoptera: Erebidae, Prodoxidae, Pyralidae, Sesiidae (18) *Mostly wood borers*
Dolichomitus pterelas (Say, 1829) [109,H]	AB: **Edmonton**, **George L**	Coleoptera: Cerambycidae; Lepidoptera: Gelechiidae, Tortricidae (9) *Borers*
Dolichomitus pygmaeus (Walsh, 1873) [109,N]	AB: **George L, Wagner NA**	Coleoptera: Cerambycidae; Lepidoptera: Gelechiidae (2) *Borers*
Dolichomitus sericeus (Hartig, 1847) [2,H]	AB: Wagner NA	Coleoptera: Buprestidae, Cerambycidae (3) *Borers*
Dolichomitus terebrans (Ratzeburg, 1844) [1,5,109,H]	AB: Calgary, **George L**, **Wagner NA**, Waterton; MB: Aweme, Onah	Coleoptera: Buprestidae, Cerambycidae, Curculionidae, Monotomidae; Hymenoptera: Cynipidae; Lepidoptera: Argyresthiidae, Erebidae, Pyralidae, Sesiidae (52) *Mostly wood borers*

Dolichomitus vitticrus Townes, 1960 [1,N]	MB: Aweme	Coleoptera: Buprestidae (1) *Wood borers*
Dreisbachia slossonae (Davis, 1898) [2,109,N]	AB: **Cooking L, George L,** Wagner NA	None
Endromopoda detrita (Holmgren, 1860) [1,2,109,113,H,O]	AB: Wagner, **Edmonton**, **George L**, **Jenner**, Lethbridge, **Pigeon L**	Coleoptera: Curculionidae, Rhynchitidae; Diptera: Chamaemyiidae, Chloropidae; Hymenoptera: Cephidae, Cynipidae, Eurytomidae, Tenthredinidae; Lepidoptera: Argyresthiidae, Coleophoridae, Crambidae, Gelechiidae, Lasiocampidae, Noctuidae, Pterophoridae, Pyralidae, Sesiidae, Tortricidae, Uraniidae (43) *Mostly concealed feeders*
Endromopoda producta (Walley, 1960) [109,N]	AB: **George L, Pembina PP**	None
Ephialtes brevis Morley, 1914 [2,114,H]	AB: Wagner NA; SK: Torch River, White Fox; MB: Aweme	Hymenoptera: Megachilidae (2) *Leafcutter bees*
Ephialtes duplicauda Heinrich, 1949 [1,H,O]	SK: Leslie; MB: Aweme	Coleoptera: Buprestidae, Cerambycidae; Hymenoptera: Vespidae (3) *Mostly wood borers*
*Ephialtes manifestato*r (Linnaeus, 1758) [114,H,O]	MB: Aweme	Coleoptera: Buprestidae, Cerambycidae, Cleridae, Curculionidae, Melyridae; Hymenoptera: Cephidae, Crabronidae, Cynipidae, Megachilidae, Siricidae, Tenthredinidae, Vespidae, Xiphydriidae; Lepidoptera: Geometridae, Pyralidae, Sesiidae, Sphingidae, Tortricidae (46) *Mostly concealed feeders*
Exeristes comstockii (Cresson, 1880) [1,2,105,N,T]	AB: Southwest[m], Wagner NA; SK: Indian Head; MB: across south[m]	Coleoptera: Curculionidae; Lepidoptera: Argyresthiidae, Gelechiidae, Pyralidae, Tortricidae (39) *Conifer borers*
Flacopimpla nigriceps (Walsh, 1873) [9,14,109,N]	AB: **Edmonton**, Medicine Hat; MB: **Fort Garry**	None
Iseropus stercorator (Fabricius, 1793) [1,2,5,46,105,H]	AB: Edmonton[m], parkland (no localities), Wagner NA; SK: Cypress Hills, nr Saskatoon[m]	Coleoptera: Curculionidae; Diptera: Anthomyiidae, Chamaemyiidae; Hymenoptera: Cephidae, Cimbicidae, Tenthredinidae; Lepidoptera: Erebidae, Gelechiidae, Geometridae, Lasiocampidae, Noctuidae, Nolidae, Notodontidae, Pieridae, Pyralidae, Tortricidae, Yponomeutidae (58)

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
**Itoplectis conquisitor* (Say, 1835) [1,5,9,105,109,N,T,Oc]	AB: Edmonton, **George L**, **Pakowki dunes**, Vermilion; SK: **Canwood PF**, **Cypress Hills P**, Katepwa P, Saskatoon, Swift Current; MB: Aweme, Brandon, **Franklin**, Red Deer River, **Spruce Woods**, **Stead**, Teulon; Widespread across prairies[m]	Coleoptera: Cerambycidae, Chrysomelidae, Curculionidae; Diptera: Tachinidae; Hymenoptera: Braconidae, Diprionidae, Ichneumonidae; Lepidoptera: Choreutidae, Coleophoridae, Cosmopterigidae, Crambidae, Epermeniidae, Erebidae, Gelechiidae, Geometridae, Gracillariidae, Hesperiidae, Lasiocampidae, Noctuidae, Nolidae, Notodontidae, Nymphalidae, Papilionidae, Pieridae, Plutellidae, Psychidae, Pterophoridae, Pyralidae, Saturniidae, Sesiidae, Tortricidae (155) *Mostly concealed feeders*
Itoplectis curticauda (Kriechbaumer, 1887) [2,109,H]	AB: **Cooking L,** Wagner NA	Hymenoptera: Braconidae; Lepidoptera: Gelechiidae, Zygaenidae (5)
Itoplectis fustiger (Townes 1960) [109,N]	AB: **Edmonton**, **George L**	None
Itoplectis quadricingulata (Provancher, 1880) [1,2,5,9,105,H]	AB: Vermilion, Wagner NA, Waterton Lakes, several locations in prairie/parkland[m]; SK: Indian Head, southwest[m]; MB: **Winnipeg**	Hymenoptera: Braconidae, Diprionidae, Ichneumonidae, Tenthredinidae; Lepidoptera: Choreutidae, Coleophoridae, Erebidae, Gelechiidae, Geometridae, Gracillariidae, Lasiocampidae, Oecophoridae, Psychidae, Pyralidae, Tortricidae, Yponomeutidae, Zygaenidae (63) *Mostly concealed feeders*
Itoplectis vesca (Townes, 1960) [2,109,N]	AB: **Edmonton,** Wagner NA	Lepidoptera: Coleophoridae, Gelechiidae, Tortricidae (10) *Concealed feeders*
Itoplectis viduata (Gravenhorst, 1829) [1,5,105,H]	AB: Lethbridge[m], Sylvan L, Waterton[m]; SK: Pike L, Saskatoon	Coleoptera: Curculionidae; Hymenoptera: Cimbicidae; Lepidoptera: Crambidae, Erebidae, Gelechiidae, Lasiocampidae, Noctuidae, Nymphalidae, Pieridae, Plutellidae, Psychidae, Pyralidae, Saturniidae, Sesiidae, Tortricidae, Yponomeutidae, Zygaenidae (55)
Liotryphon dentatus (Townes, 1960) [1,109,N]	AB: Bilby, **George L**	Coleoptera: Cleridae (2) *Underbark Clerids*
Liotryphon masoni (Townes, 1960) [1,N]	AB: Blackfoot Hills, Drumheller; MB: Transcona	None

Oxyrrhexis carbonator (Gravenhorst, 1807) [1,2,5,109,H]	AB: Edmonton, **George L**, Lethbridge, Wabamun, Wagner NA; MB: Aweme, Teulon	Araneae: Araneidae, Linyphiidae, Tetragnathidae, Theridiidae, Thomisidae; Coleoptera: Cerambycidae, Hymenoptera: Tenthredinidae; Lepidoptera: Geometridae (12) *Mostly spiders*
Perithous scurra (Panzer, 1804) [5,109,H]	AB: Edmonton, Red Deer, Waterton, **George L**, **Wagner NA**	Coleoptera: Cerambycidae; Hymenoptera: Apidae, Cephidae, Chrysididae, Crabronidae, Cynipidae, Vespidae, Xiphydriidae; Lepidoptera: Lasiocampidae (27) *Mostly Crabronidae*
Pimpla aquilonia Cresson, 1870 [1,5,105,109,H]	AB: Bilby, Calgary, **Cooking L**, Edmonton, **George L**, **Pembina PP**, **Pigeon L**, **Wagner NA**, Waterton Lakes[m]; MB: Aweme, Swan River, southwest[m]	Araneae: Araneidae, Theridiidae; Coleoptera: Curculionidae; Lepidoptera: Coleophoridae, Elachistidae, Erebidae, Gelechiidae, Geometridae, Lasiocampidae, Tortricidae (19)
**Pimpla pedalis* Cresson, 1865 [1,2,5,9,105,109,N]	AB: Armena, Bilby, Calgary, Edmonton, **George L**, **Jenner**, Lethbridge, **Pembina PP**, **Pigeon L**, Red Deer, Wagner NA, Waterton, Waterton Lakes; SK: **Bodmin Hill**, **Cypress Hills**, Eagle Hill Cr, Regina, Val Marie, White Fox; MB: Aweme, **Kenville**, Red Deer River, Russell, Swan River, **Winnipeg**; Widespread across region, especially in parkland	Coleoptera: Cerambycidae; Hymenoptera: Diprionidae; Lepidoptera: Erebidae, Geometridae, Hesperiidae, Lasiocampidae, Noctuidae, Notodontidae, Pieridae, Tortricidae (42)
Pimpla stricklandi (Townes, 1960) [1,2,109,N]	AB: Clymont, Edmonton, **George L**, **Pembina PP**, **Pigeon L**, Wagner NA; SK: Dafoe, Quill L at Kandahar, Manitou, Regina	None
Pimpla tenuicornis Cresson, 1865 [1,2,5,9,109,N]	AB: **Cooking L**, Edmonton, **George L**, **Pembina PP**, **Pigeon L**, Red Deer, **Wabamun**, Wagner NA; SK: Cypress Hills; MB: Deepdale, Keld, **Swan River**, Teulon, Treesbank	Diptera: Tachinidae; Lepidoptera: Erebidae, Sesiidae, Tortricidae (6) *Mostly concealed feeders*
Polysphincta burgessii Cresson, 1870 [1,2,5,9,N]	AB: Edmonton, Wagner NA, Waterton; MB: **Glenlea**	None
Polysphincta koebeli Howard, 1892 [109,N]	AB: **Pigeon L**	Araneae: Araneidae (1)
Scambus atrocoxalis (Ashmead, 1902) [1,109,H]	AB: Edmonton, **George L**	Coleoptera: Cerambycidae; Lepidoptera: Tortricidae (2)
Scambus brevicornis (Gravenhorst, 1829) [1,105,H]	AB: Wateron Lakes NP[m]	Coleoptera: Buprestidae, Cerambycidae, Curculionidae; Diptera: Scathophagidae, Tephritidae; Hymenoptera: Braconidae, Cynipidae, Diprionidae, Tenthredinidae; Lepidoptera: Choreutidae, Coleophoridae, Elachistidae, Erebidae, Gelechiidae, Geometridae, Gracillariidae, Lasiocampidae, Momphidae, Noctuidae, Pieridae, Plutellidae, Pterophoridae, Pyralidae, Tischeriidae, Tortricidae (127) *Mostly concealed feeders*

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
Scambus canadensis Walley, 1960 [1,105,N]	AB: Elkwater P[m], nr Lloydminster	Hymenoptera: Diprionidae; Lepidoptera: Tortricidae (5)
Scambus deceptor Walley, 1960 [2,109,N]	AB: **Edmonton**, Wagner	None
Scambus decorus Walley, 1960 [1,9,105,109,N]	AB: Edmonton, **George L**, **Pembina PP**, **Wagner NA**; MB: Aweme, nr Winnipeg[m], **Winnipeg**, southwest[m]	Hymenoptera: Diprionidae; Lepidoptera: Coleophoridae, Gelechiidae, Gracillariidae, Incurvariidae, Tortricidae (18) *Mostly concealed feeders*
Scambus dioryctriae Walley, 1960 [1,105,N]	AB: nr Medicine Hat[m], southwest[m]; SK: Indian Head, Sutherland	Lepidoptera: Pyralidae, Tortricidae (2) *Concealed conifer feeders*
Scambus granulosus Walley, 1960 [1,2,N]	AB: Edmonton, Wagner	Lepidoptera: Momphidae (1) *Stem borers*
**Scambus hispae* (Harris, 1835) [1,5,9,8,105,109,N]	AB: **Cooking L**, Cochrane,Cowley, Edmonton, Elkwater, **George L**, Lethbridge, **Pembina PP**, **Pigeon L**, Red Deer, Rockyford, Waterton Lakes; SK: White Fox; MB: Aweme, **Kenville**, **Roblin**; midcentral Canada (AB, SK) in sunflower fields; several locations across prairies[m]	Coleoptera: Chrysomelidae; Hymenoptera: Braconidae, Cynipidae, Diprionidae, Ichneumonidae, Tenthredinidae; Lepidoptera: Choreutidae, Coleophoridae, Cosmopterigidae, Crambidae, Gelechiidae, Geometridae, Gracillariidae, Erebidae, Lasiocampidae, Lyonetiidae, Nolidae, Psychidae, Pyralidae, Saturniidae, Sesiidae, Tischeriidae, Tortricidae (93) *Mostly concealed feeders*
Scambus imparis Walley, 1960 [1,109,N]	AB: Edmonton, **George L**	Lepidoptera: Yponomeutidae (1) *Concealed feeders*
Scambus longicorpus Walley, 1960 [1,105,N]	SK: Indian Head[m]	Diptera: Anthomyiidae; Lepidoptera: Pyralidae, Tortricidae (6) *Concealed conifer feeders*
Scambus pterophori (Ashmead, 1890) [1,2,5,N]	AB: Edmonton, Lethbridge, Vermilion, Wagner; SK: Great Sand Hills (W of Swift Current), Rutland, Saskatoon, Swift Current, White Fox; MB: Aweme, Shoal L, Winnipeg	Coleoptera: Curculionidae; Hymenoptera: Tenthredinidae; Lepidoptera: Cosmopterigidae, Crambidae, Gelechiidae, Momphidae, Noctuidae, Pterophoridae, Tortricidae (23) *Concealed feeders*
Scambus tenebrosus Walley 1960 [2,N]	AB: Wagner NA	Lepidoptera: Tortricidae (3)

Scambus vesicarius (Ratzeburg, 1844) [1,109,H]	AB: Blackfoot Hills, **Edmonton**, **Pembina PP**, **Pigeon L**; SK: Snowden; MB: Winnipeg, Birtle	Coleoptera: Curculionidae; Hymenoptera: Cynipidae, Ichneumonidae, Tenthredinidae; Lepidoptera: Gracillariidae, Sesiidae, Tischeriidae, Tortricidae; Raphidioptera: Raphidiidae (76) *Mostly gall makers*
Schizopyga circulator (Panzer, 1800) [1,H]	MB: Stockton	Araneae: Clubionidae (3)
Schizopyga frigida Cresson, 1870 [1,2,5,109,H]	AB: Bilby, Edmonton, **George L**, **Pembina PP**, **Pigeon L**, Wabamun, Wagner NA, Waterton	Araneae: Clubionidae (2)
Sinarachna pallipes (Holmgren, 1860) [1,5,109,H]	AB: Edmonton, **George L**, **Pembina PP**, **Wagner NA**	Araneae: Araneidae, Linyphiidae, Theridiidae, Curculionidae (9) *Mostly spiders*
Theronia atalantae (Poda, 1761) [5,9,46,105,109,115,H,O]	AB: Calgary, Edmonton, nr Cooking L, Waterton; SK: **Bodmin Hills**	Diptera: Tachinidae; Hymenoptera: Braconidae, Ichneumonidae; Lepidoptera: Crambidae, Drepanidae, Erebidae, Geometridae, Hesperiidae, Lasiocampidae, Lycaenidae, Noctuidae, Notodontidae, Nymphalidae, Papilionidae, Pieridae, Psychidae, Saturniidae, Tortricidae, Yponomeutidae (90)
Tromatobia ovivora (Boheman, 1821) [1,2,5,109,H,T,Oc]	AB: Bilby, **Cooking L**, Edmonton, **George L**, Lethbridge, **Pigeon L**, Sylvan L, Wabamun, Wagner NA, Waterton; SK: Cypress Hills, Swift Current, White Fox; MB: Aweme	Araneae: Araneidae, Linyphiidae, Philodromidae, Theridiidae; Coleoptera: Chrysomelidae; Hymenoptera: Diprionidae, Tenthredinidae; Lepidoptera: Drepanidae, Erebidae, Gelechiidae, Geometridae, Noctuidae, Notodontidae, Papilionidae, Tortricidae (36) *Mostly spiders*
Tromatobia variabilis (Holmgren, 1856) [1,2,5,H]	AB: Edmonton, Red Deer, Wabamun, Wagner NA; SK: Atton's L, Bateman, Saskatoon, Swift Current	Araneae: Araneidae, Tetragnathidae; Lepidoptera: Elachistidae, Tortricidae (6)
**Zabrachypus primus* Cushman, 1920 [1,5,109,H]	AB: Edmonton, **Jenner**	None
Zaglyptus varipes (Gravenhorst, 1829) [2,5,9,109,H]	AB: Edmonton, Lethbridge, **George L**, **Pigeon L**, Red Deer, **Wabamun**, Wagner NA	Araneae: Araneidae, Clubionidae, Miturgidae, Salticidae; Lepidoptera: Acrolepiidae, Elachistidae, Lasiocampidae, Noctuidae (9)
Zatypota anomala (Holmgren, 1860) [2,14,H,T]	AB: Edmonton, Wagner NA	Araneae: Dictynidae, Linyphiidae; Coleoptera: Scolytidae (5) *Mostly spiders*
Zatypota crassipes Townes, 1960 [9,N]	MB: **Winnipeg**	Araneae: Theriidae (1)

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
Zatypota percontatoria (Müller, 1776) [1,2,109,H]	AB: Edmonton, **George L**, Wagner NA	Araneae: Araneidae, Dictynidae, Theridiidae, Gracillariidae; Lepidoptera: Tortricidae (11) *Mostly spiders*
POEMENIINAE		
Neoxorides borealis (Cresson, 1870) [1,N]	MB: Aweme	Coleoptera: Buprestidae, Cerambycidae; Lepidoptera: Tortricidae (6) *Mostly wood borers*
Neoxorides pilulus Townes 1960 [2,109,N]	AB: **George L**, **Pigeon L**, Wagner NA	None
Podoschistus vittifrons (Cresson, 1868) [109,N]	AB: **George L**, **Pembina PP**	Coleoptera, Hymenoptera: Buprestidae, Cerambycidae, Siricidae (4) *Wood borers*
Poemenia albipes (Cresson, 1870) [1,2,109,N]	AB: Edmonton, Midnapore, Wagner NA; SK: Indian Head	None
Poemenia thoracica (Cresson, 1879) [5,N]	AB: Red Deer	Coleoptea: Cerambycidae; Hymenoptera: Megachilidae (2)
Poemenia americana (Cresson, 1870) [2,5,109,N]	AB: Edmonton, **George L**, Wagner NA	Coleoptera: Cerambycidae; Hymenoptera: Crabronidae, Megachilidae; Lepidoptera: Tortricidae (6) *Mostly cone borers*
Pseudorhyssa alpestris (Holmgren, 1860) [1,5,H]	AB: Waterton	Hymenoptera: Ichneumonidae, Siricidae, Xiphydriidae (7) *Wood borers*
RHYSSINAE		
Megarhyssa atrata Fabricius, 1781 [9,N]	AB: **Winnipeg**	Hymenoptera: Siricidae; Lepidoptera: Notodontidae (3)
Megarhyssa nortoni (Cresson, 1864) [1,5,9,109,N,Au,Oc]	AB: Calgary, **George L**, Lethbridge, Waterton; MB: **Winnipeg**	Hymenoptera: Siricidae (3) *Wood borers*
Rhyssa alaskensis Ashmead, 1902	AB: Wagner NA, Waterton	Hymenoptera: Siricidae (1)
Rhyssa lineolata (Kirby, 1837) [1,109,N,Oc]	AB: Edmonton, **George L**	Coleoptera: Cerambycidae, Melandryidae; Hymenoptera: Siricidae (10) *Wood borers*
Rhyssa persuasoria (Linnaeus, 1758) [5,109,H,O,Oc,Au]	AB: Cochrane, **George L**	Hymenoptera: Ichneumonidae, Siricidae, Xiphydriidae (7) *Wood borers*

Rhyssella nitida (Cresson, 1864) [109,N]	AB: **George L**	Hymenoptera: Xiphydriidae (3) *Wood borers*
TERSILOCHINAE		
Aneuclis interstitialis Horstmann, 2012 [116,N]	AB: Gilchrist Ranch, Aden, Oldman River, Lethbridge, Onefour, Scandia; SK: Elbow; MB: Shilo	None
Barycnemis brevicauda Horstmann, 2010 [117,N]	AB: Elkwater	None
Barycnemis harpura Schrank, 1802) [5,9,H]	AB: Edmonton; MB: **Franklin**	Hymenoptera: Cynipidae (1) *Gall makers*
Barycnemis rufipes Horstmann, 2010 [117,N]	AB: Writing-on-Stone PP; SK: Willow Bunch	None
Barycnemis rugosa (Provancher, 1879) [14,117,N]	AB: Calgary, Cameron L, Edmonton, Irvine, Lethbridge, Scandia; SK: Cypress Hills PP, Lloydminster, Saskatoon	None
Diaparsis baldufi (Walkley, 1956) [118,N]	SK: Saskatoon	Coleoptera: Attelabidae (1)
TRYPHONINAE		
Aderaeon bedardi (Provancher, 1879) [9,H,O]	SK: **MacDowall**	Hymenoptera: Diprionidae, Tenthredinidae (3)
Boethus schizoceri (Riley & Howard, 1888) [119,N]	MB: 13 mi N Glenboro, Onah	Hymenoptera: Argidae (2)
Cosmoconus posticatus Townes & Gupta, 1992 [119,N]	SK: Bagley, Katepwa, Wood Mt; MB: Horton	None
Cteniscus leptonyx (Mason, 1955) [120,N]	AB: Blackfoot Hills nr Wainwright, Edmonton, Lethbridge	None
Cteniscus promediatus (Mason, 1955) [120,N]	AB: Edmonton; SK: Saskatoon	Hymenoptera: Tenthredinidae (3)
*Cteniscus scaphuloides (*Mason, 1955) [2,N]	AB: Wagner NA	None
Cteniscus vitticollis Cresson, 1868 [14,120,N]	AB: Bilby, Edmonton, Morrin; SK: Earl Grey	Hymenoptera: Tenthredinidae (1)
Ctenochira analis (Cresson, 1864) [2,14,74,N]	AB: Bilby, Edmonton, Wabamun, Wagner NA	None
Ctenochira arcuata (Holmgren, 1857) [14,74,H]	AB: Bilby, Calgary, Edmonton, Gleichen; SK: Dafoe, Regina	None
Ctenochira debilis Townes & Townes, 1949 [2,N]	AB: Wagner NA	None
Ctenochira deplanata Townes & Townes, 1949 [2,N]	AB: Wagner NA	None
Ctenochira extricata (Davis, 1897) [2,N]	AB: Wagner NA	None
Ctenochira gillettei (Davis, 1897) [5,74,N]	AB: Bilby, Edmonton, Orkney District, Waterton	None
Ctenochira haemosterna (Haliday, 1838) [2,74,H]	AB: Bilby, Edmonton, Wagner NA	Hymenoptera: Tenthredinidae (4)

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
Ctenochira infans Townes & Townes, 1949 [2,N]	AB: Wagner NA	None
Ctenochira niveicola (Ashmead, 1902) [74,N]	AB: Edmonton	None
Ctenochira pikonematis Townes & Townes, 1949 [2,N]	AB: Wagner NA	Hymenoptera: Tenthredinidae (2)
Ctenochira rufa (Ashmead, 1902) [2,14,N]	AB: Edmonton, Wagner NA	None
Ctenochira subcrassa (Cresson, 1868) [74,N]	AB: Bilby	None
Dyspetes rufus (Provancher, 1874) [119,N]	MB: Beausejour	None
Eridolius clypeatus (Cresson, 1868) [5,N]	AB: Edmonton, Red Deer	None
Erromenus analis Brischke, 1871 [2,119,H]	AB: Aspen Beach, Elkwater P, Jumping Pound Cr, Wagner NA	Hymenoptera: Tenthredinidae (5) *Concealed feeders*
Erromenus caelator Townes & Townes, 1949 [1,119,N]	AB: Jumping Pound Cr, Wagner NA	None
Erromenus glabrosus Davis, 1897 [119,N]	AB: Blairmore, Elkwater P, Medicine Hat, Onefour, Waterton; SK: Cypress Hills, Saskatoon, Scout L, Val Marie; MB:Carberry	None
Erromenus marginatus Provancher, 1883 [5,119,N]	AB: Aspen Beach, Bilby, Edmonton, Elkwater P, Jumping Pound Cr, Sundre; SK: Kenosee, White Fox, Prince Albert	Hymenoptera: Tenthredinidae (3)
Erromenus nasalis Townes & Townes, 1949 [2,N]	AB: Wagner NA	None
Erromenus planus Townes & Townes, 1949 [2,14,119,N]	AB: Edmonton, Wagner NA; SK: Elbow	Hymenoptera: Tenthredinidae (4)
Erromenus punctatus (Woldstedt, 1878) [2,14,H]	AB: Red Deer, Wagner NA	Hymenoptera: Tenthredinidae (6)
Erromenus punctulatus Holmgren, 1857 [2,14,119,H]	AB: Drumheller, Edmonton, Elkwater P, Frank, Jumping Pound Cr, Milk River, Mountain View, Red Deer, Wagner NA, Waterton; SK: Allen L at Cut Knife, Prince Albert	Hymenoptera: Tenthredinidae (5)
Erromenus zonarius (Gravenhorst, 1820) [5,119,H]	AB: Bilby, Edmonton, Elkwater L, Elkwater P, Jumping Pound Cr, Wabamun, Waterton; SK: Saskatoon; MB: Aweme, 9 mi N Forrest, Ninette	None
Excavarus etrocaulus (Mason, 1956) [121,N]	AB: Bilby, Gull L	None
Excavarus velox (Walley, 1937) [5,121,N]	AB: Edmonton, Lacombe, Red Deer; SK: Dahlton, Sutherland	Hymenoptera: Tenthredinidae (3)

**Exyston boreotis* Davis, 1897 [5,121,N]	AB: Bilby, Edmonton; SK: Regina	None
Exyston californicus Mason, 1959 [122,N]	AB: Cowley	None
Exyston chamaeleon Mason, 1959 [122,N]	AB: Bilby, Drumheller; SK: Saskatoon, Great Sand Hills, Roche Percee	None
**Exyston clavatus* (Cresson, 1864) [122,N]	MB: Winnipeg	None
Exyston hadros Mason, 1959 [122,N]	SK: Swift Current, Assiniboia, Cut Knife, Regina, Qu'Appelle	None
Exyston lophotos Mason, 1959 [122,N]	AB: Edmonton, Waterton, Willow Bunch; SK: Roche Percee	None
Exyston maculosus (Provancher, 1875) 2,[122,N]	AB: Edmonton, Gull L, Wagner NA, Waterton L; SK: Snowden	Hymenoptera: Tenthredinidae (3)
Exyston marginatus Provancher, 1886 [122,N]	AB: Gull L; SK: Saskatoon	None
Exyston spinulosus Mason, 1959 2,[122,N]	AB: Wagner NA; SK: Attons L nr Cut Knife, Indian Head	None
Exyston variatus Provancher, 1877 5,[122,N]	AB: Bilby, Blackfoot Coulee nr Wainwright, Edmonton, Wabamun; SK: Harlan, White Fox	None
Exyston venustus (Cresson, 1865) [122,N]	SK: Roche Percee	None
Grypocentrus albipes Ruthe, 1855 [14,70,119,H]	AB: Edmonton	Hymenoptera: Tenthredinidae (3) *Leafmining sawflies*
Grypocentrus barbatus Townes & Townes, 1951 [119,N]	AB: Calgary, Jumping Pound Cr	None
Hercus fontinalis (Holmgren, 1857) [5,119,H]	AB: Edmonton, Jumping Pound Cr (20 mi W Calgary); SK: Canora, Kenosee, Lloydminster, Saskatoon; MB: E. Selkirk, Fort Garry, Ninette	Lepidoptera: Gracillariidae, Pyralidae, Tortricidae (18) *Concealed feeders*
Monoblastus ferius (Davis, 1898) [119,N]	AB: Elkwater P, Frank, Jumping Pound Cr; SK: St. Victor; MB: Aweme	None
Monoblastus kaniacensis (Hall, 1919) [14,119,N]	AB: Acme, Drumheller; MB: Dunrae	None
Monoblastus montezuma (Cameron, 1886) [14,119,N,T]	AB: Bilby, Calgary, Cochrane, Cypress H, Edmonton, Elkwater P, Jumping Pound Cr, Waterton; SK: Snowden; MB: Aweme	None
Neliopisthus elegans (Ruthe, 1855) [14,119,N]	AB: Edmonton; SK: Elbow, Willow Bunch; MB: Shell River	Hymenoptera, Lepidoptera: Tenthredinidae, Blastobasidae, Coleophoridae, Elachistidae, Gelechiidae, Pyralidae (10) *Mostly concealed feeders*
Neliopisthus fulvicoxis Townes, 1992 [119,N]	AB: Edmonton	None
Neliopisthus niger Cushman, 1922 [119,N]	AB: Twin Butte	None
Neliopisthus piceae Cushman, 1935 [119,N]	AB: Jumping Pound Cr (20 mi W Calgary)	Lepidoptera: Gelechiidae (3) *Needle miners*
Netelia alaskensis (Ashmead, 1902) [2,5,N]	AB: Edmonton, Wagner NA	None
Netelia barberi (Cushman, 1924) [5,N]	AB: Edmonton	None

SUBFAMILY Species[a]	Localities[b]	Host Family (No. spp.) *Guild/Notes*
Netelia brevicornis (Cushman, 1924) [5,123,N,T]	AB: Edmonton, Lethbridge	Lepidoptera: Noctuidae (2)
Netelia chloris (Olivier, 1811) [97,N,T]	AB: Treesbank	Lepidoptera: Noctuidae (6) *Mostly cutworms*
Netelia deceptor (Morley, 1913) [9,N]	MB: **Franklin**	Lepidoptera: Noctuidae, Notodontidae (2)
Netelia johnsoni (Ashmead, 1900) [14,N]	AB: Edmonton	None
Netelia latungula (Thomson, 1888) [14,H]	AB: Edmonton	Lepidoptera: Erebidae, Geometridae, Notodontidae (8)
Netelia longipalpus Townes, 1939 [9,N]	MB: **Swan River**	Lepidoptera: Erebidae (1) *Loopers*
Netelia ocellata (Viereck, 1909) [5,9,N,T]	AB: Lethbridge; MB: **Franklin**	Lepidoptera: Noctuidae (1) *Cutworms*
Netelia pallens (Cushman, 1924) [43,N]	MB: Treesbank	Lepidoptera: Erebidae
Netelia sayi (Cushman, 1924) [9,N,T]	MB: **Franklin**	Lepidoptera: Noctuidae (8)
Netelia tarsata (Brischke, 1880) [5,H]	AB: Edmonton	Lepidoptera: Drepanidae, Geometridae (16) *Loopers*
Phytodietus burgessi (Cresson, 1868) [2,5,20,124,N]	AB: Calgary, Chin, Lethbridge, Wagner NA; SK: Glaslyn, Rockglen; MB: Deepdale	Lepidoptera: Elachistidae, Pyralidae, Tortricidae (23) *Concealed feeders*
Phytodietus conflictanae Loan, 1981 [124,N]	AB: Hespero, Cypress Hills; SK: Mossbank	Lepidoptera: Tortricidae (2) *Concealed feeders*
Phytodietus coxanotus Loan, 1981 [124,N]	AB: Elkwater	Lepidoptera: Tortricidae (1) *Concealed feeders*
Phytodietus criddleanae Loan, 1981 [124,N]	AB: Edmonton, Elkwater P, Twin Butte, Waterton Prairie 4200'	Lepidoptera: Tortricidae (3) *Concealed feeders*
Phytodietus fuscus Loan, 1981 [124,N]	AB: Mountain View	None
Phytodietus improbanae Loan, 1981 [124,N]	AB: Elkwater	Lepidoptera: Gelechiidae, Tortricidae (6) *Concealed feeders*
Phytodietus obscurus (Ratzeburg, 1852) [5,124,N]	AB: Blackfoot Coulee, Brooks, Calgary, Drumheller, Edmonton, Lethbridge, Lloydminster, Jumping Pound Cr (20 mi W Calgary), Morrin, Vermilion, Wainwright; SK: Assiniboia, Battle River, Earl Grey, Elbow, Great Deer, Indian Head, Kenosee, Mossbank, Nipawin, Prince Albert, Redberry, Regina, Saskatoon, Swift Current; MB: 5 mi N Minnedosa	Diptera, Lepidoptera: Cecidomyiidae, Crambidae, Noctuidae, Tortricidae (10) *Concealed feeders*
Phytodietus plesius Rohwer, 1920 [124,N]	SK: Fort a la Corne; MB: Transcona	Lepidoptera: Pyralidae (3) *Concealed feeders*
Phytodietus pleuralis Cresson, 1865 [5,124,N]	AB: Edmonton, Onefour, Red Deer, Sylvan L, Waterton; SK: Balgonie, Cut Knife, Hubbard, Waldron; MB: Turtle Mt FR, 5 mi SW Shilo, Stonewall	Lepidoptera: Gelechiidae, Tortricidae (10) *Concealed feeders*

Phytodietus rufosus Loan, 1981 [124,N]	AB: Orion; MB: Glenboro	None
Phytodietus semirufus Loan, 1981 [124,N]	MB: Aweme, Ninette	Lepidoptera: Tortricidae (1) *Concealed feeders*
Phytodietus solicitanae Loan, 1981 [124,N]	MB: Ninette	Lepidoptera: Tortricidae (3) *Concealed feeders*
Phytodietus varianae Loan, 1981 [124,N]	AB: Chedderville	Lepidoptera: Tortricidae (1) *Concealed feeders*
Phytodietus vulgaris Cresson, 1870 [2,5,124,N]	AB: Calgary, Edmonton, Wagner NA; SK: Nipawin, Pike L, Poplar Cr; MB: Dauphin, Durban, 5 mi SW Shilo	Lepidoptera: Pyralidae, Tortricidae (27) *Concealed feeders*
Polyblastus alternans Schiødte, 1838 [14,119,H]	AB: Edmonton; MB: 6 mi NW Brandon	Hymenoptera: Ichneumonidae (1)
Polyblastus bimacula Townes & Townes, 1949 [2,14,119,N]	AB: Bilby, Edmonton, Elkwater P, Wabamun, Wagner NA; SK: Lloydminster; MB: 5 mi SW Shilo, Souris	None
Polyblastus botrys Townes & Townes, 1949 [119,N]	AB: Lundbreck; MB: Aweme, 5 mi SW Shilo	None
Polyblastus cancer (Hartig, 1837) [119,H]	SK: Canora; MB: Minnedosa	Hymenoptera: Tenthredinidae (7)
Polyblastus flexus Townes & Townes, 1949 [119,N]	AB: Edmonton	None
Polyblastus gloriosus (Davis, 1897) [14,119,N]	AB: Elkwater L, Elkwater P, Jumping Pound Cr, Vermilion	None
Polyblastus melanostigmus Holmgren, 1857 [2,119,H]	AB: Longview, Wagner NA	Hymenoptera: Tenthredinidae (1)
Polyblastus pedalis (Cresson, 1864) [2,5,9,119,H]	AB: Castor, Cypress Hills, Edmonton, Elkwater, Elkwater P, Gull L, Jumping Pound Cr, Red Deer, Wabamun, Wagner NA, Waterton; SK: Canora, Elbow, Earl Grey, Mossbank, Redberry, Rockglen, Saskatoon, Scout L; MB: Aweme, Carberry, Dawson Rd, **Gilbert Plains**, 5 mi W Shilo, Souris, Treesbank	Hymenoptera: Tenthredinidae (9)
Polyblastus provancheri Kasparyan, 1970 [2,5,119,N]	AB: Edmonton, Elkwater L, Elkwater P, Jumping Pound Cr, Oldman River nr Lethbridge, Wagner NA, Wainwright; SK: Saskatoon, Snowden, White Fox; MB: Aweme, Shilo, 2 mi W Stockton	Hymenoptera: Tenthredinidae (1)
Polyblastus pumilus Holmgren, 1857 [119,H]	AB: Edmonton, Elkwater P, Jumping Pound Cr, Grassy L; SK: Katepwa; MB: 2 mi W Stockton	Hymenoptera: Tenthredinidae (3) *Concealed feeders*
Polyblastus stenocentrus Holmgren, 1857 [119,H]	AB: Edmonton	Hymenoptera: Tenthredinidae (4)
Polyblastus subterminus Townes, 1992 [119,N]	AB: Elkwater P	None
Polyblastus tibialis (Cresson, 1864) [5,119,N]	AB: Edmonton, Jumping Pound Cr (20 mi W Calgary); MB: Turtle Mt FR	None

SUBFAMILY Species[a]	**Localities**[b]	**Host Family (No. spp.)** ***Guild/Notes***
Polyblastus varitarsus (Gravenhorst, 1829) [119,H]	AB: Alder Flats, Bilby, Cassils, Edmonton, Elkwater, Elkwater L, Elkwater P, Gull L, Lancaster P, Lethbridge, Manyberries, Onefour, Orion, Red Deer, Waterton; SK: Antelope L, Assiniboia, Canora, Elbow, Grenfell, Kenosee, Mossbank, Pike L, Prince Albert, Redberry L, Rutland, St. Victor, Saskatoon, Scout L, Val Marie, Wood Mt; MB: 6 mi NW Brandon	Hymenoptera: Tenthredinidae (4)
Polyblastus wahlbergi Holmgren, 1857 [14,119,N]	AB: Edmonton, nr Medicine Hat[m]	Hymenoptera: Tenthredinidae (9)
Scapnetes ornatus (Walsh, 1873) [5,N]	AB: Edmonton	None
Smicroplectrus incompletus Walley, 1937 [14,121,N]	AB: Edmonton, Lethbridge	Hymenoptera: Tenthredinidae (1)
Smicroplectrus robustus Walley, 1937 [5,121,N]	AB: Consort, Edmonton, Fawcet, Gull L, Red Deer; SK: Cut Knife, Battle River north of Cut Knife	Hymenoptera: Tenthredinidae (1)
Thymaris kansensis (Brue, 1907) [119,N,T]	SK: Saskatoon	None
Tryphon communis Cresson, 1868 [2,5,125,N]	AB: Edmonton, Lethbridge, Red Deer, Wagner NA; MB: Transcona	None
Tryphon mystax Townes & Townes, 1950 [14,125,N]	AB: Edmonton	None
Tryphon rempeli Townes & Townes, 1950 [2,14,125,N]	AB: Bilby, Edmonton, Wagner NA	None
Tryphon seminiger Cresson, 1864 [125,N]	AB: Fawcett; SK: Nipawin, Saskatoon	None
Tryphon townesi Walkley, 1958 [2,N]	AB: Wagner NA	None
Tryphon viator Townes & Townes, 1950 [2,14,125,N]	AB: Cochrane, Wagner NA; SK: Dafoe	None
XORIDINAE		
Odontocolon aethiops (Cresson, 1865) [1,N]	AB: Waterton	None
Odontocolon vicinum (Cresson, 1870) [5,N]	AB: Edmonton, Red Deer	Coleoptera: Buprestidae (2) *Wood borers*

Xorides calidus (Provancher, 1886) [1,N]	SK: Indian Head	Coleoptera: Buprestidae, Cerambycidae (4) *Wood borers*
Xorides insularis (Cresson, 1879) [5,N]	AB: Calgary	Coleoptera: Buprestidae, Cerambycidae (8) *Wood borers*
Xorides stigmapterus (Say, 1824) [1,5,N]	AB: Bilby, Edmonton	Coleoptera: Cerambycidae (2) *Wood borers*

References: [1]Townes and Townes 1960, [2]Finnamore 1994, [3]Barron 1989, [4]Dasch 1984, [5]Strickland 1946, [6]Schaaf 1972, [7]Peterson 1958, [8]Sharkey *et al.* 1987, [9]Wallis-Roughley Museum of Entomology database, [10]Brown and Lindquist 1953, [11]Townes and Townes 1978, [12] Dasch 1988, [13]Byers *et al.* 1993, [14]Strickland 1952, [15]Turnock 1988, [16]Turnock and Bilodeau 1984, [17]Wylie 1977, [18]Wylie and Ayre 1979, [19]Wylie and Bucher 1977, [20]Prentice 1955, [21]Eidt and Sippell 1961, [22]Viereck 1925–1926*a*, [23]Hobbs *et al.* 1959, [24]MacNay 1954, [25]Tigner 1969, [26]Walley 1977, [27]King and Atkinson 1928, [28]Cushman 1930, [29]Carlson 1979, [30]Walley 1927, [31]Walley 1970, [32]Walley 1947, [33]Walley 1941, [34]Sanborne 1986*a*, [35]Sanborne 1986*b*, [36]Batista *et al.* 2010, [37]Putnam 1973, [38]Putnam 1982, [39]Sarfraz *et al.* 2010, [40]Walley 1967, [41]Viereck 1925–1926*b*, [42]Walley 1940*a*, [43]Criddle 1925, [44]Walley 1944, [45]Brown 1962, [46]Parry 1995, [47]Barron and Walley 1983, [48]Sanborne 1986*c*, [49]Sanborne 1984, [50]Horstmann 1987, [51]Wahl 1987, [52]Dasch 1979, [53]Swailes 1960, [54]Mitchell 1950, [55]Townes and Townes 1962, [56]Townes and Gupta 1962, [57]Townes 1983, [58]Luhman 1990, [59]Luhman 1986, [60]Mason 1968, [61]McKay and Galloway 1999, [62]McKay and Galloway 2000, [63]Barron 1981, [64]Leblanc 1989, [65]Barron 1990, [66]Wong 1955, [67]Cushman 1919, [68]Barron 1994, [69]Digweed 1998, [70]Langor *et al.* 2000, [71]Reschikov *et al.* 2010, [72]Graham 1931, [73]Barron 1997, [74]Townes and Townes 1949*a*, [75]Barron 1992, [76]Leblanc 1999, [77]Barron 1986, [78]Walley 1940*b*, [79]Dasch 1992, [80]Dasch 1964, [81]Olfert *et al.* 2002, [82]Barron 1976, [83]Bradley 1978, [84]Heinrich 1962*a*, [85]Heinrich 1961*a*, [86]Heinrich 1960*a*, [87]Heinrich 1962*c*, [88]Hopper 1939, [89]Heinrich 1961*b*, [90]Heinrich 1962*b*, [91]Viereck 1926, [92]Criddle 1921, [93]Cushman 1927, [94]Heinrich 1960*b*, [95]Swift 1946, [96]Heinrich 1968, [97]Treherne 1916, [98]Wahl and Sime 2006, [99]Mitchell 1985, [100]Dasch 1971, [101]Lee 1991, [102]Wylie and Loan 1984, [103]Walley 1966, [104]Townes and Townes 1959, [105]Bradley 1974, [106]Walley 1969, [107]Felt 1904, [108]Norton 1863, [109]MDS, unpublished, [110]Barron 1977, [111]Still and Wong 1973, [112]Gupta 1982, [113]Holmes 1953, [114]Horstmann 2008, [115]Stehr and Cook 1968, [116]Horstmann 2012, [117]Horstmann 2010, [118]Walkley 1956, [119]Townes *et al.* 1992, [120]Mason 1955, [121]Mason 1956, [122]Mason 1959, [123]Townes 1938, [124]Loan 1981, [125]Townes and Townes 1949*b*, [126]Townes 1963

Range: [N]Nearctic, [H]Holarctic, [T]Neotropical, [O]Oriental, [Oc]Oceanic, [A]Afrotropical, [Au]Australasian.

Hosts: No. spp. = number of host species recorded per ichneumonid species. The host families were summarized from Yu *et al*. (2012) by J. Dombroskie (Cornell Museum of Entomology). Where the hosts were entirely or mostly of a particular guild (e.g., leafrollers) or morphology (e.g., having spiny or setose larvae), or from certain of the listed families, these notes were also provided by J. Dombroskie.

[a]**Species authorities**: Parentheses indicate the species was originally described in a different genus.

[b]**Abbreviations:** Cr = Creek; FR = Forest Reserve; L = Lake; Mt = Mountain; NA = Natural Area; NP = National Park; P = Park; PP = Provincial Park; PF = Provincial Forest; Stn = Station.

References

Askew, R.R., and Shaw, M.R. 1986. *Parasitoid communities: their size, structure and development. In* Insect Parasitoids. 13th Symposium of the Royal Entomological Society of London, 18–19 September 1985. *Edited by* J. Waage and D. Greathead. Academic Press, London, U.K. pp. 225–264.

Barron, J.R. 1976. Systematics of Nearctic *Euceros* (Hymenoptera: Ichneumonidae: Eucerotinae). Naturaliste Canadien, **103:** 285–375.

Barron, J.R. 1977. The Nearctic species of *Orthopelma* (Hymenoptera: Ichneumonidae). Systematic Entomology, **2:** 283–299.

Barron, J.R. 1981. The Nearctic species of *Ctenopelma* (Hymenoptera, Ichneumonidae, Ctenopelmatinae). Naturaliste Canadien, **108:** 17–56.

Barron, J.R. 1986. A revision of the Nearctic species of *Rhorus* (Hymenoptera, Ichneumonidae, Ctenopelmatinae). Naturaliste Canadien, **113:** 1–37.

Barron, J.R. 1989. Status of the parasite *Agrypon flaveolatum* (Gravenhorst) (Hymenoptera, Ichneumonidae), introduced to control the winter moth in Nova Scotia and British Columbia. The Canadian Entomologist, **121:** 11–26.

Barron, J.R. 1990. The Nearctic species of *Homaspis* (Hymenoptera, Ichneumonidae, Ctenopelmatinae). The Canadian Entomologist, **122:** 191–216.

Barron, J.R. 1992. The Nearctic species of *Perilissus* (Hymenoptera, Ichneumonidae, Ctenopelmatinae). The Canadian Entomologist, **124:** 211–272.

Barron, J.R. 1994. The Nearctic species of *Lathrolestes* (Hymenoptera, Ichneumonidae, Ctenopelmatinae). Contributions of the American Entomological Institute, **28:** 1–135.

Barron, J.R. 1997. The Nearctic species of *Oetophorus* (Hymenoptera, Ichneumonidae, Ctenopelmatinae). Insecta Mundi, **11:** 117–128.

Barron, J.R., and Walley, G.S. 1983. Revision of the Holarctic genus *Pyracmon* (Hymenoptera: Ichneumonidae). The Canadian Entomologist, **115:** 227–241.

Batista, P.D., Keddie, B.A., Dosdall, L.M., and Harris, H.L. 2010. Phylogenetic placement and evidence for horizontal transfer of *Wolbachia* in *Plutella xylostella* (Lepidoptera: Plutellidae) and its parasitoid *Diadegma insulare* (Hymenoptera: Ichneumonidae). The Canadian Entomologist, **142:** 57–64.

Belshaw, R., Fitton, M., Herniou, E., Gimeno, C., and Quicke, D.J.J. 1998. A phylogenetic reconstruction of the Ichneumonoidea (Hymenoptera) based on the D2 variable region of 28S ribosomal RNA. Systematic Entomology, **23:** 109–123.

Bradley, G.A. 1974. Parasites of Forest Lepidoptera in Canada, Subfamilies Metopiinae and Pimplinae (Hymenoptera: Ichneumonidae). Part 1. Publication No. 1336. Canadian Forestry Service, Environment Canada, Ottawa, Ontario.

Bradley, G.A. 1978. Parasites of Forest Lepidoptera in Canada, Subfamily Ichneumoninae Stenopneusticae (Hymenoptera: Ichneumonidae). Part 2. Forestry Technical Report 26. Canadian Forestry Service, Environment Canada, Ottawa, Ontario.

Brown, C.E. 1962. The life history and dispersal of the Bruce spanworm, *Operophtera bruceata* (Hulst), (Lepidoptera: Geometridae). The Canadian Entomologist, **94:** 1103–1107.

Brown, C.E., and Lindquist, O.H. 1953. The Spotless Fall Webworm. Canada Department of Agriculture, Division of Forest Biology, Bi-monthly Progress Report, **9:** 2.

Byers, J.R., Yu, D.S., and Jones, J.W. 1993. Parasitism of the army cutworm, *Euxoa auxiliaris* (Grt.) (Lepidoptera: Noctuidae), by *Copidosoma bakeri* (Howard) (Hymenoptera: Encyrtidae) and effect on crop damage. The Canadian Entomologist, **125:** 329–335.

Cárcamo, H.A, and Beres, B.L. 2013. *Cephus cinctus* Norton, wheat stem sawfly (Hymenoptera: Cephidae). *In* Biological Control Programmes in Canada, 2001–2012. *Edited by* P.G. Mason and D.R. Gillespie. CABI, Wallingford, U.K. pp. 112–119.

Carlson, R.W. 1979. Family Ichneumonidae. *In* Catalog of Hymenoptera in America North of Mexico, Vol. 1: Symphyta and Apocrita (Parasitica). *Edited by* K.V. Krombein, P.D. Hurd, D.R. Smith, and B.D. Burks. Smithsonian Institution Press, Washington, D.C. pp. 315–740.

Criddle, N. 1921. The entomological record, 1920. Reports of the Entomological Society of Ontario, **51:** 72–90.

Criddle, N. 1925. The entomological record 1924. Reports of the Entomological Society of Ontario, **55:** 89–106.

Cushman, R.A. 1919. New genera and species of Ichneumon-flies (Hym.). Proceedings of the Entomological Society of Washington, **21:** 112–120.

Cushman, R.A. 1927. Miscellaneous notes and description of Ichneumon-flies. Proceedings of the United States National Museum, **72:** 1–22.

Cushman, R.A. 1930. New species of Ichneumon-flies and taxonomic notes. Proceedings of the United States National Museum, **76:** 1–18.

Dasch, C.E. 1964. Ichneumon-flies of America north of Mexico: 5, subfamily Diplazontinae. Memoirs of the American Entomological Institute, **3:** 1–304.

Dasch, C.E. 1971. Ichneumon-flies of America north of Mexico: 6, subfamily Mesochorinae. Memoirs of the American Entomological Institute, **16:** 1–376.

Dasch, C.E. 1979. Ichneumon-flies of America north of Mexico: 8, subfamily Cremastinae. Memoirs of the American Entomological Institute, **29:** 1–702.

Dasch, C.E. 1984. Ichneumon-flies of America north of Mexico: 9, subfamilies Theriinae and Anomaloninae. Memoirs of the American Entomological Institute, **36:** 1–610.

Dasch, C.E. 1988. Ichneumon-flies of America north of Mexico: 10, subfamily Banchinae, tribe Glyptini. Memoirs of the American Entomological Institute, **43:** 1–644.

Dasch, C.E. 1992. Ichneumon-flies of America north of Mexico: 12, subfamilies Microleptinae, Helictinae, Cylloceriinae, and Oxytorinae (Hymenoptera: Ichhneumonidae). Memoirs of the American Entomological Institute, **52:** 1–470.

Digweed, S.C. 1998. Mortality of birch leafmining sawflies (Hymenoptera: Tenthredinidae): impacts of natural enemies on introduced pests. Environmental Entomology, **27:** 1357–1367.

Dowton, M., and Austin, A.D. 1994. Molecular phylogeny of the insect order Hymenoptera: apocritan relationships. Proceedings of the National Academy of Science USA, **91:** 9911–9915.

Eidt, D.C., and Sippell, W.L. 1961. The life history, parasites, and economic status of the larch shoot moth, *Argyresthia laricella* Kft. (Lepidoptera, Yponomeutidae), and comparisons with *A. laevigatella* H.-S. The Canadian Entomologist, **93:** 7–24.

Felt, E.P. 1904. Nineteenth report of the State Entomologist on injurious and other insects of the state of New York 1903. Bulletin of the New York State Museum, **76:** 91–235.

Finnamore, A.T. 1994. Hymenoptera of the Wagner Natural Area, a boreal spring fen in central Alberta. Memoirs of the Entomological Society of Canada, **169:** 181–220.

Fitton, M.G., and Rotheray, G.E. 1982. A key to the European genera of diplazontine ichneumon-flies, with notes on the British fauna. Systematic Entomology, **7:** 311–320.

Fitton, M.G., Shaw, M.R., and Austin, A.D. 1987. The Hymenoptera associated with spiders in Europe. Zoological Journal of the Linnean Society, **90:** 65–93.

Gauld, I.D. 1983. The classification, evolution and distribution of the Labeninae, an ancient southern group of Ichneumonidae (Hymenoptera). Systematic Entomology, **8:** 167–178.

Gauld, I.D. 1988*a*. Evolutionary patterns of host utilization by ichneumonoid parasitoids (Hymenoptera: Ichneumonidae and Braconidae). Biological Journal of the Linnean Society, **35:** 351–377.

Gauld, I.D. 1988*b*. The species of the *Enicospilus americanus* complex (Hymenoptera: Ichneumonidae) in eastern North America. Systematic Entomology, **13:** 31–53.

Gauld, I.D. 1991. The Ichneumonidae of Costa Rica, 1. Memoirs of the American Entomological Institute, **47:** 1–589.

Gauld, I.D. 2002. The Ichneumonidae of Costa Rica, 4. Memoirs of the American Entomological Institute, **66**: 1–768.

Gauld, I., and Bolton, B. 1988. The Hymenoptera. Oxford University Press, New York.

Gauld, I.D., and Wahl, D.B. 2002. Genera Ichneumonorum Nearcticae [online]. Available from http://www.amentinst.org/GIN/ [accessed 22 October 2012].

Godfray, H.C.J. 1994. Parasitoids: Behavioral and Evolutionary Ecology. Princeton University Press, Princeton, New Jersey.

Graham, A.R. 1931. The present status of the larch sawfly (*Lygaeonematus erichsonii* Hartig) in Canada, with special reference to its specific parasite, *Mesoleius tenthredinis* Morley. The Canadian Entomologist, **63:** 99–102.

Graham, A.R. 1965. A Preliminary List of Natural Enemies of Canadian Agricultural Pests. Canada Department of Agriculture Research Institute, Information Bulletin No. 4.

Gupta, V.K. 1982. A revision of the genus *Delomerista* (Hymenoptera: Ichneumonidae). Contributions to the American Entomological Institute, **19:** 1–42.

Heinrich, G.H. 1960*a*. Synopsis of Nearctic Ichneumoninae Stenopneusticae with particular reference to the northeastern region (Hymenoptera), Part I. The Canadian Entomologist, **92**(Suppl. 15): 1–88.

Heinrich, G.H. 1960*b*. Synopsis of Nearctic Ichneumoninae Stenopneusticae with particular reference to the northeastern region (Hymenoptera), Part II. The Canadian Entomologist, **92**(Suppl. 18): 89–205.

Heinrich, G.H. 1961*a*. Synopsis of Nearctic Ichneumoninae Stenopneusticae with particular reference to the northeastern region (Hymenoptera), Part III. The Canadian Entomologist, **93**(Suppl. 21): 207–368.

Heinrich, G.H. 1961*b*. Synopsis of Nearctic Ichneumoninae Stenopneusticae with particular reference to the northeastern region (Hymenoptera), Part IV. The Canadian Entomologist, **93**(Suppl. 23): 369–506.
Heinrich, G.H. 1962*a*. Synopsis of Nearctic Ichneumoninae Stenopneusticae with particular reference to the northeastern region (Hymenoptera), Part V. The Canadian Entomologist, **94**(Suppl. 26): 507–672.
Heinrich, G.H. 1962*b*. Synopsis of Nearctic Ichneumoninae Stenopneusticae with particular reference to the northeastern region (Hymenoptera), Part VI. The Canadian Entomologist, **94**(Suppl. 27): 675–802.
Heinrich, G.H. 1962*c*. Synopsis of Nearctic Ichneumoninae Stenopneusticae with particular reference to the northeastern region (Hymenoptera), Part VII. The Canadian Entomologist, **94**(Suppl. 29): 803–886.
Heinrich, G.H. 1968. Contributions to the knowledge of North America Ichneumoninae. Naturaliste Canadien, **95:** 703–722.
Heraty, J., Ronquist, F., Carpenter, J.M., Hawks, D., Schulmeister, S., Dowling, A.P., Murray, D., Munro, J., Weeler, W.C., Schiff, N., and Sharkey, M. 2011. Evolution of the hymenopteran megaradiation. Molecular Phylogenetics and Evolution, **60:** 73–88.
Hobbs, G.A., Nummi, W.O., and Virostek, J.F. 1959. History of the alfalfa weevil, *Hypera postica* (Gyll.) (Coleoptera: Curculionidae), in Alberta. The Canadian Entomologist, **91**: 562–565.
Holmes, N.D. 1953. Note on *Scambus detritus* (Holg.) (Hymenoptera, Ichneumonidae) a new parasite of the wheat sawfly *Cephus cinctus* Nort. The Canadian Entomologist, **85:** 339.
Hopper, H.P. 1939. A synoptical revision of the tribe Trogini of the United States and Canada. Transactions of the American Entomological Society, **65:** 307–346.
Horstmann, K. 1987. Bemerkungen zur Systematik einiger Gattungen der Campopleginae III (Hymenoptera, Ichneumonidae). Mitteilungen Munchener Entomologischen Gesellschaft, **76:** 143–164.
Horstmann, K. 2008. Revision der europaischen Arten von *Ephialtes* Gravenhorst, 1829, mit Bemerkungen zu weiteren holarktischen Arten (Hymenoptera, Ichneumonidae, Pimplinae). Entomofauna, **29:** 145–165.
Horstmann, K. 2010. Revisions of Nearctic Tersilochinae II. Genera *Allophrys* Förster, *Barycnemis* Förster, *Ctenophion* gen. nov., *Sathropterus* Förster, *Spinolochus* Horstmann and *Stethantyx* Townes (Hymenoptera, Ichneumonidae). Spixiana, **33:** 73–109.
Horstmann, K. 2012. Revisions of Nearctic Tersilochinae III. Genera *Aneuclis* Förster and *Diaparsis* Förster (Hymenoptera, Ichneumonidae). Spixiana, **35:** 117–142.
King, K.M., and Atkinson, N.J. 1928. The biological control factors of the immature stages of *Euxoa ochrogaster* Gn. (Lepidoptera: Phalaenidae) in Saskatchewan. Annals of the Entomological Society of America, **21:** 167–188.
Klopfstein, S., Quicke, D.L.J., Kropf, C., and Frick, H. 2011. Molecular and morphological phylogeny of Diplazontinae (Hymenoptera, Ichneumonidae). Zoologica Scripta, **40:** 379–402.
Langor, D.W., Digweed, S.C., Williams, D.J.M., Spence, J.R., and Saunders, C. 2000. Establishment and spread of two introduced parasitoids (Ichneumonidae) of the birch leafminer, *Fenusa pusilla* (Tenthredinidae). Biocontrol, **45:** 415–423.
Leblanc, L. 1989. A taxonomic revision of the Nearctic species of *Himerta* (Hymenoptera: Ichneumonidae). Contributions of the American Entomological Institute, **25:** 1–76.
Leblanc, L. 1999. The Nearctic species of *Protarchus* Foerster (Hymenoptera: Ichneumonidae: Ctenopelmatinae). Journal of Hymenoptera Research, **8:** 251–267.
Lee, J.W. 1991. A revision of the genus *Cidaphus* (Hymenoptera: Ichneumonidae: Mesochorinae). Contributions of the American Entomological Institute, **26:** 1–48.
Loan, C.C. 1981. North American species of *Phytodietus* and *Neuchorus* (Hymenoptera: Ichneumonidae: Tryphoninae). Naturaliste Canadien, **108:** 331–470.
Luhman, J. 1986. Revision of the Nearctic *Glyphicnemis* Foerster (Hymenoptera: Ichneumonidae, Gelinae). Insecta Mundi, **1:** 133–142.
Luhman, J. 1990. A taxonomic revision of Nearctic *Endasys*. University of California Publications in Entomology, **109:** 1–185.
MacNay, C.G. 1954. Summary of important insect infestations, occurrences and damage in Canada in 1954. Reports of the Entomological Society of Ontario, **1954:** 61–91.
Mason, W.R.M. 1955. A revision of the Nearctic Cteniscini (Hymenoptera: Ichneumonidae) I. *Eudiaborus* Kerrich and a new genus. Canadian Journal of Zoology, **33:** 18–73.
Mason, W.R.M. 1956. A revision of the Nearctic Cteniscini (Hymenoptera: Ichneumonidae) II. *Acrotomus* Hlgr. and *Smicroplectrus* Thom. Canadian Journal of Zoology, **34:** 120–151.
Mason, W.R.M. 1959. A revision of the Nearctic Exenterini (Hymenoptera: Ichneumonidae) III. *Exyston* Schiødte. Canadian Journal of Zoology, **37:** 1067–1115.
Mason, W.R.M. 1968. New Canadian Cryptinae (Ichneumonidae: Hymenoptera). The Canadian Entomologist, **100:** 17–23.

McKay, T., and Galloway, T.D. 1999. Survey and release of parasitoids (Hymenoptera) attacking house and stable flies (Diptera: Muscidae) in dairy operations. The Canadian Entomologist, **131:** 743–756.

McKay, T., and Galloway, T.D. 2000. Biology of *Phygadeuon fumator* Gravenhorst (Hymenoptera: Ichneumonidae), a pupal parasitoid of house and stable flies (Diptera: Muscidae) in Manitoba. Proceedings of the Entomological Society of Manitoba, **55:** 17–27.

Mills, N.J. 1992. Parasitoid guilds, life-styles, and host ranges in the parasitoid complexes of tortricoid hosts (Lepidoptera: Tortricoidea). Environmental Entomology, **21:** 230–239.

Mitchell, R.T. 1950. The genus *Acroricnus* in America (Hymenoptera, Ichneumonidae). Annals of the Entomological Society of America, **43:** 249–261.

Mitchell, R.T. 1985. New distribution and host records of Canadian *Trogus* (Hymenoptera: Ichneumonidae). Maryland Entomologist, **2:** 62.

Norton, E. 1863. Catalogue of our species of *Ophion*, *Anomalon*, *Paniscus* and *Campoplex*. Proceedings of the Entomological Society of Philadelphia, **1:** 357–368.

Olfert, O.O., Doane, J.F., Carl, K., Erlandson, M.A., and Goettel, M.S. 2002. *Diuraphis noxia* (Kurdjumov), Russian wheat aphid (Homoptera: Aphididae). *In* Biological Control Programmes in Canada, 1981–2000. *Edited by* P.G. Mason and J.T. Huber. CABI Publishing, New York. pp. 110–114.

Parry, D. 1995. Larval and pupal parasitism of the forest tent caterpillar, *Malacosoma disstria* Hubner (Lepidoptera: Lasiocampidae), in Alberta, Canada. The Canadian Entomologist, **127:** 877–893.

Peterson, L.O.T. 1958. The box elder twig borer, *Proteoteras willingana* (Kearfott), (Lepidoptera: Olethreutide). The Canadian Entomologist, **90:** 639–646.

Prentice, R.M. 1955. The life history and some aspects of the ecology of the large aspen Tortrix, *Choristoneura conflictana* (Walker) (n.comb) (Lepidoptera: Tortricidae). The Canadian Entomologist, **87:** 461–473.

Putnam, L.G. 1973. Effects of the larval parasites *Diadegma insularis* and *Microplitis plutellae* on the abundance of diamondback moth Saskatchewan rape and mustard crops. Canadian Journal of Plant Science, **53:** 911–914.

Putnam, L.G. 1982. Sentinel colonies of diamond-back larvae for early season detection. Blue Jay, **40:** 181–183.

Quicke, D.L.J., Laurenne, N.M., Fitton, M.G., and Broad, G.R. 2009. A thousand and one wasps: a 28S rDNA and morphological phylogeny of the Ichneumonidae (Insecta: Hymenoptera) with an investigation into alignment parameter space and elision. Journal of Natural History, **43:** 1305–1421.

Rasnitsyn, A.P. 1988. An outline of evolution of the hymenopterous insects. Oriental Insects, **22:** 115–145.

Reschikov, A.V., Soper, A., and Van Driesche, R.G. 2010. Review and key to Nearctic *Lathrolestes* Förster (Hymenoptera: Ichneumonidae), with special reference to species attacking leaf mining tenthredinid sawflies in *Betula* Linnaeus (Betulaceae). Zootaxa, **2614:** 1–17.

Sanborne, M. 1984. A revision of the world species of *Sinophorus* (Ichneumonidae). Memoirs of the American Entomological Institute, **38:** 1–403.

Sanborne, M. 1986*a*. A revision of the Nearctic species of *Cymodusa* Holmgren (Hymenoptera: Ichneumonidae). Contributions to the American Entomological Institute, **22:** 1–26.

Sanborne, M. 1986*b*. A revision of the Nearctic species of *Cymodusopsis* Viereck (Hymenoptera: Ichneumonidae). Contributions to the American Entomological Institute, **22:** 1–24.

Sanborne, M. 1986*c*. Revision of the Nearctic species of *Xylophylax* Kriechbaumer (Hymenoptera: Ichneumonidae). Contributions of the American Entomological Institute, **22:** 1–44.

Sarfraz, R.M., Dosdall, L.M., Blake, A.J., and Keddie, B.A. 2010. Leaf nutrient levels and the spatio-temporal distributions of *Plutella xylostella* and its larval parasitoids *Diadegma insulare* and *Microplitis plutellae* in canola. BioControl, **55:** 229–244.

Schaaf, A.C. 1972. The parasitoid complex of *Euxoa ochrogaster* (Guenee) (Lepidoptera: Noctuidae). Quaestiones Entomologicae, **8:** 81–120.

Shanower, T.G., and Hoelmer, K.A. 2004. Biological control of wheat stem sawflies: past and future. Journal of Agricultural and Urban Entomology, **21:** 197–221.

Sharanowski, B.J., Robbertse, B., Walker, J., Voss, S.R., Yoder, R., Spatafora, J., and Sharkey, M.J. 2010. Expressed sequence tags reveal Proctotrupomorpha (minus Chalcidoidea) as sister to Aculeata (Hymenoptera: Insecta). Molecular Phylogenetics and Evolution, **57:** 101–112.

Sharkey, M., Arthur, A., Bisdee, G., Yoshimoto, C., and Barron, J. 1987. The parasitic Hymenoptera associated with sunflower (*Helianthus* spp.) in mid-western Canada. The Canadian Entomologist, **119:** 611–628.

Sharkey, M.J., Carpenter, J.M., Vilhelmsen, L., Heraty, J., Liljeblad, J., Dowling, A.P.G., Schulmeister, S., Murray, D., Deans, A.R., Ronquist, F., Krogmann, L., and Wheeler, W.C. 2012. Phylogenetic relationships among superfamilies of Hymenoptera. Cladistics, **28:** 80–112.

Sharkey, M.J., and Wahl, D.B. 1992. Cladistics of the Ichneumonoidea (Hymenoptera). Journal Hymenoptera Research, **1:** 15–24.

Shaw, M.R. 2004. *Notes on the biology of Lycorina triangulifera Holmgren (Hymenoptera: Ichneumonidae: Lycorininae)*. Journal of Hymenoptera Research, **13:** 302–308.
Shorthouse, J.D. 2010. Ecoregions of Canada's prairie grasslands. *In* Arthropods of Canadian grasslands, Vol. 1: Ecology and Interactions in Grassland Habitats. *Edited by* J.D. Shorthouse and K.D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 53–81.
Smith, C.W. 1931. Colonization in Canada of *Collyria calcitrator* (Hym. Ichn.), a parasite of the wheat stem sawfly. Bulletin of Entomological Research, **22:** 547–550.
Smith, R.W. 1961. Notes on parasites of the wheat stem sawfly, *Cephus pygmaeus* (L.) (Hymenoptera: Cephidae) from Continental Europe. The Canadian Entomologist, **91:** 697–700.
Stehr, F.W., and Cook, E.F. 1968. A revision of the genus *Malacosoma* Hübner in North America (Lepidoptera: Lasiocampidae): systematics, biology, immatures, and parasites. Bulletin of the United States National Museum, **276:** 1–321.
Still, G.N., and Wong, H.R. 1973. Life history and habits of a leaf miner, *Cameraria macrocarpae*, on bur oak in Manitoba (Lepidoptera: Gracillariidae). The Canadian Entomologist, **105:** 239–244.
Strickland, E.H. 1946. An annotated list of the Ichneumonoidea of Alberta. The Canadian Entomologist, **78:** 36–46.
Strickland, E.H. 1952. Additions to the list of Ichneumonoidea from Alberta. The Canadian Entomologist, **84:** 118–122.
Swailes, G.E. 1960. Influence of soil and moisture on the beet webworm, *Loxostege sticticalis*, and its parasites. Journal of Economic Entomology, **53:** 585–586.
Swift, H.H. 1946. North American species of the genus *Hoplismenus*. Annals of the Entomological Society of America, **39:** 397–410.
Tigner, T.C. 1969. Three new species and a key for the genus *Callidora* (Hymenoptera: Icheumonidae). Michigan Entomologist, **2:** 36–39.
Townes, H.K. 1938. The Nearctic species of *Netelia* (*Paniscus*) of authors and a revision of genera of Neteliini (Hymenoptera, Ichneumonidae). Lloydia, **1:** 168–231.
Townes, H.K. 1963. A revision of *Demopheles* (Hymenoptera: Ichneumonidae). Proceedings of the Entomological Society of Washington, **65:** 47–50.
Townes, H.K. 1969. The genera of Ichneumonidae, part 1. Ephialtinae, Tryphoninae, Labiinae, Adelognathinae, Xoridinae, Agriotypinae. Memoirs of the American Entomological Institute, **11:** 1–300.
Townes, H.K. 1970*a*. The genera of Ichneumonidae, part 2. Gelinae. Memoirs of the American Entomological Institute, **12:** 1–537.
Townes, H.K. 1970*b*. The genera of Ichneumonidae, part 3. Lycorininae, Banchinae, Scolobatinae, Porizontinae. Memoirs of the American Entomological Institute, **13:** 1–307.
Townes, H.K. 1971. The genera of Ichneumonidae, part 4. Cremastinae, Phrudinae, Tersilochinae, Ophioninae, Mesochorinae, Metopiinae, Anomalinae, Acaenitinae, Microleptinae, Orthopelmatinae, Collyriinae, Orthocentrinae, Diplazontinae. Memoirs of the American Entomological Institute, **17:** 1–372.
Townes, H.K. 1983. Revisions of twenty genera of Gelini (Ichneumonidae). Memoirs of the American Entomological Institute, **35:** 1–281.
Townes, H.K., and Gupta, V.K. 1962. Ichneumon-flies of America north of Mexico: 4. Subfamily Gelinae, tribe Hemigasterini. Memoirs of the American Entomological Institute, **2:** 1–305.
Townes, H.K., Gupta, V.K., and Townes, M. 1992. Ichneumon-flies of America North of Mexico: 11. Subfamily Tryphoninae, Tribes Oedemopsini, Tryphonini, and Idiogrammatini. Memoirs of the American Entomological Institute, **50:** 1–296.
Townes, H.K., and Townes, M. 1949*a*. A revision of the genera and of the American species of Tryphoninae Part I. Annals of the Entomological Society of America, **42:** 321–395.
Townes, H.K., and Townes, M. 1949*b*. A revision of the genera and of the American spp of Tryphoninae Part II. Annals of the Entomological Society of America, **42:** 397–447.
Townes, H.K., and Townes, M. 1959. Ichneumon-flies of America north of Mexico: 1. Subfamily Metopiinae. United States National Museum Bulletin, **216** (1): 1–318.
Townes, H.K., and Townes, M. 1960. Ichneumon-flies of America north of Mexico: 2. Subfamilies Ephialtinae, Xoridinae, and Acaenitinae. Bulletin of the United States National Museum Bulletin, **216** (2): 1–676.
Townes, H.K., and Townes, M. 1962. Ichneumon-flies of America north of Mexico: 3. Subfamily Gelinae, tribe Mesostenini. United States National Museum Bulletin, **216** (3): 1–602.
Townes, H., and Townes, M. 1978. Ichneumon-flies of America north of Mexico: 7. Subfamily Banchinae, tribes Lissonotini and Banchini. Memoirs of the American Entomological Institute, **26:** 1–614.
Treherne, R.C. 1916. A preliminary list of parasitic insects known to occur in Canada. Reports of the Entomological Society of Ontario, **46:** 178–193.

Turnock, W.J. 1988. Density, parasitism and disease incidence of larvae of the bertha armyworm, *Mamestra configurata* Walker (Lepidoptera: Noctuidae), in Manitoba 1973–1986. The Canadian Entomologist, **120:** 401–413.

Turnock, W.J., and Bilodeau, R.J. 1984. Survival of pupae of *Mamestra configurata* (Lepidoptera: Noctuidae) and two of its parasites in untilled and tilled soil. The Canadian Entomologist, **116:** 257–267.

Viereck, H.L. 1925–1926*a*. A preliminary revision of the Campopleginae in the Canadian National Collection, Ottawa. The Canadian Entomologist, **57:** 176–181, 198–204, 223–228, 296–303; **58:** 2–8, 30–38, 71–78, 122–130, 143–149, 176–182, 196–201, 219–225, 257–260, 276–283.

Viereck, H.L. 1925–1926*b*. A preliminary revision of some Charopsinae, a subfamily of Ichneumonoidea or Ichneumon flies. Proceedings and Transactions of the Royal Society of Canada, **19:** 259–273; **20:** 173–186.

Viereck, H.L. 1926. The entomological record 1925, Hymenoptera. Reports of the Entomological Society of Ontario, **56:** 104–105.

Wahl, D.B. 1987. A revision of *Venturia* north of Central America (Hymenoptera: Ichneumonidae). University of Kansas Science Bulletin, **53:** 275–356.

Wahl, D.B. 1993. Ichneumonidae. *In* Hymenoptera of the World: An Identification Guide to Families. *Edited by* H. Goulet and J.T. Huber. Agriculture Canada, Ottawa, Ontario. pp. 395–448.

Wahl, D.B., Shanower, T.G., and Hoelmer, K.A. 2007. A new species of *Collyria* Schiodte (Hymenoptera: Ichneumonidae: Collyriinae), a parasitoid of *Cephus fumipennis* (Hymenoptera: Cephidae) in China, and potential biological control agent for *Cephus cinctus* in North America. Journal of the Kansas Entomological Society, **80:** 43–50.

Wahl, D.B., and Sime, K.R. 2006. A revision of the genus *Trogus* (Hymenoptera: Ichneumonidae, Ichneumoninae). Systematic Entomology, **31:** 584–610.

Walkley, L.M. 1956. A new Tersilochine parasite of the rose curculio (Hymenoptera: Ichneumonidae). Entomological News, **67:** 153–156.

Walley, G.S. 1927. New species of *Sagaritis* with a key to the genus (Ichneumonidae, Hymen.). The Canadian Entomologist, **59:** 227–234.

Walley, G.S. 1940*a*. A revision of the Ichneumon-flies of the genus *Campoplegidea* occurring in America north of Mexico. Scientific Agriculture, **20:** 647–734.

Walley, G.S. 1940*b*. A synopsis of the North American species of *Syndipnus* (Hymen., Ichneumonidae). The Canadian Entomologist, **72:** 135–145.

Walley, G.S. 1941. Some new and little known Canadian Ichneumonidae (Hymenoptera). The Canadian Entomologist, **73:** 164–170.

Walley, G.S. 1944. Campoplegine notes and descriptions (Hymenoptera, Ichneumonidae). The Canadian Entomologist, **76:** 157–161.

Walley, G.S. 1947. The genus *Casinaria* Holmgren in America north of Mexico (Hymen., Ichneumonidae). Scientific Agriculture, **27:** 364–395.

Walley, G.S. 1966. A review of the Nearctic genus *Bothromus* Townes and Townes, with a description of a new species (Hymenoptera: Ichneumonidae). The Canadian Entomologist, **98:** 1272–1275.

Walley, G.S. 1967. Nearctic species of the *Diadegma stenosomus* complex (Hymenoptera: Ichneumonidae). The Canadian Entomologist, **99:** 925–943.

Walley, G.S. 1969. A synopsis of the Nearctic species of the *onitis* group of the genus *Trieces*. The Canadian Entomologist, **101:** 1092–1106.

Walley, G.S. 1970. A new Nearctic *Campoletis* parasite of Pyralidae (Hymenoptera: Ichneumonidae). The Canadian Entomologist, **102:** 1528–1530.

Walley, G.S. 1977. Revision of the new world genus *Campoctonus* Viereck (Hymenoptera: Ichneumonide; Campopleginae). Annals of the Entomological Society of America, **70:** 423–435.

Wong, H.R. 1955. Larvae of the Nearctic species of *Anoplonyx* (Tenthredinidae, Hymenoptera). The Canadian Entomologist, **87:** 224–227.

Wylie, H.G. 1977. Insect parasites reared from bertha armyworm, *Mamestra configurata* Walker, collected from artificial field populations near Winnipeg, Manitoba. Manitoba Entomologist, **11:** 50–55.

Wylie, H.G., and Ayre, G.L. 1979. Hosts of *Banchus flavescens* (Hymenoptera: Ichneumonidae) and *Athyrcia cinerea* (Diptera: Tachinidae) in Manitoba. The Canadian Entomologist, **111:** 747–748.

Wylie, H.G., and Bucher, G.E. 1977. The bertha armyworm, *Mamestra configurata* (Lepidoptera: Noctuidae). Mortality of immature stages on the rape crop, 1972–1975. The Canadian Entomologist, **109:** 823–837.

Wylie, H.G., and Loan, C.C. 1984. Five Nearctic and one introduced Euphorine species (Hymenoptera: Braconidae) that parasitize adults of crucifer-infesting flea beetles. The Canadian Entomologist, **116:** 235–246.

Yu, D.S.K., van Achterberg, C., and Horstmann, K. 2012. Taxapad 2012, Ichneumonoidea 2011 [database on USB]. Available from www.ichneumonoidea.name/taxapadmain.php [accessed 20 March 20 2014].

Chapter 10
Annotated Checklist of Braconidae (Hymenoptera) in the Canadian Prairies Ecozone

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Abstract. With more than 19,000 described species worldwide, parasitic wasps in the family Braconidae are the second largest group of Hymenoptera next to its sister lineage, Ichneumonidae. Despite their abundance and economic importance as potential biological control agents of forest and agricultural pests, little is known about the biodiversity of braconids in the Prairies Ecozone of Canada. The checklist of Braconidae was compiled by cross-referencing specimen localities with published records of braconid species found in the Prairie Provinces and supplemented with databased specimens from the Wallis-Roughley Museum of Entomology at the University of Manitoba. This checklist consists of 251 species, representing 22 different subfamilies, and includes14 new species records. Braconids in subfamilies such as Microgastrinae, Agathidinae, and Aphidiinae have a relatively large number of known species because of past research attention. Other subfamilies with fewer known species are undoubtedly more speciose than currently known, but are more difficult to identify because of a lack of taxonomic research and resources. It is hoped that this checklist serves as a baseline that will facilitate future biodiversity studies, conservation programs, and biological control research on Braconidae in the Prairies Ecozone of Canada.

Résumé. Comptant plus de 19 000 espèces décrites à travers le monde, les guêpes parasites de la famille des Braconidae forment le deuxième groupe d'hyménoptères le plus important après sa lignée sœur, les Ichneumonidae. En dépit de leur abondance et de leur importance économique comme agents possibles de lutte biologique contre les ravageurs des forêts et des cultures, on connaît peu de choses sur leur biodiversité dans l'écozone des prairies du Canada. La liste des Braconidae a été établie par recoupements des données sur les lieux de capture et des mentions publiées d'espèces recensées dans les provinces des Prairies, ainsi qu'à partir d'informations tirées des bases de données du musée d'entomologie Wallis-Roughley de l'Université du Manitoba. Cette liste contient 251 espèces réparties en 22 sous-familles, et compte 14 nouvelles mentions. Certaines sous-familles — par exemple, Microgastrinae, Agathidinae et Aphidiinae — renferment un nombre relativement élevé d'espèces connues parce qu'elles ont attiré l'attention des chercheurs par le passé. D'autres sous-familles moins connues sont sans doute plus riches en espèces qu'il n'y parait, mais les lacunes de la recherche et des ressources taxonomiques compliquent l'identification des espèces. Cette liste devrait servir de référence et faciliter à l'avenir les études sur la biodiversité, les programmes de conservation et la recherche sur la lutte biologique axés sur les Braconidae de l'écozone des prairies au Canada.

Introduction

Braconidae (Hymenoptera) is one of the most fascinating, diverse, and beneficial groups of insects. Braconids are parasitic wasps (also called parasitoids) that are valued for their ability to kill pest insects, especially forest pests and insects that cause economic damage to crops. However, they are underused as biocontrol agents, as many species are understudied or simply unknown to science. The sheer diversity of Braconidae poses challenges for researchers to implement taxonomic, ecological, or biodiversity studies. Currently, there are

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more than 19,000 described species (Yu *et al.* 2011), making Braconidae the second largest family in Hymenoptera next to its sister lineage, Ichneumonidae. Approximately 2,000 species have been described since 2005. However, the known species likely represent only 30–50% of the actual number of species on Earth (Jones *et al.* 2009), which is unfortunate given their great value as biocontrol agents.

Members of Braconidae have a wide range of parasitic lifestyles and a few rare species are herbivorous (Austin and Dangerfield 1998). Generally, parasitic braconids are either ectoparasitic, feeding on the outside of their host, or endoparasitic, feeding from within their host. Braconids may cause permanent paralysis of the host upon oviposition, and thus the host can no longer continue development (idiobiosis) (Askew and Shaw 1986; Gupta 1988; Wharton 1993). Alternatively, some parasitoids allow their hosts to continue development throughout much of the parasitoid's life (koinobiosis) (Askew and Shaw 1986). Many braconids can be solitary, with one individual using one host. However, others are gregarious, as multiple parasitoids from the same mother utilize the same host (Clausen 1940). Polyembryony (more than one embryo from a single egg) also occurs among some braconids, although it is relatively rare (Lu *et al.* 2006).

Parasitoids can also be described by the stage of the host they attack (i.e., the host stage in which the reproductive female parasitoid will lay her eggs) and the stage in which the host is killed (by the offspring of the reproductive female) (Askew and Shaw 1986; Wharton 1993). For example, an egg–larval parasitoid will lay eggs within the egg of her host, and her offspring will kill the host in the larval stage. Alternatively, a pupal parasitoid will attack the pupal stage, and her offspring will also kill the host in the same stage. Relative to their sister lineage Ichneumonidae, many species of Braconidae have adaptations for attacking early life stages of their hosts (Gauld 1988). This has important implications for pest management, as the most effective parasitoids for biocontrol are those that kill their hosts prior to the stage when the host causes economic damage (to crops, for example) (Austin and Dowton 2000).

The potential of Braconidae for controlling pest insects in agricultural areas makes them an important group to assess in the Prairies Ecozone of Canada, where the native landscape has been largely converted to agricultural farmland. Control of insect pests that damage crops is crucial to producers, especially as crop prices continue to rise (Agriculture and Agri-Food Canada 2013). Knowing which species of Braconidae are present in this region, and their potential as biocontrol agents, would be valuable in the farming heartland of Canada. Conservation of remnant native prairie, by protecting habitats for endemic species and promoting a more sustainable ecosystem for adjacent lands with intensive agriculture, is also important for preserving these species (Samson and Knopf 1996; Macfadyen *et al.* 2012). We cannot determine whether species are under threat of extinction or extirpation unless we know which species are present in the first place, and thus species checklists are exceptionally useful tools for tracking biodiversity over time (Mace 2004). However, our knowledge of braconid wasps in the Prairies Ecozone is limited for several reasons. First, there has been a lack of taxonomic and biodiversity studies on braconid wasps in this region. Second, while excellent generic keys are available (e.g., Wharton *et al.* 1997), there are few species-level identification keys for most taxa. Finally, there are few taxonomic experts in Canada working on Braconidae, which poses challenges for accurate braconid identification for ecological, biocontrol, or biodiversity studies.

The purpose of this chapter is to provide an annotated checklist of the Braconidae in the Prairies Ecozone of Canada. This checklist will serve as a starting point for future studies on Braconidae in this region, whether taxonomic, ecological, conservation, or biocontrol in nature.

Methods for Compiling the Checklist

The annotated checklist of Braconidae (Table 1) found in the Canadian Prairies Ecozone (as defined in Shorthouse 2010) was generated from published records of Braconidae from Alberta, Saskatchewan, and Manitoba in the Taxapad database of Ichneumonoidea (Yu *et al.* 2011). Of the 956 braconid species recorded in Taxapad from Canada (Yu *et al.* 2011), 187 were from Alberta, 103 from Saskatchewan, and 139 from Manitoba, totalling 313 different species. The locality data for each of the 313 species recorded from these provinces were then cross-referenced with the geographical region of the Prairies Ecozone (Shorthouse 2010) to exclude records from other ecozones. We used relatively relaxed borders, as many of the ecoregions within the Prairies Ecozone have been altered as a result of agricultural intensification. Records from Waterton Lakes National Park, which borders the Prairies Ecozone, were not included in the final checklist. Additional records were obtained from Batulla and Robinson (1984) and Wylie *et al.* (2005), as these publications were not included in the reference list in Taxapad. When the exact localities of specimens were unknown (i.e., if only the province was listed), these records were included in the checklist (Table 1), but should be considered as tentative records for the Prairies Ecozone. Unpublished new records were also added from databased specimens from the Wallis-Roughley Museum of Entomology (JBWM). The identification of most species that represent new records was confirmed by BJS and these species are listed in bold type in Table 1. Locality information was also added to the checklist from JBWM specimens if they were from the Prairies Ecozone and the published record listed only a provincial locality (Table 1).

The locality information for all new provincial and Canadian records is listed in Table 2. Labels were recorded verbatim to accurately capture the collector's meaning, style, and scientific notation and to avoid unnecessary interpretation. Individual labels were not included if they were specific to an unpublished experiment, for example, a label with just a number on it that refers to a collection event or rearing experiment. All museum bar codes are provided (Table 2), as these data will be uploaded to the Canadensys data repository (http://data.canadensys.net/) in the future.

Annotated Checklist of Braconidae in the Prairies Ecozone

Introductory Comments

The checklist of Braconidae in the Canadian Prairies Ecozone consists of 251 species (Table 1).These species represent 22 different subfamilies of the 42 recognized by Sharanowski *et al.* (2011). Most of the subfamilies not represented in this region include those that are not recorded from the Nearctic (e.g., Amicrocentrinae) or subfamilies that are rarely collected (e.g., Meteorideinae). Although no members of Hormiinae are included in the checklist, *Chremylus* sp. (putatively *C. elaphus*) has been collected in Spruce Woods Provincial Park in Manitoba (BJS, unpublished data), and it is likely that ongoing collections will reveal additional members of this commonly collected subfamily. Surprisingly, members of Helconinae (*sensu* Sharanowski *et al.* 2011) are not included in the checklist, although many species of their wood-boring beetle hosts are frequently collected in the ecozone. *Wroughtonia* spp. have been collected in Whiteshell Provincial Park in the Boreal Shield Ecozone in Manitoba (BJS, unpublished data), although rarely, and not within the Prairies Ecozone.

Table 1. Annotated checklist of Braconidae (Hymenoptera) in the Canadian Prairies Ecozone. Species are listed alphabetically under their containing subfamily. New records determined from specimens in the Wallis-Roughley Museum of Entomology are indicated by an asterisk (*) and listed in bold type; these have the museum acronym, JBWM, listed as the only reference for the locality. If the identity of the species could not be confidently confirmed using keys or species descriptions, the species was included in the final list and has an asterisk preceding the species binomial, but is not listed in bold type. New JBWM localities are indicated by a period separating the published localities. Abbreviations: AB = Alberta; MB = Manitoba; SK = Saskatchewan; NP = national park; PP = provincial park.

Species	Locality and Locality Reference
Agathidinae	
1 *Agathis gibbosa* (Say, 1836)	Edmonton, AB (Strickland 1946)
2 *Agathis tibiator* Provancher, 1880	Vermilion, AB (Strickland 1946)
3 *Bassus binominatus* (Muesebeck, 1958)	MB; SK (Wong 1972)
4 *Bassus buttricki* Viereck, 1917	AB (Sharkey *et al.* 1987)
5 *Bassus dimidiator* (Nees, 1834)	Edmonton, AB (Strickland 1952)
6 *Bassus discolor* (Cresson, 1873)	Edmonton, AB (Strickland 1946)
7 *Bassus nigripes* (Cresson, 1865)	MB (Sharkey *et al.* 1987)
8 *Crassomicrodus apicipennis* Muesebeck, 1927	Lethbridge, AB (Strickland 1946)
9 *Cremnops ashmeadi* (Morrison, 1917)	AB (Marsh 1961)
10 *Cremnops comstocki* (Morrison, 1917)	Edmonton, AB (Strickland 1946)
11 *Cremnops montrealensis* (Morrison, 1917)	SK (Marsh 1961)
12 *Cremnops nigrosternum* (Morrison, 1917)	SK (Marsh 1961)
13 *Cremnops vulgaris* (Cresson, 1865)	Edmonton, AB (Strickland 1946)
14 *Earinus limitaris* (Say, 1835)	Edmonton, AB (Strickland 1946)
15 *Therophilus agilis* (Cresson, 1873)	Drumheller, AB (Strickland 1952)
16 *Therophilus arthurellus* (Sharkey, 1985)	Drinkwater, SK (Sharkey 1985)
17 *Therophilus perforator* (Provancher, 1880)	Athabasca, AB (Strickland 1946)
Alysiinae	
18 *Alysia frigida* Haliday, 1838	Elkwater Lake, AB (Wharton 1986)
19 *Alysia lucia* Haliday, 1838	Scoutlake, SK (Wharton 1986)
20 *Alysia lucicola* Haliday, 1838	Elkwater Lake, AB (Wharton 1986)
21 *Alysia subaperta* Thomson, 1895	Kananaskis, AB (Wharton 1988*a*)
22 *Alysia truncator* (Nees, 1812)	Elkwater Lake, AB (Wharton 1986)
23 *Anisocyrta curticubita* Wharton, 1980	Elkwater Lake, AB (Wharton 1980)
24 **Aphaereta minuta* (Nees,1811)	Carman, MB JBWM
25 *_Aphaereta pallipes_ (Say, 1829)	**Glenlea, MB JBWM**
26 *Coelinius hopkinsii* (Ashmead, 1893)	MB (Muesebeck 1967)
27 *Cratospila neocirce* Wharton, 1980	Elkwater Lake, AB; Shilo, MB (Wharton 1980)
28 *Idiasta maritima* (Haliday, 1838)	Onefour, AB (Wharton 1980)
29 *Phaenocarpa puberae* Fischer, 1974	Cypress Hills, SK (Fischer 1974)
Aphidiinae	
30 *Acanthocaudus tissoti* Smith, 1944	St Ambroise, MB (Batulla and Robinson 1984)
31 *Adialytus salicaphis* (Fitch, 1855)	Sandilands PP, MB (Batulla and Robinson (1984)
32 **Aphidius avenaphis* (Fitch, 1861)	SK. Sandilands, MB (Olfert *et al.* 2002). JBWM
33 *Aphidius ervi* Haliday, 1834	Glenlea, MB (Wylie *et al.* (2005)

	Species	Locality and Locality Reference
34	*Aphidius matricariae* Haliday, 1834	Glenlea, MB; SK (Batulla and Robinson 1984; Olfert *et al.* 2002)
35	*Aphidius nigripes* Ashmead, 1901	Edmonton, AB (Strickland 1952)
36	*Aphidius obscuripes* Ashmead, 1889	Glenlea, MB (Batulla and Robinson 1984)
37	*Aphidius pisivorus* Smith, 1941	Edmonton, AB (Strickland 1952)
38	*Aphidius ribis* Haliday, 1834	Hansen Creek, MB (Batulla and Robinson 1984)
39	*Aphidius rosae* Haliday, 1833	Morden, MB (Batulla and Robinson 1984)
40	*Aphidius smithi* Sharma and Subba Rao, 1959	Brooks, AB (Harper 1976)
41	***Diaeretiella rapae* (McIntosh, 1855)**	**Lethbridge, AB (Strickland, 1946). Winnipeg, MB JBWM**
42	*Ephedrus incompletus* (Provancher, 1886)	Sandilands PP, MB (Batulla and Robinson 1984)
43	*Lysiphlebus testaceipes* (Cresson, 1880)	Edmonton, AB (Strickland 1952)
44	*Pauesia californica* (Ashmead, 1889)	AB (Muesebeck 1967)
45	*Praon artemisaphis* Smith, 1944	Winnipeg, MB (Batulla and Robinson 1984)
46	*Praon carinum* Johnson, 1987	Spruce Woods PP, MB (Johnson 1987)
47	*Praon exsoletum* (Nees, 1811)	Glenlea, MB (Wylie 1981)
48	*Praon occidentale* Baker, 1909	Winnipeg, Glenlea, St. Agathe, MB (Wylie *et al.* 2005)
49	*Praon pequodorum* Viereck, 1917	Winnipeg, Glenlea, Morden, Morris, Myrtle, St. Adolphe, St. Agathe, MB (Wylie *et al.* 2005)
50	*Praon simulans* (Provancher, 1886)	Cypress Hills, AB (Strickland 1952)
Brachistinae		
51	*Blacus asaphus* van Achterberg, 1976	Lethbridge, AB (van Achterberg 1976)
52	*Blacus cognatus* van Achterberg, 1976	Indian Head, SK (van Achterberg 1976)
53	*Blacus defectuosus* Provancher, 1886	SK (van Achterberg 1976)
54	*Blacus masoni* van Achterberg, 1976	Edmonton, AB (van Achterberg 1976)
55	*Blacus ruficornis* (Nees,1811)	AB, SK, MB (van Achterberg 1976)
56	*Blacus rufipes* (Ashmead,1889)	SK (van Achterberg 1988)
57	*Blacus striatus* van Achterberg, 1976	Saskatoon, SK (van Achterberg 1976)
58	*Triaspis magnafoveae* Martin, 1956	Edmonton, AB (Martin 1956)
Braconinae		
59	*Atanycolus charus* (Riley, 1875)	Edmonton, AB (Strickland 1946)
60	*Bracon cephi* (Gahan, 1918)	Drumheller, AB (Strickland 1946; Nelson and Farstad 1953)
61	*Bracon connecticutorum* (Viereck, 1917)	Edmonton, AB (Strickland 1946)
62	*Bracon gastroideae* Ashmead, 1889	Edmonton, AB (Strickland 1946)
63	*Bracon hyslopi* (Viereck, 1912)	Vermilion, AB (Strickland 1946)
64	*Bracon lissogaster* Muesebeck, 1953	Couts, Coaldale, Coalhurst, AB (Cárcamo *et al*. 2012)
65	*Bracon lutus* Provancher, 1880	MB; SK (Wong 1972)
66	*Bracon nuperus* Cresson, 1872	Vermilion, AB (Strickland 1946)
67	*Bracon pini* (Muesebeck, 1925)	Seebe, AB (Powell 1971)
68	*Bracon rhyacioniae* (Muesebeck, 1931)	MB (DeBoo *et al.* 1971)
69	*Bracon tenuis* Muesebeck and Walkley, 1951	Northwest AB (Wesley *et al.* 2006)
70	*Coeloides crocator* (Kirby, 1837)	Edmonton, AB (Mason 1978)
71	*Coeloides rufovariegatus* (Provancher, 1880)	Aweme, MB (Mason 1978)
72	*Habrobracon gelechiae* (Ashmead, 1889)	Edmonton, AB (Strickland 1946)

	Species	Locality and Locality Reference
73	*Vipio croceus* (Cresson, 1865)	Lethbridge, AB (Strickland 1946)
74	*Vipio piceipectus* Viereck, 1905	AB (Inayatullah *et al*. 1998)
Cardiochilinae		
75	*Cardiochiles explorator* (Say, 1836)	Lethbridge, AB (Strickland 1946)
76	*Toxoneuron viator* (Say, 1836)	Lethbridge, AB (Strickland 1946)
Cenocoeliinae		
77	*Cenocoelius sanguineiventris* (Ashmead, 1889)	Steinbach, MB (Saffer 1982)
78	*Cenocoelius saperdae* (Ashmead, 1889)	Gladstone, MB (Saffer 1982)
79	*Cenocoelius tenuicornis* (Rohwer, 1914)	Langruth, MB (Saffer 1982)
Charmontinae		
80	*Charmon extensor* (Linnaeus, 1758)	Edmonton, AB; Saskatoon, SK (van Achterberg 1979)
Cheloninae		
81	**Ascogaster argentifrons* (Provancher, 1886)	Winnipeg, MB JBWM
82	*Ascogaster aurea* Shaw, 1983	Indian Head, SK (Shaw 1983)
83	*Ascogaster borealis* Shaw, 1983	Rose Valley, SK (Shaw 1983)
84	*Chelonus gracilis* McComb, 1968	Scandia, AB (McComb 1968)
85	*Chelonus insolitus* McComb, 1968	Morden, MB (McComb 1968)
86	*Chelonus medicaginis* McComb, 1968	Brooks, AB (McComb 1968)
87	*Chelonus pecki* McComb, 1968	Saskatoon, SK (McComb 1968)
88	*Chelonus phaloniae* Mason, 1959	Morden, Altona, MB (Mason 1959)
89	***_Chelonus sericeus_ (Say, 1824)**	**Oakbank, MB JBWM**
90	*Chelonus subtuberculatus* McComb, 1968	Richard, SK (McComb 1968)
91	*Phanerotoma diversa* (Walker, 1874)	MB (Zettel 1992)
92	*Phanerotoma fasciata* Provancher, 1881	AB; SK; MB (Zettel 1992)
93	*Phanerotoma longicauda* Walley, 1951	AB (Zettel 1992)
Doryctinae		
94	*Doryctes californicus* Marsh, 1969	Seebe, AB (Powell 1971)
95	*Doryctes rufipes* (Provancher, 1880)	AB (Marsh 1969)
96	*Doryctes slossonae* Marsh, 1969	Onah, MB (Marsh 1969)
97	*Ecphylus hypothenemi* Ashmead, 1896	Canada (Marsh 1965)
98	*Ontsira imperator* (Haliday, 1836)	AB (Marsh 1966)
99	*Rhaconotus badius* Marsh, 1976	Lethbridge, AB (Marsh 1976)
100	*Rhaconotus canadensis* Marsh, 1976	St. Victor, SK (Marsh 1976)
101	*Rhaconotus fasciatus* (Ashmead, 1893)	AB (Marsh 1976)
102	*Spathius sequoiae* Ashmead, 1889	AB; MB (Matthews 1970)
Euphorinae		
103	*Dinocampus coccinellae* (Schrank, 1802)	Lethbridge, AB (Strickland 1946)
104	*Leiophron braunae* (Goulet, 2006)	Lethbridge, AB (Goulet and Mason 2006)
105	*Leiophron broadbenti* (Goulet, 2006)	Lethbridge, AB (Goulet and Mason 2006)
106	*Leiophron carcamoi* (Goulet, 2006)	Lethbridge, AB (Goulet and Mason 2006)
107	*Leiophron guttatipidis* (Loan, 1979)	Saskatoon, SK (Loan 1979)
108	*Leiophron otaniae* (Goulet, 2006)	Saskatoon, SK (Goulet and Mason 2006)
109	*Leiophron pallipes* Curtis, 1833	Edmonton, AB (Strickland 1946)
110	*Meteorus betulini* Mason, 1968	Traverse Bay, MB (Mason 1968)

	Species	Locality and Locality Reference
111	*Meteorus campestris* Viereck, 1905	Calgary, AB (Strickland 1921)
112	*Meteorus dimidiatus* (Cresson, 1872)	Edmonton, AB (Strickland 1946)
113	***Meteorus humilis* (Cresson, 1872)**	**Winnipeg, MB JBWM**
114	***Meteorus hyphantriae* Riley, 1887**	**Starbuck, MB JBWM**
115	***Meteorus pendulus* Muller, 1776**	**Winnipeg, MB JBWM**
116	*Meteorus politus* (Provancher, 1886)	SK (Muesebeck 1923)
117	*Meteorus rubens* (Nees, 1811)	Saskatoon, SK (Pivnick 1993)
118	*Neoneurus mantis* Shaw, 1992	Onefour, Vockeroth, AB (Shaw 1992)
119	*Perilitus bicolor* (Wesmael, 1835)	Glenlea, MB (Wylie 1988)
120	*Perilitus brevipetiolatus* Thomson 1892	Glenlea, MB (Wylie 1982)
121	*Perilitus eleodis* Viereck, 1913	Medicine Hat, AB (Strickland 1946)
122	*Perilitus melanopus* (Ruthe, 1856)	Lethbridge, AB (Fox *et al.* 2004)
123	*Perilitus nigritus* Provancher, 1888	MB (Muesebeck 1958)
124	*Perilitus psylliodis* (Loan, 1969)	MB; SK (Wylie and Loan 1984)
125	*Perilitus punctulatae* (Loan and Wylie 1984)	MB; SK (Wylie and Loan 1984)
126	*Syntretus transversus* (Papp and Shaw 2000)	Riding Mountain NP, MB (Papp and Shaw 2000)
127	*Zele albiditarsus* Curtis, 1832	Sundre, AB (van Achterberg 1979)
Gnamptodontinae		
128	*Exodontiella muesebecki* Wharton, 1977	Cypress Hills, Elkwater, AB (Wharton 1978)
Homolobinae		
129	*Homolobus truncator* (Say, 1829)	Beverley, SK; Lethbridge, AB (van Achterberg 1979)
Ichneutinae		
130	*Ichneutes pikonematis* Mason, 1968	Marshall, SK (Mason 1968)
Macrocentrinae		
131	*Austrozele uniformis* (Provancher, 1880)	Spruce Woods PP, MB (Mason 1976)
132	*Hymenochaonia delicata* (Cresson, 1872)	Winnipeg, MB (Ahlstrom 2005)
133	*Macrocentrus aegeriae* Rohwer, 1915	Morris, MB (Ahlstrom 2005)
134	*Macrocentrus ancylivorus* Rohwer, 1923	Morden, MB (Ahlstrom 2005)
135	*Macrocentrus canarsiae* Muesebeck, 1932	Aweme, MB (Ahlstrom 2005)
136	*Macrocentrus cerasivoranae* Viereck, 1912	Lethbridge, AB (Strickland 1946)
137	*Macrocentrus crambi* (Ashmead, 1894)	Winnipeg, MB (Ahlstrom 2005)
138	*Macrocentrus crassipes* Muesebeck, 1932	Vermilion, AB (Strickland 1946)
139	*Macrocentrus cuniculus* Walley, 1933	Hinton, AB (Ahlstrom 2005)
140	*Macrocentrus incompletus* Muesebeck, 1932	Lethbridge, AB (Strickland 1946)
141	*Macrocentrus instabilis* Muesebeck, 1932	Edmonton, AB (Strickland 1946)
142	*Macrocentrus linearis* (Nees, 1811)	Islay, AB (Ahlstrom 2005)
143	*Macrocentrus marginator* (Nees, 1811)	Seebe, AB (Ahlstrom 2005)
144	*Macrocentrus nigridorsis* Viereck, 1924	Edmonton, AB (Strickland 1946)
145	*Macrocentrus pallisteri* DeGant, 1930	Edmonton, AB (Strickland 1946)
146	*Macrocentrus pectoralis* Provancher, 1880	Estevan, SK (Ahlstrom 2005)
147	*Macrocentrus terminalis* (Ashmead, 1889)	Edmonton, AB (Strickland 1946)
Microgastrinae		
148	*Apanteles crassicornis* (Provancher, 1886)	Edmonton, AB (Strickland 1946)
149	*Apanteles ensiger* (Say, 1836)	MB (Fernández-Triana 2010)

	Species	Locality and Locality Reference
150	*Apanteles feltiae* Viereck, 1912	SK (Fernández-Triana 2010)
151	*Apanteles forbesi* Viereck, 1910	MB (Fernández-Triana 2010)
152	*Apanteles morrisi* Mason, 1974	Cypress River, MB (Mason 1974)
153	*Apanteles polychrosidis* Viereck, 1912	MB (Fernández-Triana 2010)
154	*Cotesia acronyctae* (Riley, 1871)	AB; SK (Fernández-Triana 2010)
155	*Cotesia atalantae* (Packard, 1881)	AB; SK; MB (Fernández-Triana 2010)
156	*Cotesia autographae* (Muesebeck, 1921)	MB; Winnipeg, MB (Fernández-Triana 2010). JBWM
157	*Cotesia cingiliae* (Muesebeck, 1931)	AB (Fernández-Triana 2010)
158	*Cotesia congregata* (Say, 1836)	MB (Fernández-Triana 2010)
159	*Cotesia diversa* (Muesebeck and Walkley, 1951)	MB (Fernández-Triana 2010)
160	*Cotesia fiskei* (Viereck, 1910)	AB; MB; SK (Fernández-Triana 2010)
161	*Cotesia flavicornis* (Riley, 1889)	MB (Fernández-Triana 2010)
162	*Cotesia griffini* (Viereck, 1911)	AB (Fernández-Triana 2010)
163	*Cotesia halisidotae* (Muesebeck, 1931)	MB (Fernández-Triana 2010)
164	*Cotesia hyphantriae* (Riley, 1887)	MB. East Braintree, MB (Fernández-Triana 2010). JBWM
165	*Cotesia laeviceps* (Ashmead, 1890)	AB; MB; SK. Altona, MB (Fernández-Triana 2010). JBWM
166	*Cotesia murtfeldtae* (Ashmead, 1898)	MB (Fernández-Triana 2010)
167	*Cotesia nemoriae* (Ashmead, 1898)	MB; SK. Beausejour, MB (Fernández-Triana 2010). JBWM
168	*Cotesia phobetri* (Rohwer, 1915)	AB (Fernández-Triana 2010)
169	*Cotesia plathypenae* (Muesebeck, 1921)	MB. Franklin, MB (Fernández-Triana 2010). JBWM
170	*Cotesia teleae* (Muesebeck, 1926)	AB (Fernández-Triana 2010)
171	*Cotesia xylina* (Say, 1836)	Glenlea, MB (Wylie and Bucher 1977)
172	*Cotesia yakutatensis* (Ashmead, 1902)	MB (Fernández-Triana 2010)
173	*Diolcogaster bakeri* (Muesebeck, 1922)	SK (Fernández-Triana 2010)
174	*Diolcogaster facetosa* (Weed, 1888)	AB (Fernández-Triana 2010)
175	*Dolichogenidea consimilis* (Viereck, 1911)	MB (Muesebeck 1921)
176	*Dolichogenidea homoeosomae* (Muesebeck, 1933)	SK (Fernández-Triana 2010)
177	*Hygroplitis melligaster* (Provancher, 1886)	MB (Fernández-Triana 2010)
178	*Microgaster canadensis* Muesebeck, 1922	Edmonton, AB (Strickland 1946)
179	*Microgaster congregatiformis* Viereck, 1917	Edmonton, AB (Strickland 1946)
180	*Microgaster leechi* Walley, 1935	MB (Fernández-Triana 2010)
181	*Microplitis alaskensis* Ashmead, 1902	Medicine Hat, Lethbridge, AB (Strickland 1946)
182	*Microplitis carteri* Walley, 1932	Lethbridge, AB (Strickland 1946)
183	*Microplitis ceratomiae* Riley, 1881	SK (Fernández-Triana 2010)
184	*Microplitis hyphantriae* Ashmead, 1898	Edmonton, AB (Strickland 1946)
185	*Microplitis impressus* (Wesmael, 1837)	MB (Fernández-Triana 2010)
186	*Microplitis kewleyi* Muesebeck, 1922	Calahoo, AB (Schaaf 1972)
187	*Microplitis melianae* Viereck, 1911	Edmonton, AB (Strickland 1952)
188	*Microplitis plutellae* Muesebeck, 1922	Lethbridge, AB (Sarfraz *et al.* 2010)
189	*Microplitis scutellatus* Muesebeck, 1922	Edmonton, AB (Strickland 1952)

	Species	Locality and Locality Reference
190	*Pholetesor ornigis* (Weed, 1887)	Birdshill PP, MB (Still and Wong 1973)
191	*Pholetesor salicifoliellae* (Mason, 1959)	MB (Fernández-Triana 2010)
192	*Pholetesor variabilis* Whitfield 2006	Ceylon, Elfos, SK (Whitfield 2006)
193	*Pholetesor viminetorum* (Wesmael, 1837)	AB (Whitfield 2006)
194	*Pholetesor zelleriae* Whitfield 2006	Sprague, MB (Whitfield 2006)
195	*Protapanteles fulvipes* (Haliday, 1834)	AB (Fernández-Triana 2010)
196	*Protapanteles militaris* (Walsh, 1861)	MB. Glenlea, MB (Fernández-Triana 2010). JBWM
197	*Protapanteles neomexicanus* (Muesebeck, 1921)	AB; MB (Williams 1988)
198	*Protapanteles paleacritae* (Riley, 1881)	MB (Fernández-Triana 2010)
199	*Protapanteles stigmaticus* (Muesebeck, 1922)	AB (Strickland 1952; Fernández-Triana 2010)
200	*Venanides xeste* (Mason, 1981)	MB (Fernández-Triana 2010)
Opiinae		
201	***Biosteres carbonarius* (Nees, 1834)**	**Glenlea, MB JBWM**
202	*Biosteres incertus* (Fischer, 1965)	Edmonton, AB (Fischer 1965)
203	*Biosteres numerosus* (Fischer, 1965)	Winnipeg, MB (Fischer 1965)
204	*Biosteres spinaciae* (Thomson, 1895)	AB (Fischer 1965, 1977)
205	*Desmiostoma parvulum* (Wesmael, 1835)	Cut Knife, SK (Fischer 1964)
206	***Diachasma alloeum* (Muesebeck, 1956)**	**Morden, MB JBWM**
207	***Diachasmimorpha mellea* (Gahan, 1915)**	**Morden, MB JBWM**
208	*Eurytenes abnormis* (Wesmael, 1835)	Cut Knife, SK (Fischer 1965)
209	*Opius amplus* (Ashmead, 1890)	AB (Fischer 1964)
210	*Opius bidentis* Fischer, 1964	Edmonton, AB (Fischer 1964)
211	*Opius bruneipes* Gahan, 1913	AB (Fischer 1965)
212	*Opius cinctus* Provancher, 1886	SK (Muesebeck 1958)
213	*Opius curtiarticulatus* Fischer, 1964	Saskatoon, SK (Fischer 1964)
214	**Opius dimidiatus* (Ashmead, 1889)	Grandview, MB JBWM
215	*Opius downesi* Gahan, 1919	Edmonton, AB (Strickland 1946)
216	*Opius longicubitalis* Fischer, 1965	Drumheller, AB (Fischer 1965)
217	*Opius pallipes* Wesmael, 1835	Blackfoot Hills, AB (Fischer 1965)
218	*Opius succineus* Gahan, 1913	SK (Fischer 1964)
219	*Phaedrotoma complicans* (Fischer, 1965)	Drumheller, AB (Fischer 1965)
220	*Phaedrotoma nitidulator* (Nees, 1834)	Edmonton, AB (Fischer 1964)
221	*Phaedrotoma turneri* (Gahan, 1919)	AB (Fischer 1965)
222	*Utetes canaliculatus* (Gahan, 1915)	MB (Fischer 1964)
223	*Utetes frequens* (Fischer, 1964)	Morden, MB (Fischer 1964)
224	*Utetes gahani* (Muesebeck, 1931)	MB (Fischer 1964)
225	*Utetes juniperi* (Fischer, 1964)	Morden, MB (Fischer 1964)
226	*Utetes rosicola* (Muesebeck, 1950)	Saskatoon, SK (Balduf 1959)
227	*Xynobius cincticornis* (Gahan, 1915)	SK (Fischer 1964)
228	*Xynobius severini* (Fischer, 1964)	Coaldale, AB (Fischer 1964)
Orgilinae		
229	*Orgilus agrestis* Muesebeck, 1970	Drumheller, AB (Muesebeck 1970)
230	*Orgilus detectus* Provancher, 1886	Lethbridge, AB (Strickland 1946)
231	*Orgilus hyalinus* Muesebeck, 1970	Onefour, AB, MB (Muesebeck 1970)

Species	Locality and Locality Reference
232 *Orgilus pedalis* Muesebeck, 1970	Lethbridge, AB (Muesebeck 1970)
233 *Orgilus pratensis* Muesebeck, 1970	Scandia, AB (Muesebeck 1970)
Rhysipolinae	
234 *Cantharoctonus canadensis* Mason, 1968	Audy Lake, MB (Mason 1968)
235 *Rhysipolis decorator* (Haliday, 1836)	AB; SK (Spencer and Whitfield 1999)
236 *Rhysipolis pallipes* (Provancher, 1888)	AB; MB (Spencer and Whitfield 1999)
237 *Rhysipolis platygaster* Spencer, 1999	Morley, Calgary, Jumoing Pd, AB; Tamarack, MB (Spencer and Whitfield 1999)
238 *Rhysipolis stenodes* Spencer, 1999	Elbow, Bounty, SK (Spencer and Whitfield 1999)
Rhyssalinae	
239 *Histeromerus canadensis* Ashmead, 1891	AB (van Achterberg 1992)
Rogadinae	
240 *Aleiodes bucculentus* Marsh and Shaw 2001	Bilby, AB (Marsh and Shaw 2001)
241 *Aleiodes crassijugosus* Fortier 2007	MB (Fortier 2007)
242 *Aleiodes dichromatus* Shaw and Marsh 2006	Saskatoon, SK; Elkwater, AB (Shaw *et al*. 2006)
243 *Aleiodes malacosomatos* (Mason, 1979)	Coaldale, AB; Crane Lake, Shaunavon, SK (Mason 1979)
244 *Aleiodes maritimus* Shaw and Marsh 2004	Spruce Grove, AB (Shaw and Marsh 2004)
245 *Aleiodes megastomus* Marsh and Shaw 1999	Saskatoon, SK (Marsh and Shaw 1999)
246 *Aleiodes rileyi* Cresson, 1869	SK (Shaw *et al.* 1998)
247 *Aleiodes sexmaculativorax* Fortier 2007	Stony Plain, Spruce Grove, AB (Fortier 2007)
248 *_Aleiodes stigmator_ (Say, 1824)	**Carrot River, Ordale, Wadena, SK; Glenlea, Winnipeg, MB JBWM**
249 *Aleiodes terminalis* Cresson, 1869	Lethbridge, Edmonton, AB (Strickland 1946)
250 *Stiropius bucculatricis* (Ashmead, 1889)	Edmonton, AB; Ninetee, MB (Whitfield 1988)
Sigalphinae	
251 *Sigalphus bicolor* (Cresson, 1880)	MB (Muesebeck 1958)

Of the 251 species recorded from the Prairies Ecozone, 14 are new records determined from material within the JBWM. These new records highlight the importance of museums and specimen databasing, as they provide readily accessible information on Canada's biodiversity. Furthermore, the specimens provide a record of species distributions through time and are critical sources of information for assessing changing species distributions, whether through evolution, biological invasions, or climate change. Collating species data into regional checklists also helps to further knowledge on species presence and distribution. For example, species of Microgastrinae are the most common of the 22 subfamilies represented, comprising 21% of the total known species in the ecozone, most being known from the extensive checklist produced by Fernández-Triana (2010). Of the 251 species of Braconidae now known from the Prairies Ecozone, 46 are known from Strickland's (1946, 1952) checklists of the Ichneumonoidea of Alberta.

Other subfamilies with a relatively large number of known species from the Prairies Ecozone (e.g., Agathidinae, Aphidiinae, Euphorinae, Opiinae, Macrocentrinae) have received considerable research attention for taxonomic reasons (e.g., Fischer 1964, 1965; van Achterberg 1976; Wharton 1986; Ahlstrom 2005) or to facilitate biological control of crop pests (e.g., Batulla and Robinson 1984; Wylie and Loan 1984; Goulet and Mason 2006). Subfamilies with fewer known species (e.g., Alysiinae, Brachistinae, Orgilinae) are likely much more speciose than is reflected in the checklist, as they are commonly collected (BJS, pers. obs.) but are more difficult to identify to species because of a lack of taxonomic research and resources. Comments for each subfamily represented in the checklist are provided below.

Agathidinae

Agathidines are koinobiont endoparasitoids (where the host continues development while being fed upon) of lepidopteran larvae, many of which are small caterpillars concealed in leaf rolls or stems (Sharkey 1992; Sharkey *et al.* 2006). There are 17 species from six genera recorded from the Prairies Ecozone. Most specimens are recorded from in and around cities, and certainly additional sampling in native grassland habitats will reveal additional species. Species of *Agathis* and *Earinus* are known to be more species rich in temperate regions (Sharkey 1992), and it is likely that additional species richness will be discovered from members of these two genera. Although members of Agathidinae have not been used extensively in biocontrol programs, they do attack many pest species, including agricultural pests. For example, *Bassus nigripes* attacks the Sunflower moth, *Homeosoma ellectellum* Hurst, an occasional pest of sunflower in Manitoba (Sharkey *et al.* 1987). However, agathidines can also interfere with biological control programs where lepidopteran larvae have been brought in to control weeds (Halstead 1989).

Alysiinae

Members of Alysiinae are koinobiont endoparasitoids of flies in the infraorder Muscomorpha (which includes house flies, blowflies, and flesh flies among others). Of the two tribes in the subfamily (Alysiini and Dacnusini), members of Dacnusini are typically more specialized and mainly attack species of Agromyzidae (Wharton 1984). As many cyclorrhaphous Diptera are pests of livestock as well as crops, alysiines likely have biocontrol potential in the Canadian Prairies. For example, *Aphaereta pallipes* (=*auripes* Provancher) has been recorded as an occasional parasitoid of *Delia radicum* (Linnaeus) (=*Hylemya brassicae* Bouché) in Quebec (Wishart 1957), a major pest of cruciferous crops. Here, we report *Aphaereta pallipes* as a new record for Manitoba and the Prairies Ecozone (Table 1). Future studies should examine the abundance of this species in agroecosystems and whether or not it attacks *D. radicum* in the Prairies, where canola and other brassicas are major crops. There are 12 species from seven genera recorded from the Prairies Ecozone, two of which are new records (Table 1). *Aphaereta minuta* is recorded for the first time in Canada; however, the species identification of this specimen could not be determined with complete confidence. There are many more species of Alysiinae present within the Prairies Ecozone than is reflected in the checklist. A recent study of alysiine parasitoids found in canola in Manitoba has revealed several morphospecies of *Chorebus* and *Dacnusa* (W. Lodge-Zaparnick and BJS, unpublished data). Species identification of these specimens awaits comparison with types.

Aphidiinae

Aphidiines are solitary koinobiont endoparasitoids of nymphal and adult aphids. As aphids are major pests of many economically important agricultural and horticultural crops, the host relationships for members of Aphidiinae are probably the best known of all of the braconid subfamilies (Pike *et al.* 2000). Aphidiines have been used extensively in biocontrol programs. For example, *Aphidius ervi* has been introduced into several regions in North America, including British Columbia, to control the pea aphid, *Acyrthosiphon pisum* Harris (Mackauer and Campbell 1972). However, Marsh (1977) and Starý (1974) suggested that this species was likely present in North America prior to purposeful introductions. *Aphidius smithi* was introduced into Manitoba for pea aphid control, though *A. ervi* was discovered simultaneously to be established in Manitoba and a more effective parasitoid of the pea aphid than *A. smithi* (Wylie *et al.* 2005). There are 21 species from eight genera recorded from the Prairies Ecozone, two of which are new records (Table 1). Of particular interest is the new record for Manitoba for the parasitoid *Diaeretiella rapae*, which has been introduced into North America to control the exotic Russian wheat aphid, *Diuraphis noxia* (Mordvilko) (Brewer *et al.* 2001). *Diaeretiella rapae* has been recorded in Canada previously by Treherne (1916) in Ontario and by Strickland (1946) in Lethbridge, Alberta. We also report *Sipha agropyronensis* as a new host record for *D. rapae* on the basis of specimens in the JBWM (Table 2). *Aphidius avenaphis* (Fitch) is also a new record for Manitoba, although the species identity was not confirmed confidently.

Brachistinae

Here we follow the higher classification of Brachistinae *sensu* Sharanowski *et al.* (2011), which includes the tribes Blacini, Brachistini, Brulleiini, Diospilini, and Eadyini. Host records are scarce for most members of Brachistinae; however, it is likely that all species are solitary koinobiont endoparasitoids of Coleoptera larvae, especially species of Anobiidae, Cerambycidae, Chrysomelidae, Curculionidae, and Mordellidae (Yu *et al.* 2011). Several hosts of members of Brachistinae are major crop pests, such as the red sunflower seed weevil, *Smicronyx fulvus* LeConte, which is parasitized by *Triaspis aequoris*. Interestingly, *T. aequoris* has not yet been discovered in the Canadian Prairies Ecozone, even though sunflowers (various varieties of *Helianthus annus* L.) are grown in the southern regions of Manitoba and *T. aequoris* has been collected just across the border in North Dakota (Charlet 2002). Numerous species of *Blacus*, *Eubazus*, *Nealiolus*, and *Triaspis* have been collected in the Prairies Ecozone of Manitoba, and several will be described and recorded as new records in a future publication (BJS, unpublished data). To date, however, there are only eight published species records from two genera recorded from the Prairies Ecozone (Table 1).

Braconinae

Members of the speciose subfamily Braconinae are commonly collected in the Prairies Ecozone (BJS, pers. obs.), although generally they are far more speciose in tropical than in temperate regions (Mason 1978). Only 16 species in five genera are recorded from the Prairie Provinces, and only 12 species have definitive records from the Prairies Ecozone (Table 1). Generally, most diversity in the prairies and in Canada occurs in the large genus *Bracon* (Mason 178). The majority of records listed here (Table 1) are from Strickland's (1946) checklist of Ichneumonoidea in Alberta. Generally, braconines are idiobiont ectoparasitoids (parasitoids that immobilize the host and prevent its further development) and as a group, they attack a wide variety of insect hosts, including species of Diptera, Coleoptera, Lepidoptera, and Hymenoptera. *Atanycolus charus* attacks the bronze birch borer, *Agrilus anxius* Gory, which can be highly problematic in natural birch stands as well as in urban birch plantings in the prairies. Species of *Coeloides* are common larval parasitoids of bark beetles (Curculionidae: Scolytinae), and C. *rufovariegatus* is known to attack several pest species of *Dendroctonus* and *Ips* (Mason 1978). *Habrobracon gelechiae* has a broad host range that includes some agricultural pests such as the European corn borer, *Ostrinia nubialis* Hübner. *Bracon cephi* attacks the wheat stem sawfly (*Cephus cinctus* Norton), one of the major pests of wheat in the grassland prairies of Canada and the United States; therefore, its biology is well-known (Nelson and Farstad 1953). *Bracon lissogaster* Muesebeck was recently reported in the Prairies Ecozone in southern Alberta (Cárcamo *et al*. 2012).

Cardiochilinae

Cardiochilines are koinobiont endoparasitoids of lepidopteran larvae, especially species of Noctuidae and Pyralidae (Huddleston and Walker 1988). There are only five cardiochiline species known from Canada (Yu *et al.* 2011), two of which have been recorded from the Prairies Ecozone (Table 1) and only known from Lethbridge, Alberta. Additional sampling will likely reveal more species; however, we have yet to collect cardiochilines, at least in Manitoba (BJS, pers. obs.).

Cenocoeliinae

Cenocoeliinae is a small subfamily with seven genera worldwide, of which only *Cenocoelius* is found in Canada (Yu *et al.* 2011). Saffer (1982) recognized 24 species of *Cenocoelius* in North America, four of which occur in Canada and three of which are recorded from the Prairies Ecozone, all from Manitoba (Table 1). However, they are rare in Malaise trap and sweep net samples from this region (BJS, pers. obs.). Reliable host records indicate that species of *Cenocoelius* attack wood-boring beetle larvae, primarily species of Buprestidae, Cerambycidae, and Curculionidae (Saffer 1982).

Charmontinae

Charmontini was formerly placed within Homolobinae (van Achterberg 1979), but was elevated to subfamily rank by Quicke and van Achterberg (1990) on the basis of morphological characters of the ovipositor that suggested a closer relationship to Macrocentrinae. This hypothesis was also supported by the molecular phylogeny of Sharanowski *et al.* (2011). Generally, charmontines are koinobiont endoparasitoids of concealed lepidopteran larvae (Quicke and van Achterberg 1990). Charmontinae includes two genera, *Charmontia* and *Charmon*, only the latter of which occurs in Canada. Two species have been reported in Canada, and only one of these, the widely distributed *Charmon extensor*, is known from the Prairies Ecozone (Table 1).

Cheloninae

Chelonines are frequently collected in Malaise trap and sweep net samples in the Prairies Ecozone (BJS, pers. obs.). Generally, chelonines are solitary koinobiont egg–larval endoparasitoids of lepidopterans. The biology of many species is well-known, as several chelonines are excellent natural control agents of many pest species, particularly in agriculture (Jones 1985; Grossniklaus-Bürgin *et al.* 1994). They are also studied for their physiological effects on hosts, given their interesting associations with polydnaviruses and a wide variety of venom proteins (Bonvin *et al.* 2004; Kaeslin *et al.* 2010). There are 13 species from three genera recorded from the Prairies Ecozone, two of which are new records (Table 1). *Chelonus sericeus* has been recorded from the dingy cutworm, *Feltia jaculifera* Guenée (=*ducens* Walker), and the new record reported here also includes reared material from the dingy and the redbacked cutworm, *Euxoa ochrogaster* Guenée (Table 2). However, ongoing rearing experiments of both the dingy and redbacked cutworms in Manitoba have not yet produced any species of *Chelonus* (RWMUMW and BJS, unpublished data), and thus *Chelonus sericeus* is likely a rare parasitoid on these hosts.

Doryctinae

Doryctines are members of a heterogeneous lineage and in desperate need of a revision of the higher classification, as well as within several genera (Quicke and van Achterberg 1990; Sharanowski *et al.* 2011). Most doryctines are idiobiont ectoparasitoids of wood-boring Coleoptera larvae; however, several other groups are also attacked, including Lepidoptera, Hymenoptera, and even Embioptera. Many species have little to no known host information. There are currently more than 1,600 species in the subfamily, but only 33 are reported from Canada (Yu *et al.* 2011). The diversity in Canada is likely much higher, but the large size of the subfamily and paucity of identification keys for species increases the difficulty of accurate species-level identification. There are nine species from five genera reported in the Prairies Ecozone.

Euphorinae

Following the higher classification of Sharanowski *et al.* (2011), Euphorinae now includes Meteorini and Neoneurini as tribes instead of individual subfamilies. Because of the taxonomic instability of Euphorini, *Peristenus* is treated here as a subgenus of *Leiophron* in accordance with the classification in Taxapad (Yu *et al.* 2011). All euphorines are koinobiont endoparasitoids, but attack a wide variety of hosts from different orders and from early larval stages to adults (Shaw 2004). Many species of Euphorinae are important biological control agents, particularly of agricultural pests; thus, there have been several taxonomic works on euphorine taxa (e.g., Wylie and Loan 1984; Goulet and Mason 2006). Interestingly, euphorines are also studied for their ability to interfere with biological control programs, especially since they are major parasitoids of beneficial ladybird beetles (Riddick *et al.* 2009). For example, *Dinocampus coccinellae* Schrank attacks several species of ladybird beetles (Wright and Laing 1982). There are 25 species from seven genera recorded from the Prairies Ecozone, three of which are new records, all species of *Meteorus* (Table 1). Of particular interest are the species of *Leiophron*, which are biocontrol agents of *Lygus* spp. (Hemiptera: Miridae) (Loan 1974; Goulet and Mason 2006), major pests on several Canadian crops.

Gnamptodontinae

Gnamptodontinae is a very small subfamily with 88 described species worldwide (Yu *et al.* 2011). Only five species are reported from Canada and only one (*Exodontiella muesebecki* Wharton) from the Prairies Ecozone (Table 1). The hosts for this species are unknown.

Homolobinae

Homolobines are koinobiont endoparasitoids and attack exposed lepidopteran larvae (van Achterberg 1979), particularly species of Geometridae and Noctuidae, many of which are agricultural pests. Only four species are known from Canada of 62 described worldwide. Only *Homolobus truncator* is known from the Prairies Ecozone (Table 1), where it attacks numerous species of cutworms and armyworms.

Ichneutinae

Only four species of Ichneutinae have ever been reported from Canada, which is surprising given that their sawfly hosts are numerous and highly diverse in Canada (Goulet 1992). The relative rarity of ichneutines may be because ichneumonid sawfly parasitoids are better competitors than ichneutine species in temperate regions. Future biodiversity studies will certainly reveal additional species; however, as of now, only one species is known in the Prairies Ecozone (Table 1). *Ichneutes pikonematis* attacks the yellowhead spruce sawfly, *Pikonema alaskensis* (Rohwer), in eastern Canada.

Macrocentrinae
Macrocentrines are koinobiont endoparasitoids of both large and small lepidopteran larvae. There are 31 species known from Canada (Yu *et al.* 2011) and 17 of these taxa occur in the Prairies Ecozone (Table 1). Much of our knowledge of macrocentrine species comes from Ahlstrom's (2005) revision of the subfamily, and most of the diversity includes species of *Macrocentrus*. Many species are reported from multiple hosts (Yu *et al.* 2011).

Microgastrinae
Microgastrinae is a highly speciose lineage with over 2,200 species described worldwide (Yu *et al.* 2011). Microgastrines are koinobiont endoparasitoids of lepidopteran larvae and generally attack early instars. Several species are important biological control agents of both agricultural and forest pests (Krause *et al.* 1990; Sarfraz *et al.* 2005). Whitfield (1995: 245) has described Microgastrinae as "the most important single group of parasitoids of Lepidoptera in the world." Although identification to subfamily is simple given their unique wing venation and antennal flagellomeres, identification to species is often incredibly difficult as there are numerous cryptic species and few diagnostic characters at the species level for many genera (Smith *et al.* 2008). However, Whitfield (1997) provides an excellent key to genera for the New World. There are 53 species in nine genera recorded from the Prairies Ecozone (Table 1).

Opiinae
Opiinae is also a large speciose lineage, with over 1,900 described species (Yu *et al.* 2011); they are commonly collected in Malaise traps and sweep net samples throughout the region (BJS, pers. obs.). Members of Opiinae are koinobiont endoparasitoids of cyclorrhaphous Diptera and use a relatively wide diversity of hosts, although agromyzid leaf miners and tephritid fruit flies are the most common (Quicke and van Achterberg 1990). There is extensive literature on the biology and ecology of many species of opiines, particularly those species that attack *Rhagoletis* fruit flies. Much of our knowledge of the opiines in the Prairies Ecozone comes from Fischer's (1964, 1965, 1977) revisionary works. However, the more recent treatment of Opiinae by Wharton (1988*b*) includes updated taxonomic treatments for many genera and tribes. There are 28 species from nine genera recorded from the Canadian Prairies, including four new records (Table 1). *Opius dimidiatus* Ashmead could not be confidently identified to species; however, if the identification is correct, this represents a new record for Canada and Manitoba. *Opius dimidiatus* has been recorded from northern US states such as Minnesota, and so it is not unreasonable that this species would also be present in Manitoba.

Orgilinae
Members of Orgilinae are koinobiont endoparasitoids of concealed microlepidopteran larvae. There are 36 species of Orgilinae in Canada, all species of *Orgilus* (Yu *et al.* 2011). A few species of Orgilinae are commonly collected in Malaise trap samples in the prairies (BJS, pers. obs.). Five species of *Orgilus* are recorded from the Prairies Ecozone (Table 1), although there are no known host records for these species.

Rhysipolinae
This small subfamily has been variably placed within Rogadinae, Hormiinae, and Exothecinae, but has recently been elevated to subfamily status (Quicke 1994; van Achterberg 1995). Members of Rhysipolinae are koinobiont ectoparasitoids of small lepidopteran larvae. There are only six species from two genera recorded from Canada and five of these occur in the Prairies Ecozone (Table 1).

Rhyssalinae
This subfamily was recognized by Quicke and van Achterberg (1990) and now includes several taxa that were formerly included in a variety of different subfamilies. Generally, rhyssalines are idiobiont ectoparasitoids of Coleoptera and Lepidoptera (van Achterberg 1995). There are five species recorded from Canada, but only *Histeromerus canadensis* has been recorded from the Prairie Provinces—and only from Alberta (van Achterberg 1992) (Table 1).

Rogadinae
Rogadines are koinobiont parasitoids that attack both concealed and exposed lepidopteran larvae and use the dead host (or mummy) as a pupation chamber (Zaldivar-Riverón *et al.* 2008). There are 45 species recorded from Canada, all but four in the large and cosmopolitan genus *Aleiodes*. Eleven species, including 10 species of *Aleiodes*, are recorded from the Prairies Ecozone. *Aleiodes stigmator* is a new record for Manitoba and the Canadian Prairies (Tables 1 and 2). Several species in the checklist attack forest pests. For example, *Aleiodes malacosomatos* attacks the forest tent caterpillar, *Malacosoma disstria* Hübner.

Sigalphinae
Sigalphinae is small subfamily of larval lepidopteran parasitoids. There is only one species recorded from Canada and the Prairies Ecozone, *Sigalphus bicolor*, which has a wide distribution across North America (Sharkey and Janzen 1995) (Table 1). This species parasitizes dagger moths in the genus *Acronicta* (Noctuidae).

Concluding Comments
The 251 species in the compiled checklist is certainly a vast underestimate of the actual diversity of Braconidae in the Prairies Ecozone. Ongoing collections (BJS, unpublished data) have revealed numerous new species and new records; however, these species await description and formal publication. Biodiversity studies are much needed in this ecozone, particularly in remnant native grassland regions and the unique sandy or upland regions within the ecozone, such as the Tall Grass Prairie Preserve in Manitoba, Grasslands National Park in Saskatchewan, Suffield National Wildlife Area in Alberta, Spruce Woods Provincial Park in Manitoba, and Cypress Hills Interprovincial Park crossing through Saskatchewan and Alberta. Biodiversity studies of parasitic wasps in agroecosystems would also be an important and much needed contribution to facilitate ecological approaches to pest control. It is hoped that this checklist will facilitate future biodiversity studies, assist with conservation programs, and assist biocontrol researchers. The 14 new records discovered in the JBWM emphasize the importance of museums and specimen databasing. There are numerous other specimens in the museum that have not yet been determined to species, and it is likely that numerous new records will be discovered as that material is identified.

Table 2. Label data for specimens in the Wallis-Roughley Museum of Entomology (JBWM) that represent new locality records for a province or for Canada. Labels are presented verbatim. JBWM codes are internal bar-code numbers that are included as labels on individual specimens. A double bar (||) indicates a new line on a label. A double plus sign (++) indicates a new label.

<table>
<tr><th>JBWM</th><th>Verbatim Label</th></tr>
<tr><td colspan="2">Alysiinae</td></tr>
<tr><td colspan="2">Aphaereta minuta. New Record for Canada and Manitoba</td></tr>
<tr><td>114655</td><td>13.Sept.00||Fr pupa||Carman||14-15 Aug 00++Det: Hemma 03'</td></tr>
<tr><td>114656</td><td>13.Sept.00||Fr pupa||Carman||14-15 Aug 00++Det: Hemma 03'</td></tr>
<tr><td>114657</td><td>13.Sept.00||Fr pupa||Carman||14-15 Aug 00++Det: Hemma 03'</td></tr>
<tr><td>114658</td><td>13.Sept.00||Fr pupa||Carman||14-15 Aug 00++Det: Hemma 03'</td></tr>
<tr><td colspan="2">Aphaereta pallipes. New Record for Manitoba</td></tr>
<tr><td>248815</td><td>Glenlea, Man.||coll 113 25/10/77||em 19/11/77||H.G. Wylie</td></tr>
<tr><td>248816</td><td>Glenlea, Man.||coll 74a 28/07/77||H.G. Wylie++Ex. Dip puparium on||12/08/77</td></tr>
<tr><td>248817</td><td>Glenlea, Man.||coll 113 25/10/77||em 19/11/77||H.G. Wylie</td></tr>
<tr><td>248818</td><td>Glenlea, Man.||coll 113 25/10/77||em 19/11/77||H.G. Wylie</td></tr>
<tr><td>248819</td><td>Glenlea, Man.||coll 74a 27/07/77||H.G. Wylie++Ex. Dip puparium on||12/08/77</td></tr>
<tr><td>248820</td><td>Glenlea, Man.||coll 113 25/10/77||em 19/11/77||H.G. Wylie</td></tr>
<tr><td>248821</td><td>Glenlea, Man.||coll 74a 27/07/77||H.G. Wylie++Ex. Dip puparium on||12/08/77</td></tr>
<tr><td>248822</td><td>Glenlea, Man.||coll 113 25/10/77||em 19/11/77||H.G. Wylie</td></tr>
<tr><td>248823</td><td>Glenlea, Man.||coll 74a 27/07/77||H.G. Wylie++Ex. Dip puparium on||12/08/77</td></tr>
<tr><td>248824</td><td>Glenlea, Man.||coll 113 25/10/77||em 19/11/77||H.G. Wylie</td></tr>
<tr><td>248825</td><td>Glenlea, Man.||coll 74a 27/07/77||H.G. Wylie++Ex. Dip puparium on||12/08/77</td></tr>
<tr><td colspan="2">Aphidiinae</td></tr>
<tr><td colspan="2">Aphidius avenaphis. New Record for Manitoba</td></tr>
<tr><td>256793</td><td>Dugald, Man.||em. Aug. 20, 1974||H. G. Wylie++Ex. Aphid mummy||Macrosiphum||avenae ||coll. On wheat heads||Aug. 18, 1974</td></tr>
<tr><td>256796</td><td>Dugald, Man.||em. Aug. 20, 1974||H. G. Wylie++Ex. Aphid mummy||Macrosiphum||avenae ||coll. On wheat heads||Aug. 18, 1974</td></tr>
<tr><td>256792</td><td>Dugald, Man.||em. Aug. 20, 1974||H. G. Wylie++Ex. Aphid mummy||Macrosiphum||avenae ||coll. On wheat heads||Aug. 18, 1974</td></tr>
<tr><td>256795</td><td>Dugald, Man.||em. Aug. 20, 1974||H. G. Wylie++Ex. Aphid mummy||Macrosiphum||avenae ||coll. On wheat heads||Aug. 18, 1974</td></tr>
<tr><td>256794</td><td>Dugald, Man.||em. Aug. 20, 1974||H. G. Wylie++Ex. Aphid mummy||Macrosiphum||avenae ||coll. On wheat heads||Aug. 18, 1974</td></tr>
<tr><td>256791</td><td>Dugald, Man.||em. Aug. 20, 1974||H. G. Wylie++Ex. Aphid mummy||Macrosiphum||avenae ||coll. On wheat heads||Aug. 18, 1974</td></tr>
<tr><td>256790</td><td>Dugald, Man.||em. Aug. 20, 1974||H. G. Wylie++Ex. Aphid mummy||Macrosiphum||avenae ||coll. On wheat heads||Aug. 18, 1974 ++Aphidius||avenaphis||H.E. Bisdee 74</td></tr>
</table>

<table>
<tr><th>JBWM</th><th>Verbatim Label</th></tr>
<tr><td>256789</td><td>Dugald, Man.||em. Aug. 20, 1974||H. G. Wylie++Ex. Aphid mummy||Macrosiphum||avenae ||coll. On wheat heads||Aug. 18, 1974 ++Aphidius||avenaphis||H.E. Bisdee 74</td></tr>
<tr><td>256788</td><td>Dugald, Man.||em. Aug. 20, 1974||H. G. Wylie++Ex. Aphid mummy||Macrosiphum||avenae ||coll. On wheat heads||Aug. 18, 1974 ++Aphidius||avenaphis||H.E. Bisdee 74</td></tr>
<tr><td>256787</td><td>Dugald, Man.||em. Aug. 20, 1974||H. G. Wylie++Ex. Aphid mummy||Macrosiphum||avenae ||coll. On wheat heads||Aug. 18, 1974 ++Aphidius||avenaphis||H.E. Bisdee 74</td></tr>
<tr><td>256786</td><td>Dugald, Man.||em. Aug. 20, 1974||H. G. Wylie++Ex. Aphid mummy||Macrosiphum||avenae ||coll. On wheat heads||Aug. 18, 1974 ++Aphidius||avenaphis||H.E. Bisdee 74</td></tr>
<tr><td>256785</td><td>Dugald, Man.||em. Aug. 20, 1974||H. G. Wylie++Ex. Aphid mummy||Macrosiphum||avenae ||coll. On wheat heads||Aug. 18, 1974 ++Aphidius||avenaphis||H.E. Bisdee 74</td></tr>
<tr><td colspan="2">Diaeretiella rapae. New Record for Manitoba. New host record.</td></tr>
<tr><td>258007</td><td>WINNIPEG, MAN.||COLL #28||Em. July 10/80||H. G. WYLIE++Host||Sipha||agrpyronensis||Gillette)</td></tr>
<tr><td>258006</td><td>WINNIPEG, MAN.||COLL #42||Em. July 28/80||H. G. WYLIE++Host||Sipha||agrpyronensis||Gillette)</td></tr>
<tr><td>258005</td><td>WINNIPEG, MAN.||COLL #123||27/10/75||H. G. WYLIE</td></tr>
<tr><td>258004</td><td>Winnipeg, Man.||coll. #123||27/10/75||H. G. WYLIE</td></tr>
<tr><td>258003</td><td>Winnipeg, Man.||coll. #123||27/10/75||H. G. WYLIE</td></tr>
<tr><td>258002</td><td>Winnipeg, Man.||coll. #123||27/10/75||H. G. WYLIE</td></tr>
<tr><td>258001</td><td>Winnipeg, Man.||coll. #123||27/10/75||H. G. WYLIE</td></tr>
<tr><td>258000</td><td>Winnipeg, Man.||coll. #123||27/10/75||H. G. WYLIE</td></tr>
<tr><td>258219</td><td>Winnipeg, Man.||6 FEB 78||PDA GREENHOUSE++Diaeretella||rapae (McI.)</td></tr>
<tr><td>258218</td><td>Winnipeg, Man.||6 FEB 78||PDA GREENHOUSE++Diaeretella||rapae (McI.)</td></tr>
<tr><td>258217</td><td>Winnipeg, Man.||6 FEB 78||PDA GREENHOUSE++Diaeretella||rapae (McI.)</td></tr>
<tr><td>258216</td><td>Winnipeg, Man.||6 FEB 78||PDA GREENHOUSE++Diaeretella||rapae (McI.)</td></tr>
<tr><td>258215</td><td>Winnipeg, Man.||6 FEB 78||PDA GREENHOUSE++Diaeretella||rapae (McI.)</td></tr>
<tr><td>258214</td><td>Winnipeg, Man.||6 FEB 78||PDA GREENHOUSE++Diaeretella||rapae (McI.)</td></tr>
<tr><td>258213</td><td>Winnipeg, Man.||6 FEB 78||PDA GREENHOUSE++Diaeretella||rapae (McI.)</td></tr>
<tr><td>258212</td><td>Winnipeg, Man.||6 FEB 78||PDA GREENHOUSE++Diaeretella||rapae (McI.)</td></tr>
<tr><td>258211</td><td>Winnipeg, Man.||6 FEB 78||PDA GREENHOUSE++Diaeretella||rapae (McI.)</td></tr>
<tr><td>258210</td><td>La Salle, Man.||coll. #1 Fld. 1||8/05/75||H. G. WYLIE++Diaeretella||rapae (McI)</td></tr>
<tr><td>258209</td><td>La Salle, Man.||coll. #1 Fld. 1||8/05/75||H. G. WYLIE++Diaeretella||rapae (McI) W. R. Mason 75</td></tr>
<tr><td>258208</td><td>FLD 1 SAMPLE 2||VOL> RAPE||08/05/75||H. G. WYLIE++Diaeretella||rapae (McI) W. R. Mason 75</td></tr>
<tr><td colspan="2">Cheloninae</td></tr>
<tr><td colspan="2">Ascogaster argentifrons. New Record for Manitoba</td></tr>
<tr><td>248810</td><td>Winnipeg, Man.||Coll 9 Feb 80||Leaf Litter||R. bilodeau++para pupa||11 Feb 80||Em. Mar 80</td></tr>
<tr><td colspan="2">Chelonus sericeus. New Record for Manitoba</td></tr>
</table>

248809 Oakbank, Man.||H. Coll 28 May, 1981|| G.L. Ayre ++H.L. Feltia ducens||PP 29 June 1981||Em: 15 July 1981++ W.R. Mason 81'

248808 Oakbank, Man.||H. Coll 28 May, 1981|| G.L. Ayre ++H.L. Euxoa ochrogaster||PP 29 June 1981||Em: 15 July 1981++ W.R. Mason 81'

Euphorinae

Meteorus humilis. New Record for Manitoba

249424 Winnipeg, Man.||3 Nov 1982||I.R. Wylie-Toal++From Leaf Litter

Meteorus hyphantriae. New Record for Manitoba

249323 Starbuck, Man.||Coll #10 Fld 5||11/06/75||H.G.Wylie

Meteorus pendulus. New Record for Manitoba

249425 Gnadenthal Man.||Lot 220||Coll. Sept 9/74 ||G. Layre++Light trap in sugar beet field

249427 Birtle, Man.||Lot 197||Em: Sept 18/74||H.G. Wylie++Host: Lepid larva coll. On rape aug 26/74

Opiinae

Biosteres carbonarius. New Record for Manitoba

248780 Glenlea, Man.||Coll. 93 Subplot I||15/08/78||H.G. Wylie

Diachasma alloeum. New Record for Manitoba

248887 Morden, Man.||8 AUG 1951||H.P.Rie AAROSON++Det: W. Mason 79'

Diachasmimorpha mellea. New Record for Manitoba

248894 Morden, Man.|| 8 August, 1951||H.P. Richardson++W. Mason 79

248893 Morden, Man.|| 8 August, 1951||H.P. Richardson++W. Mason 79

Opius dimidiatus. New Record for Canada and Manitoba

248886 Grandview, Man.||coll.31-8||20-V-76|H.G. Wylie

Rogadinae

Aleiodes stigmator. New Record for Manitoba

248990 Carrot R.||Sask.||Em.21-9-65||Inc.3896F.I.S.++MCMONICTA||Ex.DACTTLIMA||3896

248991 Carrot R.||Sask.||Em.21-9-65||Inc.3896F.I.S.++Acronista||Ex.DACTTLIMA||3896

248993 Carrot R.||Sask.||Em.21-9-65||Inc.3896F.I.S.++Acronicta||Ex.DACTYLIMA||3896

249000 Carrot R.||Sask.||Em.21-9-65||Inc.3896F.I.S.++Acronicta||Ex.DACTYLIMA||3896

249001 Carrot R.||Sask.||Em.21-9-65||Inc.3896F.I.S.++Acronicta||Ex.DACTYLIMA||3896

248995 CARROT||RIVER,SASK.||Em.23-9-65||Ex3896-O.I.S.++Ex.3896-01||Ex.Acronicta||dactylina||W65

248996 CARROT||RIVER,SASK.||Em.23-9-65||Ex3896-O.I.++Ex.3896-01||Ex.Acronicta||dactylina||W65

248997 CARROT||RIVER,SASK.||Em.23-9-65||Ex3896-O.I.S.++Ex.3896-01||Ex.Acronicta||dactylina||W65

248998 CARROT||RIVER,SASK.||Em.23-9-65||Ex3896-O.I.S.++Ex.3896-01||Ex.Acronicta||dactylina||W65

<table>
<tr><th>JBWM</th><th>Verbatim Label</th></tr>
<tr><td>248999</td><td>CARROT||RIVER,SASK.||Em.23-9-65||Ex3896-O.I.S.++Ex.3896-01||Ex.Acronicta||dactylina||W65</td></tr>
<tr><td>249022</td><td>DESCHHAMBAULT||LAKE, MAN.||Em. 16-9-65||Ex. 3804-01 F.I.S.++Ex 3804-01||Ex.Acronicta||dactylina||W65</td></tr>
<tr><td>249028</td><td>DESCHHAMBAULT||LAKE, SASK.||Em.16-9-65||Ex. 3804-01 F.I.S.++Ex 3804-01||Ex.Acronicta||dactylina||W65</td></tr>
<tr><td>249043</td><td>DESCHHAMBAULT||LAKE, SASK.||Em. 16-9-65||Ex. 3804-01.S.++Gx3804-01||Ex.AcronitTa||dactylina||W65</td></tr>
<tr><td>249018</td><td>Deschambault||Lk., SASK.||Em.20-10-65||Ex.4097-02 .S.++Ex. 4097-02||Ex. Acronicta||dactylina:W65</td></tr>
<tr><td>249019</td><td>Deschambault||Lk., SASK.||Em.20-10-65||Ex.4097-02 .S.++Ex. 4097-02||Ex. Acronicta||dactylina:W65</td></tr>
<tr><td>249020</td><td>Deschambault||Lk., SASK.||Em.20-10-65||Ex.4097-02 .S.++Ex. 4097-02||Ex. Acronicta||dactylina:W65</td></tr>
<tr><td>249021</td><td>Deschambault||Lake, SASK.||Em.20-10-65||Ex.4097-02 .S.++Ex. 4097-02||Ex. Acronicta||dactylina:W65</td></tr>
<tr><td>249026</td><td>EAST BRAIN-||TREE, MAN.||Em.1-9-65||Ex.3242-01 F.S.I.++Ex. 3242-01||Ex. Hyphantria||cunea W65++Meteorus||bakeri||C&D</td></tr>
<tr><td>249027</td><td>EAST BRAIN-||TREE, MAN.||Em.1-9-65||Ex.3242-01 F.S.I.++Ex. 3242-01||Ex. Hyphantria||cunea:W65</td></tr>
<tr><td>249002</td><td>Gilbert plains||Man.||Em.13-9-65||Inc.3619F.I.S.++Acronicta||Ex.Dactylina||3019</td></tr>
<tr><td>249014</td><td>Gilbert plains||Man.||Em.13-9-65||Inc.3619F.S.I.++Acronicta||Ex.Dactylina||3619</td></tr>
<tr><td>249015</td><td>Gilbert plains||Man.||Em.13-9-65||Inc.3619F.S.I.++Acronicta||Ex.Dactylina||3619</td></tr>
<tr><td>249003</td><td>Gilbert plains||Man.||Em.13-9-65||Inc.3618F.I.S.++Acronicta||Ex.Dactylina||3619</td></tr>
<tr><td>249004</td><td>Gilbert plains||Man.||Em.13-9-65||Inc.3619F.I.S.++Acronicta||Ex.Dactylina||3619</td></tr>
<tr><td>249042</td><td>Glenlea, Man.||Light traps||July 10/74.||H.G. Wylie++Rogas||stigmator||(say)</td></tr>
<tr><td>249049</td><td>Glenlea, Man.||coll. #21||7/07/75||H.G. Wylie++37++Bracon sp.</td></tr>
<tr><td>249050</td><td>Glenlea, Man.||coll. #21||7/07/75||H.G. Wylie++25++Bracon sp.</td></tr>
<tr><td>249056</td><td>Glenlea, Man.||coll.41 Vac.Sample||1/06/77||H.G. Wylie++19++Bracon||sp.</td></tr>
<tr><td>249055</td><td>Glenlea, Man.||coll.43 Vac.Sample||6/06/77||H.G. Wylie++20++Bracon||sp.</td></tr>
<tr><td>249057</td><td>Glenlea, Man.||coll.43 D-Vac.||1/08/80||H.G. Wylie++from||prostrate||knotweed++42++Bracon||sp.</td></tr>
<tr><td>249024</td><td>L. Katherine||Man||Em. 21-9-65||Inc. 3877 F.I.S.++A.dactylina||Ex. 3877||W-65</td></tr>
<tr><td>249038</td><td>L. Katherine||Man||Em. 21-9-65|| Inc. 3877 F.I.S.++A.dactylina||Ex. 3877||W-65</td></tr>
<tr><td>249044</td><td>L. Katherine||Man||Em. 21-9-65||Imc. 3877 F.I.S ++ A. Dactylina||Ex. 3877|| w-65</td></tr>
<tr><td>249045</td><td>L. Katherine||Man||Em. 21-9-65||Imc. 3877 F.I.S ++ A. Dactylina||Ex. 3877|| w-65</td></tr>
<tr><td>249046</td><td>L. Katherine||Man||Em. 21-9-65||Imc. 3877 F.I.S ++ A. Dactylina||Ex. 3877|| w-65</td></tr>
<tr><td>249047</td><td>L. Katherine||Man||Em. 21-9-65||Imc. 3877 F.I.S ++ A. Dactylina||Ex. 3877||W-65</td></tr>
<tr><td>249036</td><td>L. Katherine||Sask||Em.24-9-65||Inc.3877 F.S.I++ A. Dactylina||Ex.3877||W-65</td></tr>
<tr><td>249037</td><td>L. Katherine||Sask||Em.24-9-65||Inc.3877 F.S.I++ A. Dactylina||Ex.3877||W-65</td></tr>
<tr><td>249048</td><td>L. Katherine||Sask||Em.24-9-65||Inc.3877 F.S.I++ A. Dactylina||Ex.3877||W-65</td></tr>
</table>

249034	WADENA,||SASK.||Em.31-9-65||Inc.Ex.1314 (01F).I.S.++Ex.LITHOPHANES SP.||RRD.W65||Ex1314(01)
249035	KATHERINE||LAKE MAN;||Em. 30-9-65||Ex.387701 F.S.I++Ex.3871-01||Ex.Acronicta||dactylina||W65
249039	KATHERINE||LAKE, MAN.||Em. 30-6-65||Ex.3877-01 F.I.S++Ex. 3871-01||Ex. Acronicta||dactylina||W65
249025	MilNen||Ridge MAN||Em.8-9-65||Inc.3119 F.S.I.++Ex.Tetralopha||3119||w-65
249051	MORDEN MAN.||8 AUG 1951||H.P. RICHARDSON++BRACON SP.||W. MASON 79
249052	MORDEN MAN.||8 AUG 1951||H.P. RICHARDSON++BRACON SP.||W. MASON 79
249054	MORDEN MAN.||8 AUG 1951||H.P. RICHARDSON++BRACON SP.||W. MASON 79
249010	ordale||Sask.||Em.14-10-65||Inc.4035 F.I.S++Acronicta||Ex.Dactylina||U of S
249011	ordale||Sask.||Em.14-10-65||Inc.4035 F.I.S++Acronicta||Ex.Dactylina||U of S
249012	Ordale||Sask.||Ex. 14-10-65||Inc. 4085 F.S.I.++Acranicta||Ex. Dactylina||4085
249013	Ordale||Sask.||Ex. 14-10-65||Inc. 4085 F.S.I.++Acranicta||Ex. Dactylina||4085
249016	Ordale||Sask.||Ex. 14-10-65||Inc. 4085 F.S.I.++Acranicta||Ex. Dactylina||4085
249017	Acranicta||Ex. Dactylina||4085++Ordale||Sask||14-10-65||Inc.4085 F.S.I.
249077	Swan River, Man.||Lighttrap 2||11-VII-74||G. K. Braken++14++Petalodes||palmatus||Wly.
249078	Swan River, Man.||Lighttrap 2||17-VII-74||G. K. Braken++14++PETALODES||PALMATUS||WALLEY||W.R.MASON 94
249029	WADENA,||SASK||Em.31-9-65||Inc. Ex1314(01 F).I.S.++Ex.LITHOPANE SP.|| RRD. W65||Ex.1314(01)
249030	WADENA,||SASK||Em.31-9-65||Inc. Ex1314(01 F).I.S.++Ex.LITHOPANE SP.|| RRD. W65||Ex.1314(01)
249031	WADENA,||SASK.||Em. 21-7-65||Inc EX1314(01) F.I.S++Ex. LITHOPHANE SP.||RRD. W65||Ex.1314(01)
249033	WADENA,||SASK||Em.31-9-65||Inc. Ex1314(01 F).I.S.++Ex.LITHOPANE SP.|| RRD. W65||Ex.1314(01)
249032	WADENA,||SASK||Em. 21.7.65||Inc. Ex.1314(01) F.S.I.++Ex. LITHOPHANE SP.||RRD. W65||EX1314(01)
249008	White L.||Man||Em. 30-9-65||Inc.3945F.I.S++A Dactylina||Ex.3945||w-65
249009	White L.||Man||Em. 30-9-65||Inc.3945F.I.S++A Dactylina||Ex.3945||w-65
248994	White L.||Man||Em. 30-9-65||Inc.3945F.I.S++A. Dactylina||Ex.3945||w-65
249005	White L.||Man||Em. 30-9-65||Inc.3945F.I.S++A Dactylina||Ex.3877||w-65
249006	White L.||Man||Em. 30-9-65||Inc.3945F.I.S++A Dactylina||Ex.3945||w-65
249023	White L.||Man||Em. 5-10-65||Inc.3945F.I.S++Acronicta||Ex. Dactylina||3945||w-65
249007	White L.||Man||Em. 5-10-65||Inc.3945F.I.S++Mconista||Ex. Dactylina||3045||w-65
249053	WINNIPEG, MAN.||3 NOV. 1982||I.R.WYLIE-TOAL++From||leaf litter++Bracon sp.||Det. M.J. Sharkey 1984
249079	WINNIPEG, MAN.||3 NOV. 1982||I.R.WYLIE-TOAL++From||leaf litter++Cantharoctonus canadensis||Det. M.J. Sharkey 1984
249041	WINNIPEG, MAN||7 APRIL,1983||I.R. WYLIE-TOAL++From||leaf litter++Rogas||stigmator (say)||M. Sharkey /84

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References

Agriculture and Agri-Food Canada. 2013. Canada's Farm Income Forecast for 2012 and 2013. Available from http://www.agr.gc.ca/ [accessed 10 July 2013].

Ahlstrom, K.R. 2005. Revision of the Subfamily Macrocentrinae (Hymenoptera: Braconidae) in America North of Mexico. Entomological Society of America, Lanham, Maryland.

Askew, R.R., and Shaw, M.R. 1986. Parasitoid communities: their size, structure and development. *In* Insect Parasitoids, 13th Symposium of Royal Entomological Society of London. *Edited by* J. Waage and D. Greathead. Academic Press, London, U.K. pp. 225–264.

Austin, A., and Dangerfield, P.C. 1998. Biology of *Mesostoa kerri* (Insecta: Hymenoptera: Braconidae: Mesostoinae), an endemic Australian wasp that causes stem galls on *Banksia marginata*. Australian Journal of Botany, **46**: 559–569.

Austin, A., and Dowton, M. 2000. Hymenoptera: Evolution, Biodiversity, and Biological Control. CSIRO, Canberra, Australia.

Balduf, W.V. 1959. Obligatory and Facultative Insects in Rose Hips: Their Recognition and Bionomics. Illinois Biological Monographs 26. University of Illinois Press, Urbana-Champaign, Illinois.

Batulla, B.A., and Robinson, A.G. 1984. Hymenopterous parasitoids of aphids (Homoptera: Aphididae) in Manitoba. Proceedings of the Entomological Society of Manitoba, **40**: 30–38.

Bonvin, M., Kojic, D., Blank, F., Annaheim, M., and Wehrle, I. 2004. Stage-dependent expression of *Chelonus inanitus* polydnavirus genes in the host and the parasitoid. Journal of Insect Physiology, **50**: 1015–1026.

Brewer, M.J., Nelson, D.J., and Ahern, R.G. 2001. Recovery and range expansion of parasitoids (Hymenoptera: Aphelinidae and Braconidae) released for biological control of *Diuraphis noxia* (Homoptera: Aphididae) in Wyoming. Environmental Entomology, **30**: 578–588.

Cárcamo, H.A., Weaver, D.K., Meers, S.M., Beres, B.L., and Mauduit, A.L. 2012. First record of *Bracon lissogaster* (Hymenoptera: Braconidae) in Canada—a potentially important parasitoid of *Cephus cinctus* (Hymenoptera: Cephidae) in the prairies. Biocontrol Science and Technology, **22**: 367–369.

Charlet, L.D. 2002. Parasitization of the red sunflower seed weevil (Coleoptera: Curculionidae) by its larval parasitoid, *Triaspis aequoris* (Hymenoptera: Braconidae) in cultivated sunflower. Environmental Entomology, **31**: 844–851.

Clausen, C.P. 1940. Entomophagous Insects. MacGraw-Hill, New York.

DeBoo, R.F., Sippell, W.L., and Wong, H.R. 1971. The eastern pine-shoot borer, *Eucosma gloriola* (Lepidoptera: Tortricidae), in North America. The Canadian Entomologist, **103**: 1473–1486.

Fernández-Triana, J. 2010. Eight new species and an annotated checklist of Microgastrinae (Hymenoptera, Braconidae) from Canada and Alaska. Zookeys, **63**: 1–53.

Fischer, M. 1964. Die Opiinae der Nearktischen region (Hymenoptera, Braconidae). I. Teil. Polskie Pismo Entomologiczne, **34**: 197–530.

Fischer, M. 1965. Die Opiinae der Nearktischen region (Hymenoptera, Braconidae). II. Teil. Polskie Pismo Entomologiczne, **35**: 3–212.

Fischer, M. 1974. Die Nearktischen *Phaenocarpa*-Arten. Revision der gruppe B. (Hymenoptera, Braconidae, Alysiinae). Polskie Pismo Entomologiczne, **44**: 103–230.

Fischer, M. 1977. Hymenoptera Braconidae (Opiinae II). (Amerika). Das Tierreich, **96**: 1–1001.

Fortier, J.C. 2007. The *Aleiodes pilosus* group (= *Tetrasphaeropyx* Ashmead) species of Canada, including seven new species and a key (Hymenoptera: Braconidae, Rogadinae). Transactions of the American Entomological Society Philadelphia, **133**: 1–20.

Fox, A.S., Shaw, S.R., Dosdall, L.M., and Lee, B. 2004. *Microctonus melanopus* (Ruthe) (Hymenoptera: Braconidae), a parasitoid of adult cabbage seedpod weevil (Coleoptera: Curculionidae): distribution in southern Alberta and female diagnosis. Journal of Entomological Science, **39**: 350–361.

Gauld, I.D. 1988. Evolutionary patterns of host utilization by ichneumonoid parasitoids (Hymenoptera: Ichneumonidae and Braconidae). Biological Journal of the Linnean Society, **35**: 351–377.

Goulet, H. 1992. The Genera and Subgenera of the Sawflies of Canada and Alaska: Hymenoptera: Symphyta. Part 20. The Insects and Arachnids of Canada. Research Branch, Agriculture Canada, Ottawa, Ontario.

Goulet, H., and Mason, P.G. 2006. Review of the Nearctic species of *Leiophron* and *Peristenus* (Hymenoptera: Braconidae: Euphorinae) parasitizing *Lygus* (Hemiptera: Miridae: Mirini). Zootaxa, **1323**: 1–118.

Grossniklaus-Bürgin, C., Wyler, T., Pfister-Wilhelm, R., and Lanzrein, B. 1994. Biology and morphology of the parasitoid *Chelonus inanitus* (Braconidae, Hymenoptera) and effects on the development of its host *Spodoptera littoralis* (Noctuidae, Lepidoptera). Invertebrate Reproduction and Development, **25**: 143–158.

Gupta, V.K. (*Editor*) 1988. Advances in Parasitic Hymenoptera Research. E.J. Brill, New York.

Halstead, J.A. 1989. Hymenoptera associated with a California population of the Russian thistle biological control agent *Coleoptera klimeschiella* Toll (Lepidopetra: Coleophoridae). Proceedings of the Entomological Society of Washington, **91**: 635–636.

Harper, A.M. 1976. The pea aphid parasite *Aphidius smithi* (Hymenoptera: Braconidae), found in Alberta. The Canadian Entomologist, **108**: 1296.

Huddleston, T., and Walker, A.K. 1988. *Cardiochiles* (Hymenoptera: Braconidae), a parasitoid of lepidopterous larvae, in the Sahel of Africa, with a review of the biology and host relationships of the genus. Bulletin of Entomological Research, **78**: 435–461.

Inayatullah, M., Shaw, S.R., and Quicke, D.L.J. 1998. The genus *Vipio* Latreille (Hymenoptera: Braconidae) of America north of Mexico. Journal of Natural History, **32**: 117–148.

Johnson, J.W. 1987. A revision of the species of *Praon* Haliday in North America north of Mexico (Hymenoptera: Aphididae). The Canadian Entomologist, **119**: 999–1025.

Jones, D. 1985. Endocrine interaction between host (Lepidoptera) and parasite (Cheloninae: Hymenoptera): is the host or the parasite in control? Annals of the Entomological Society of America, **78**: 141–148.

Jones, O.R., Purvis, A., Baumgart, E., and Quicke, D.L.J. 2009. Using taxonomic revision data to estimate the geographic and taxonomic distribution of undescribed species richness in the Braconidae (Hymenoptera: Ichneumonoidea). Insect Conservation and Diversity, **2**: 204–212.

Kaeslin, M., Reinhard, M., Bühler, D., Roth, T., Pfister-Wilhelm, R., and Lanzrein, B. 2010. Venom of the egg-larval parasitoid *Chelonus inanitus* is a complex mixture and has multiple biological effects. Journal of Insect Physiology, **56**: 686–694.

Krause, S.C., Fuester, R.W., and Burbutis, P.P. 1990. Competitive interactions between *Cotesia melanoscelus* and *Glyptapanteles flavicoxis* (Hymenoptera: Braconidae): implications for biological control of gypsy moth (Lepidoptera: Lymantriidae). Environmental Entomology, **19**: 1543–1546.

Loan, C.C. 1974. The North American species of *Leiophron* Nees, 1818 and *Peristenus* Foerster, 1862 (Hymenoptera: Braconidae) including the descriptions of 31 new species. Naturaliste canadien, **101**: 821–860.

Loan, C.C. 1979. Three new species of *Peristenus* Foerster from Canada and western Europe (Hymenoptera: Braconidae, Euphorinae). Naturaliste canadien, **106**: 387–391.

Lu, J.F., Hu, J., and Fu, W.J. 2006. Levels of encapsulation and melanization in two larval instars of *Ostrinia furnacalis* Guenée (Lep., Pyralidae) during simulation of parasitization by *Macrocentrus cingulum* Brischke (Hym., Braconidae). Journal of Applied Entomology, **130**: 290–296. doi:10.1111/j.1439-0418.2006.01054.x.

Mace, G.M. 2004. The role of taxonomy in species conservation. Philosophical Transactions of the Royal Society of London Series B: Biological Sciences, **359**: 711–719.

Macfadyen, S., Cunningham, S.A., Costamagna, A.C., and Schellhorn, N.A. 2012. Managing ecosystem services and biodiversity conservation in agricultural landscapes: are the solutions the same? Journal of Applied Ecology, **49**: 690–694.

Mackauer, M., and Campbell, A. 1972. The establishment of three exotic parasites (Hymenoptera: Aphidiidae) in British Columbia. Journal of the Entomological Society of British Columbia, **69**: 54–58.

Marsh, P.M. 1961. A taxonomic study of the genus *Cremnops* Foerster in America north of Mexico (Hymenoptera: Braconidae). Annals of the Entomological Society of America, **54**: 851–861.

Marsh, P.M. 1965. The Nearctic Doryctinae I. A review of the subfamily with a taxonomic revision of the tribe Hecabolini (Hymenoptera: Braconidae). Annals of the Entomological Society of America, **58**: 668–699.

Marsh, P.M. 1966. The Nearctic Doryctinae, II. The genus *Doryctodes* Hellen (Hymenoptera: Braconidae). Transactions of the American Entomological Society, **92**: 503–517.

Marsh, P.M. 1969. The Nearctic Doryctinae, VII. The genus *Doryctes* Haliday (Hymenoptera: Braconidae). Transactions of the American Entomological Society, **94**: 379–405.

Marsh, P.M. 1976. The Nearctic Doryctinae, X. The genus *Rhaconotus* Ruth (Hymenoptera: Braconidae). Proceedings of the Entomological Society of Washington, **78**: 389–403.

Marsh, P.M. 1977. Notes on the taxonomy and nomenclature of *Aphidius* species (Hym.: Aphidiidae) parasitic on the pea aphid in North America. Entomophaga **22**: 365–372.

Marsh, P.M., and Shaw, S.R. 1999. Revision of North American *Aleiodes* Wesmael (Part 5): the *melanopterus* (Erichson) species-group (Hymenoptera: Braconidae, Rogadinae). Journal of Hymenoptera Research, **8**: 98–108.

Marsh, P.M., and Shaw, S.R. 2001. Revision of North American *Aleiodes* Wesmael (Part 6): the *gasterator* (Jurine) and *unipunctator* (Thunberg) species-groups (Hymenoptera: Braconidae: Rogadinae). Proceedings of the Entomological Society of Washington, **103**: 291–307.

Martin, J.C. 1956. A Taxonomic Revision of the Triaspidine Braconid Wasps of Nearctic America (Hymenoptera). Canadian Department of Agriculture, Ottawa, Ontario.

Mason, W.R.M. 1959. Some new Braconidae (Hymenoptera). The Canadian Entomologist, **91**: 42–50.

Mason, W.R.M. 1968. New Canadian Braconidae (Hymenoptera). The Canadian Entomologist, **100**: 715–728.

Mason, W.R.M. 1974. The *Apanteles* species (Hymenoptera: Braconidae attacking Lepidoptera in the micro-habitat of the spruce budworm (Lepidoptera: Tortricidae). The Canadian Entomologist, **106**: 1087–1102.

Mason, W.R.M. 1976. The identity of *Macrocentrus uniformis* Provancher (nec. Cresson), description of a sibling species and a possible grooming organ (Hym.: Braconidae). Naturaliste canadien, **103**: 513–515.

Mason, W.R.M. 1978. A synopsis of the Nearctic Braconini, with revisions of Nearctic species of *Coeloides* and *Myosoma* (Hymenoptera: Braconidae). The Canadian Entomologist, **110**: 721–765.

Mason, W.R.M. 1979. A new *Rogas* (Hymenoptera: Braconidae) parasite of tent caterpillars (*Malacosoma* spp.; Lepidoptera: Lasiocampidae) in Canada. The Canadian Entomologist, **111**: 783–786.

Matthews, R.W. 1970. A revision of the genus *Spathius* in America north of Mexico (Hymenoptera, Braconidae). Contributions of the American Entomological Institute, **4**: 1–86.

McComb, C.W. 1968. A Revision of the *Chelonus* Subgenus *Microchelonus* in North America North of Mexico (Hymenoptera: Braconidae). University of Maryland Agricultural Experiment Station Bulletin.

Muesebeck, C.F.W. 1921. A revision of the North American species of ichneumon-flies belonging to the genus *Apanteles*. Proceedings of the United States National Museum, **58**: 483–576.

Muesebeck, C.F.W. 1923. A revision of the North American species of Ichneumon-flies belonging to the genus *Meteorus* Haliday. Proceedings of the United States National Museum, **63**: 1–44.

Muesebeck, C.F.W. 1958. Family Braconidae. *In* Hymenoptera of America North of Mexico Synoptic Catalog, first supplement. *Edited by* K.V. Krombein. United States Department of Agriculture, Agricultural Monograph 2, Washington, D.C. pp. 18–36.

Muesebeck, C.F.W. 1967. Family Braconidae. *In* Hymenoptera of America North of Mexico Synoptic Catalog, second supplement. *Edited by* K.V. Krombein and B.D. Burks. United States Government Printing Office, Agriculture Monograph 2, Washington, D.C. pp. 27–60.

Muesebeck, C.F.W. 1970. The Nearctic species of *Orgilus* Haliday (Hymenoptera: Braconidae). Smithsonian Contributions to Zoology, **30:** 1–104.

Nelson, W.A., and Farstad, C.W. 1953. Biology of *Bracon cephi* (Gahan) (Hymenoptera: Braconidae), an important native parasite of the wheat stem sawfly, *Cephus cinctus* Nort. (Hymenoptera: Cephidae), in western Canada. The Canadian Entomologist, **85**: 103–107.

Olfert, O.O., Doane, J.F., Carl, K., Erlandson, M.A., and Goettel, M.S. 2002. *Diuraphis noxia* (Kurdjumov), Russian wheat aphid (Homoptera: Aphididae). *In* Biological Control Programmes in Canada, 1981–2000. *Edited by* P.G. Mason and J.T. Huber. CAB Publishing, Oxon, U.K. pp. 110–119.

Papp, J., and Shaw, S.R. 2000. A study of the genus *Falcosyntretus* Tobias from the new world with five new species and a key to known species (Hymenoptera: Braconidae: Euphorinae). Proceedings of the Entomological Society of Washington, **102**: 634–642.

Pike, K.S., Starý, P., Miller, T., Graf, G., Allison, D., Boydston, L., and Miller, R. 2000. Aphid parasitoids (Hymenoptera: Braconidae: Aphidiinae) of Northwest USA. Proceedings of the Entomological Society of Washington, **102**: 688–740.

Pivnick, K. 1993. Response of *Meteorus leviventris* (Hymenoptera: Braconidae) to mustard oils in field trapping experiments. Journal of Chemical Ecology, **19**: 2075–2079.

Powell, J.M. 1971. The arthropod fauna collected from the comandra blister rust, *Cronartium comandrae*, on lodgepole pine in Alberta. The Canadian Entomologist, **103**: 908–918.

Quicke, D.L. 1994. Phylogenetics and biological transitions in the Braconidae (Hymenoptera: Ichneumonoidea). Norwegian Journal of Agricultural Sciences Supplement, **16**: 155–162.

Quicke, D.L.J., and van Achterberg, C. 1990. Phylogeny of the subfamilies of the family Braconidae (Hymenoptera: Ichneumonoidea). Zoologische Verhandelingen Leiden, **258**: 1–180.
Riddick, E.W., Cottrell, T.E., and Kidd, K.A. 2009. Natural enemies of the Coccinellidae: parasites, pathogens, and parasitoids. Biological Control, **51**: 306–312.
Saffer, B. 1982. A systematic revision of the genus *Cenocoelius* (Hymenoptera: Braconidae) in North America including Mexico. Polskie Pismo Entomologiczne, **52**: 73–167.
Samson, F.B., and Knopf, F.L. 1996. Prairie Conservation: Preserving North America's Most Endangered Ecosystem. Island Press, Washington, D.C.
Sarfraz, R.M., Dosdall, L.M., Blake, A.J., and Keddie, B.A. 2010. Leaf nutrient levels and the spatio-temporal distributions of *Plutella xylostella* and its larval parasitoids *Diadegma insulare* and *Microplitis plutellae* in canola. BioControl, **55**: 229–244.
Sarfraz, R. M., Keddie, A.B., and Dosdall, L.M. 2005. Biological control of the diamondback moth, *Plutella xylostella*: a review. Biocontrol Science and Technology, **15**: 763–789.
Schaaf, A.C. 1972. The parasitoid complex of *Euxoa ochrogaster* (Guenee) (Lepidoptera: Noctuidae). Quaestiones Entomologicae, **8**: 81–120.
Sharanowski, B.J., Dowling, A.P.G., and Sharkey, M.J. 2011. Molecular phylogenetics of Braconidae (Hymenoptera: Ichneumonoidea) based on multiple nuclear genes, and its implications for classification. Systematic Entomology, **36**: 549–572.
Sharkey, M.J. 1985. Notes on the genera *Bassus* Fabricius and *Agathis* Latreille, with a description of *Bassus arthurellus* n.sp. (Hymenoptera: Braconidae). The Canadian Entomologist, **117**: 1497–1502.
Sharkey, M.J. 1992. Cladistics and tribal classification of the Agathidinae (Hymenoptera: Braconidae). Journal of Natural History, **26**: 425–447.
Sharkey, M.J., Arthur, A., Bisdee, G., Yoshimoto, C., and Barron, J. 1987. The parasitic Hymenoptera associated with sunflower (*Helianthus* spp.) in mid-western Canada. The Canadian Entomologist, **119**: 611–628.
Sharkey, M.J., and Janzen, D.H. 1995. Review of the world species of *Sigalphus* (Hymenoptera: Braconidae: Sigalphinae) and biology of *Sigalphus romeroi*, new species. Journal of Hymenoptera Research, **4**: 99–109.
Sharkey, M.J., Laurenne, N., Sharanowski, B.J., Quicke, D.L.J., and Murray, D. 2006. Revision of the Agathidinae (Hymenoptera: Braconidae) with comparisons of static and dynamic alignments. Cladistics, **22**: 546–567.
Shaw, S.R. 1983. A taxonomic study of Nearctic *Ascogaster* and a description of a new genus *Leptodrepana* (Hymenoptera: Braconidae). Entomography, **2**: 1–54.
Shaw, S.R. 1992. Seven new North American species of *Neoneurus* (Hymenoptera: Braconidae). Proceedings of the Entomological Society of Washington, **94**: 26–47.
Shaw, S.R. 2004. Essay on the evolution of adult-parasitism in the subfamily Euphorinae (Hymenoptera: Braconidae). Trudy Russkogo Entomologicheskogo Obshchestva, **75**: 82–95.
Shaw, S.R., and Marsh, P.M. 2004. Two new Eastern North American species of the *Aleiodes coxalis* (Spinola) species-group (Hymenoptera: Braconidae, Rogadinae) reared from Geometridae. Zootaxa, **656**: 1–10.
Shaw, S.R., Marsh, P.M., and Fortier, J.C. 1998. Revision of North American *Aleiodes* Wesmael (Part 4): the *albitibia* Herrich-Schaeffer and *praetor* Reinhard species-groups (Hymenoptera: Braconidae: Rogadinae) in the New World. Proceedings of the Entomological Society of Washington, **100**: 553–565.
Shaw, S.R., Marsh, P.M., and Fortier, J.C. 2006. Revision of Nearctic *Aleiodes* Wesmael (part 8): the *coxalis* (Spinola) species-group (Hymenoptera: Braconidae, Rogadinae). Zootaxa, **1314**: 1–30.
Shorthouse, J.D. 2010. Ecoregions of Canada's prairie grasslands. *In* Arthropods of Canadian Grasslands, Vol. 1: Ecology and Interactions in Grassland Habitats. *Edited by* J.D. Shorthouse and K.D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 53–81.
Smith, M.A., Rodriguez, J.J., Whitfield, J.B., Deans, A.R., Janzen, D.H., Hallwachs, W., and Hebert, P.D.N. 2008. Extreme diversity of tropical parasitoid wasps exposed by iterative integration of natural history, DNA barcoding, morphology, and collections. Proceedings of the National Academy of Sciences, **105**: 12359–12364.
Spencer, L., and Whitfield, J.B. 1999. Revision of the Nearctic species of *Rhysipolis forster* (Hymenoptera: Braconidae). Transactions of the American Entomological Society, **125**: 295–324.
Starý, P. 1974. Taxonomy, origin, distribution and host range of *Aphidius* species [Hym., Aphidiidae] in relation to biological control of the pea aphid in Europe and North America. Zeitschrift für Angewandte Entomologie, **77**: 141–171.
Still, G.N., and Wong, H.R. 1973. Life history and habits of a leaf miner, *Cameraria macrocarpae*, on bur oak in Manitoba (Lepidoptera: Gracillariidae). The Canadian Entomologist, **105**: 239–244.

Strickland, E.H. 1921. The invasion of southern Alberta by beet webworms. Reports of the Entomological Society of Ontario, **51**: 29–31.
Strickland, E.H. 1946. An annotated list of the Ichneumonoidea of Alberta. The Canadian Entomologist, **78**: 36–46.
Strickland, E.H. 1952. Additions to the list of Ichneumonoidea from Alberta. The Canadian Entomologist, **84**: 118–122.
Treherne, R.C. 1916. A preliminary list of parasitic insects known to occur in Canada. Reports of the Entomological Society of Ontario, **46**: 178–193.
van Achterberg, C. 1976. A revision of the tribus Blacini (Hymenoptera: Braconidae: Helconinae). Tijdschrift voor Entomologie, **118**: 159–322.
van Achterberg, C. 1979. A revision of the subfamily Zelinae Auct. (Hymenoptera: Braconidae). Tijdschrift voor Entomologie, **122**: 241–479.
van Achterberg, C. 1988. Revision of the subfamily Blacinae Foerster (Hymenoptera: Braconidae). Zoologische Verhandelingen Leiden, **249**: 1–324.
van Achterberg, C. 1992. Revision of the genus *Histeromerus* Wesmael (Hymenoptera: Braconidae). Zoologische Mededelingen, **66**: 189–196.
van Achterberg, C. 1995. Generic revision of the subfamily Betylobraconinae (Hymenoptera: Braconidae) and other groups with modified fore tarsus. Zoologische Verhandelingen Leiden, **298**: 1–242.
Wesley, J., Williams, D.J.M., Langor, D.W., and Spence, J.R. 2006. Spruce beetle (Coleoptera: Scolytidae) parasitoids: cephalic morphology of larvae and a key to species (Hymenoptera: Braconidae, Pteromalidae). The Canadian Entomologist, **138**: 87–90.
Wharton, R.A. 1978. Exodontiellini, a new tribe of Opiinae with exodont mandibles. Pan-Pacific Entomologist, **53**: 297–303.
Wharton, R.A. 1980. Review of the Nearctic Alysiini (Hymenoptera, Braconidae) with Discussion of Generic Relationships within the Tribe. University of California Press, Berkeley.
Wharton, R.A. 1984. Biology of the Alysiini (Hymenoptera: Braconidae), parasitoids of cyclorrhaphous Diptera. Texas Agricultural Experimental Station Technical Monograph, **11**: 1–39.
Wharton, R.A. 1986. The braconid genus *Alysia* (Hymenoptera): description of the subgenera and a revision of the subgenus *Alysia*. Systematic Entomology, **11**: 453–504.
Wharton, R.A. 1988*a*. The braconid genus *Alysia* (Hym.): a revision of the subgenus *Anarcha*. Contributions of the American Entomological Institute, **25**: 1–69.
Wharton, R.A. 1988*b*. Classification of the braconid subfamily Opiinae (Hymenoptera). The Canadian Entomologist, **120**: 333–360.
Wharton, R.A. 1993. Bionomics of the Braconidae. Annual Review of Entomology, **38**: 121–143.
Wharton, R.A., Marsh, P.M., and Sharkey, M.J. (*Editors*) 1997. Manual of the New World Genera of the Family Braconidae. The International Society of Hymenopterists, Washington, D.C.
Whitfield, J.B. 1988. Revision of the Nearctic species of the genus *Stiropius* Cameron (=*Bucculatriplex* Auct.) with the description of a new related genus (Hymenoptera: Braconidae). Systematic Entomology, **13**: 373–385.
Whitfield, J.B. 1995. Annotated checklist of the Microgastrinae of North America north of Mexico (Hymenoptera: Braconidae). Journal of the Kansas Entomological Society, **68**: 245–262.
Whitfield, J.B. 1997. Subfamily Microgastrinae. *In* Manual of the New World Genera of the Family Braconidae (Hymenoptera). *Edited by* R.A. Wharton, P.M. Marsh, and M.J. Sharkey. International Society of Hymenopterists, Washington, D.C. pp. 333–364.
Whitfield, J.B. 2006. Revision of the Nearctic species of the genus *Pholetesor* Mason (Hymenoptera: Braconidae). Zootaxa, **1144**: 3–94.
Williams, D.J.M. 1988. Classification, phylogeny and zoogeographic studies of species of *Sathon* Mason (Hymenoptera: Braconidae). Quaestiones Entomologicae, **24**: 529–638.
Wishart, G. 1957. Surveys of parasites of *Hylemya* spp. (Diptera: Anthomyiidae) that attack cruciferous crops in Canada. The Canadian Entomologist, **89**: 450–454.
Wong, H.R. 1972. *Dioryctria banksiella* (Lepidoptera: Pyralidae) in the western gall rust, *Endocronartium harknessii* (Basidiomycetes: Uredinales). The Canadian Entomologist, **104**: 251–255.
Wright, E.J., and Laing, J.E. 1982. State-specific mortality of *Coleomegilla maculata lengi* Timberlake on corn in Southern Ontario. Environmental Entomology, **11**: 32–37.
Wylie, H.G. 1981. Effects of collection method on estimates of parasitism and sex ratio of flea beetles (Coleoptera: Chrysomelidae) that infest rape crops in Manitoba. The Canadian Entomologist, **113**: 665–671.
Wylie, H.G. 1982. An effect of parasitism by *Microctonus vittatae* (Hymenoptera: Braconidae) on emergence of *Phyllotreta cruciferae* and *Phyllotreta striolata* (Coleoptera: Chrysomelidae) from overwintering sites. The Canadian Entomologist, **114**: 727–732.

Wylie, H.G. 1988. Release in Manitoba, Canada of *Townesilitus bicolor* (Hym.: Braconidae), an European parasite of *Phyllotreta* spp. (Col.: Chrysomelidae). Entomophaga, **33**: 25–32.

Wylie, H.G., and Bucher, G.E. 1977. The bertha armyworm, *Mamestra configurata* (Lepidoptera: Noctuidae). Mortality of immature stages on the rape crop, 1972–1975. The Canadian Entomologist, **109**: 823–837.

Wylie, H.G., and Loan, C.C. 1984. Five Nearctic and one introduced Euphorine species (Hymenoptera: Braconidae) that parasitize adults of crucifer-infesting flea beetles (Coleoptera: Chrysomelidae). The Canadian Entomologist, **116**: 235–246.

Wylie, H.G., Matheson, F.O., Uddin, M.J., and Holliday, N.J. 2005. Release and establishment studies in Manitoba, Canada, of *Aphidius smithi* (Hymenoptera: Aphidiidae), a parasitoid of *Acyrthosiphon pisum* (Hemiptera: Aphididae). The Canadian Entomologist, **137**: 91–97.

Yu, D.S., Horstmann, K., and van Achterberg, C. 2011. Taxapad: Scientific Names for Information Management. Biological and Taxonomical Information: Ichneumonoidea 2011 [CD]. Taxapad, Vancouver, British Columbia.

Zaldivar-Riverón, A., Shaw, M.R., Sáez, A.G., Mori, M., Belokobylskij, S.A., Shaw, S.R., and Quicke, D.L.J. 2008. Evolution of the parasitic wasp subfamily Rogadinae (Braconidae): phylogeny and evolution of lepidopteran host ranges and mummy characteristics. BMC Evolutionary Biology, **8**: 329.

Zettel, H. 1992. Revision der *Phanerotoma*—Arten Nordamerikas (Hymenoptera: Braconidae, Cheloninae). Linzer Biologische Beiträge, **24**: 275–330.

Chapter 11
The Bees (Hymenoptera: Apoidea, Apiformes) of the Prairies Ecozone with Comparisons to other Grasslands of Canada

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Abstract. The prairie grasslands of Canada are home to at least 387 bee species. This represents almost half (i.e., 48%) of the bee taxa reported for Canada and over 90% of the total recorded from the three Prairie Provinces of Alberta, Saskatchewan, and Manitoba. The Prairies Ecozone thus represents one of the most diverse and important areas supporting bee diversity in the country, with 23% of the bee species listed not found anywhere else in Canada, a value similar to that of the tallgrass savanna of the Mixedwood Plains Ecozone (southern Ontario and Québec) and only surpassed by that of the bunchgrass/sagebrush grasslands of the Western Interior Basin Ecozone (south central British Columbia) with respect to endemism. However, the Canadian Prairies support a higher proportion of bee species with dietary specialization; over half of these are oligoleges of the Asteraceae. Over 70% of the native prairie grasslands were lost before 1990. Therefore, it is likely that many of the endemic floral specialists have also become much less common, though little baseline data exist for rigorous comparison. Much of the Canadian Prairies have not been surveyed extensively for bees, and several new records are reported here. A full taxonomic review of the bees of the prairie grasslands is presented, including bionomic summaries.

Résumé. Les prairies canadiennes abritent au moins 386 espèces d'abeilles, soit près de la moitié (48 %) de tous les taxons de ce groupe répertoriés au Canada et plus de 90 % du total des taxons signalés dans les trois provinces des Prairies —Alberta, Saskatchewan et Manitoba. L'écozone des prairies constitue une des régions les plus importantes pour le maintien de la diversité des abeilles au Canada : 23 % des espèces d'abeilles recensées n'existent nulle part ailleurs dans le pays, un pourcentage d'endémisme semblable à celui établi pour les prairies à herbes hautes de l'écozone des plaines à forêts mixtes (sud de l'Ontario) et qui n'est surpassé que dans les peuplements de graminées cespiteuses ou d'armoises de l'écozone du bassin intérieur de l'ouest (centre-sud de la Colombie-Britannique). Les prairies herbeuses abritent cependant une proportion plus élevée d'abeilles affichant une spécialisation alimentaire, la moitié étant des espèces oligolectiques strictement inféodées aux Asteraceae. Plus de 70 % des peuplements de prairies indigènes étaient déjà disparus en 1990. Il est donc probable que plusieurs des espèces endémiques oligolectiques de ces habitats soient devenues beaucoup plus rares, même si l'on dispose de peu de données de référence permettant une comparaison rigoureuse. Seule une infime partie de l'écozone des prairies a fait l'objet de recensements complets des abeilles, et ce chapitre présente plusieurs nouvelles mentions. Il propose en outre un examen taxonomique complet des abeilles des prairies herbeuses, accompagné de résumés bionomiques.

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Introduction

No previous review of the bee species occurring in Canada or any of its ecozones has been completed, though distributional data from taxonomic revisions provide information for some taxa (see taxonomic treatments listed below). Previous published estimates of the number of bee species in Canada range from 520 (Hurd 1979: catalogue) to over 970 (Danks 1979: general estimate). Sheffield *et al*. (2011*a*) reported 803 species and provided totals for each province and territory, but subsequent work verifying occurrence, new synonymies, and taxonomic clarification resulted in a more conservative tally of 797 confirmed species (CSS, unpublished data). This number represents about 4% of the current world total of just over 20,000 species (Ascher and Pickering 2014). Globally, bee diversity is highest in semi-arid environments (Michener 1979, 2007), and this pattern probably holds relatively well within Canada. However, we do not have a complete picture of the bees for Canada as a whole or within many of the country's ecozones. Additional surveys, including application of genetic methods to reveal cryptic species (e.g., Gibbs 2009; Sheffield *et al*. 2009; Rehan and Sheffield 2011), should increase the confirmed number of bee species in Canada.

Bees are dependent on pollen and nectar (and in rarer cases, floral oils). Therefore, they require habitats rich in food plants to complete their life cycle. Bees also require suitable nesting sites (see Table 1), and for some species, nesting materials (Westrich 1996). Therefore, grasslands of Canada should be ideal habitats for most bees, as grasslands are dominated by herbaceous vegetation and have some of the best soil for plant growth in the country (Federal, Provincial and Territorial Governments of

Table 1. Review of the literature on bee nesting behaviour and ecology for some of the bee species occurring in the Prairies Ecozone.

Family	Reference and Bee Species
COLLETIDAE	Batra 1980: *Colletes inequalis, C. thoracicus, C. validus*
	Rajotte 1979: *Colletes validus*
	Torchio *et al.* 1988: *Colletes kincaidi*
	Fye 1965: *Hylaeus annulatus* (as *H. ellipticus*)*, H. basalis, H. verticalis*
	Torchio 1984: *Hylaeus leptocehpalus* (as *H. bisinuatus*)
ANDRENIDAE	Batra 1990: *Andrena alleghaniensis*
	Johnson 1981: *Andrena dunningi*
	Miliczky 1988: *Andrena erythrogaster*, *A. cressonii*,
	Miliczky 2008: *Andrena prunorum*
	Miliczky and Osgood 1995: *Andrena vicina, A. regularis*
	Miliczky *et al*. 1990: *Andrena nivalis*
	Norden and Scarbrough 1979: *Andrena miserabilis*
	Rozen 1973: *Andrena accepta*
	Schrader and LaBerge 1978: *Andrena carlini, A. regularis*
	Miliczky 1991: *Calliopsis coloradensis*
	Eickwort 1977*b*: *Perdita halictoides, P. octomaculata*

Family	Reference and Bee Species
HALICTIDAE	Eickwort 1981: *Agapostemon* spp.
	LaBerge and Ribble 1966: *Agapostemon sericeus* (as *L. radiatus*), *A. splendens*
	Packer and Knerer 1986: *Halictus ligatus*
	Soucy 2002: *Halictus rubicundus*
	Yanega 1990; *Halictus rubicundus*
	Batra 1987: *Lasioglossum laevissimum*
	Bohart and Youssef 1976: *Lasioglossum lusorium* (as *Evylaeus galpinsiae*), *L. abberans*
	LaBerge and Isakson 1963: *Lasioglossum zephyrum*
	McGinley 2003: *Lasioglossum* subgenus *Sphecodogastra s.s*.
	Packer and Owen 1989: *Lasioglossum cooleyi*
	Packer *et al.* 1989*a*: *Augochlora aurata*, *Lasioglossum cinctipes*, *L. laevissimum*
	Packer 1992: *Lasioglossum laevissimum*
	Packer 1994: *Lasioglossum tenax*
MELITTIDAE	Rozen and Jacobson 1980: *Macropis nuda*
MEGACHILIDAE	Custer and Hicks 1927: Anthidiini
	Clement 1974: *Dianthidium pudicum*
	Michener and Michener 1999: *Dianthidium curvatum*
	Fye 1965: *Hoplitis albifrons, H. spoliata, Osmia atriventris, O. proxima, Megachile inermis, M. relativa, M. gemula*
	Eickwort *et al.* 1981: *Megachile texana*
	Hobbs 1954: *Megachile* in prairies
	Jenkins and Matthews 2004: *Megachile frigida*
	Neff and Simpson 1991: *Megachile fortis*
	Sheffield *et al.* 2011*b*: *Megachile* in Canada
	Cane *et al*. 2007: *Osmia* spp. review
	Cane 2012: *Osmia integra*
	Parker and Tepedino 1982: *Osmia sculleni*
	Rightmyer *et al*. 2013: *Osmia* spp. review
APIDAE	Hobbs *et al.* 1961; *Anthophora occidentalis*
	Torchio 1971: *Anthophora peritomae*
	Hobbs 1964, 1965*a*, 1965*b*, 1966*a*, 1966*b*, 1967, 1968: *Bombus* spp.
	Rau 1928: *Ceratina calcarata*
	Rehan and Richards 2010: *Ceratina calcarata*
	Vickruck *et al*. 2011: *Ceratina calcarata, C. dupla*
	Eickwort 1977*a*: *Diadasia diminuta*
	Linsley and MacSwain 1957: *Diadasia* spp.
	Linsley *et al.* 1963: *Eucera speciosa*
	Miliczky 1985: *Eucera hamata*
	Linsley 1943: brief account of *Habropoda cineraria*
	Cameron *et al*. 1996: *Melissodes druriella* (as *M. rustica*)
	Clement 1973: *Melissodes druriella* (as *M. rustica*)
	Miliczky 2000: *Melissodes microsticta*
	Parker *et al*. 1981: *Melissodes agilis*

Canada 2010). These conditions have also resulted in these habitats being among the most heavily modified in the country (Scoggan 1978). Most grasslands in the three Prairie Provinces were converted to cropland prior to the 1930s (Federal, Provincial and Territorial Governments of Canada 2010), a phenomenon continuing today (Javorek and Grant 2011). Little of the original natural cover of the Canadian Prairies remains intact, and this region is now primarily an agricultural system (Riley *et al*. 2007; Shorthouse 2010). Globally, grassland systems are the most altered, and thus threatened, of all ecosystem types, yet they provide some of the most important ecological services (reviewed by Federal, Provincial and Territorial Governments of Canada 2010) and serve as regional and global "breadbaskets" for food production. Despite the key pollination service provided by bees and other organisms (Kevan and Baker 1983; Ollerton *et al*. 2011), they remain poorly studied in Canada. Current concerns about pollinator losses underscore the importance of understanding the patterns of diversity of native bees within agricultural regions and how to conserve these patterns and the services of bees. Native bees make significant contributions to crop production (Richards and Kevan 2002), though typically are not considered as important as managed pollinators (i.e., the European honey bee, *Apis mellifera*, and the alfalfa leafcutter bee, *Megachile rotundata*). Thus, native and/or restored grasslands could serve as important reservoirs of native pollinators for future crop pollination needs. In this chapter, we present a taxonomic, annotated account of all the bees of the grasslands in the Prairies Ecozone of Canada, including information on nesting biology, sociality, cleptoparasitism, and floral relations. General comparisons will be made to grasslands ecoregions within the Western Interior Basin and Mixedwood Plains.

Sources for Distributional Information Used in This Review

The data used to compile the lists were obtained from published taxonomic papers and/or diversity studies, catalogues (Hurd 1979; Moure and Hurd 1987), and recent surveys and examination of specimens in various collections across Canada and the United States. These collections included the Canadian National Collection of Insects, Arachnids, and Nematodes (CNC) (Ottawa, Ontario), York University (Toronto, Ontario), University of Guelph (Guelph, Ontario), University of Manitoba (Winnipeg, Manitoba), Manitoba Provincial Museum (Winnipeg, Manitoba), the Royal Saskatchewan Museum (Regina, Saskatchewan), University of Alberta (Edmonton, Alberta), the Royal Alberta Museum (Edmonton, Alberta), Lethbridge Research Station (Lethbridge, Alberta), the University of Calgary (Calgary, Alberta), the Royal British Columbia Museum (Victoria, British Columbia), the Beaty Biodiversity Museum, University of British Columbia (Vancouver, British Columbia), the University of Kansas (Lawrence, Kansas), the USDA Bee Biology and Systematics Laboratory (Logan, Utah), and the American Museum of Natural History (New York, New York). All species of bees from the provinces of Alberta, Manitoba, and Saskatchewan listed in the upcoming Canadian Endangered Species Conservation Council Wild Species 2015 report (CSS and Jennifer Heron, BC Ministry of Environment, unpublished data) were incorporated; this data set includes provincial/territorial listings and assignments of each species to the ecozones of Canada. All species with specimen localities within the Prairies Ecozone, including the Cypress Upland Ecoregion (Acton *et al.* 1998), as defined by the Ecological Stratification Working Group (1995) and Federal, Provincial and Territorial Governments of Canada (2010), are included in this chapter.

Bees of the Prairies Ecozone

The grasslands of the Prairies Ecozone are among the country's most diverse regions for bees (Fig. 1), potentially supporting over 387 species (Tables 2 and 3). The Prairies Ecozone also has a high percentage of bee species that are unique to this region in Canada (23%), surpassing the Mixwood Plains Ecozone (22%), and second to the Western Interior Basin Ecozone of British Columbia (33%) (Fig. 2). As most of our food production occurs in the Prairies and Mixwood Plains ecozones (Federal, Provincial and Territorial Governments of Canada 2010), agriculture in these areas is highly dependent on pollinating insects, especially bees. However, intensive agriculture has had negative impacts on wildlife in these two ecozones (Javorek and Grant 2011), probably including native bees.

The Prairie Provinces vary in bee diversity: Alberta has 323 bee species (299 in the Prairies Ecozone), Saskatchewan has 219 species (215 in the Prairies Ecozone), and Manitoba has 231 species (218 in the Prairies Ecozone). The discrepancies are partly an artifact of sampling, since previous sampling effort has been highest in southern Alberta. For example, several of the Canadian records for some bee species are limited to southern

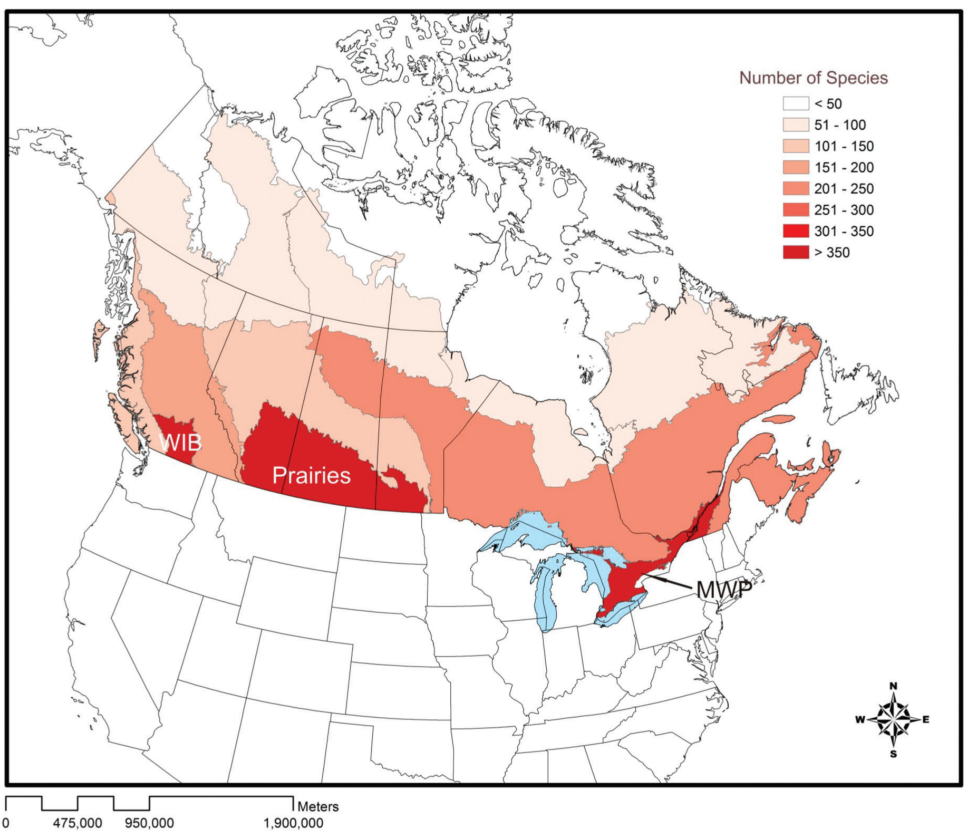

Fig. 1. The number of bee species (in increments of 50) recorded for Canada's ecozones. Darker shades represent higher species richness. Three ecozones containing grasslands are labelled: Prairies, Western Interior Basin (WIB), and Mixedwood Plains (MWP).

Alberta (98 species are reported in Canada only from this area, mostly between Lethbridge and Medicine Hat). In contrast, only 29 and 39 bee species are unique to the Prairies Ecozone of Saskatchewan and Manitoba, respectively. However, increased sampling efforts in Saskatchewan (CSS, unpublished data) and the Manitoba grasslands have resulted in at least seven new records for those provinces (see below).

Nesting Biology

The details of nesting are known for only a small proportion of bees (Thorp 1969*a*). Most bees excavate nests in the ground (Stephen *et al*. 1969; Michener 2007), though many species use small-diameter (i.e., <10 mm) pre-existing cavities in trees (e.g., created by emerging wood-boring beetles), hollow stems, or other substrates. The Prairies Ecozone offers an extensive range of nesting habitats and soil types for ground-nesting bees, but comparatively few natural nesting sites for these cavity nesters, demonstrating how landscape strongly influences the proportion of bees that are ground- or cavity-nesting

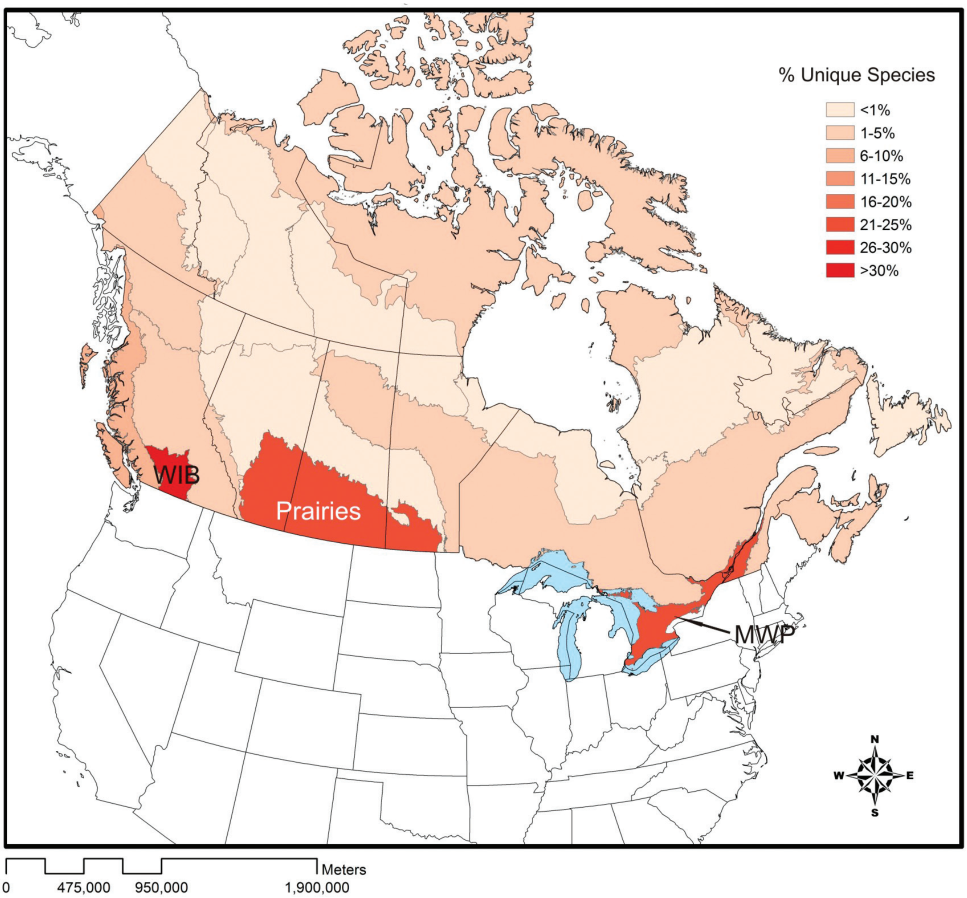

Fig. 2. The percentage of bee species unique to each ecozone in Canada. Darker shades represent higher percentages. Three ecozones containing grasslands are labelled: Prairies, Western Interior Basin (WIB), and Mixedwood Plains (MWP).

Table 2. Bee genera in Canada and the number of species of each genus recorded for the Prairies, Western Interior Basin, and Mixwood Plains Ecozones, and all of Canada.

Family/Subfamily	Genus	Number of Recorded Species in Ecozone			
		Prairies	Western Int. Basin	Mixwood Plains	Canada
COLLETIDAE					
Colletinae	*Colletes*	21	11	14	27
Hylaeinae	*Hylaeus*	10	12	12	18
ANDRENIDAE					
Andreninae	*Andrena*	68	78	70	144
Panuginae	*Calliopsis*	4	1	1	5
Panuginae	*Panurginus*	2	2	0	4
Panuginae	*Pseudopanurgus*	9	1	5	12
Panuginae	*Perdita*	9	2	6	12
HALICTIDAE					
Rophitinae	*Dufourea*	4	4	4	8
Nomiinae	*Dieunomia*	1	0	0	1
Halictinae	*Agapostemon*	8	4	4	8
Halictinae	*Augochlora*	0	0	1	1
Halictinae	*Augochlorella*	1	0	1	1
Halictinae	*Augochloropsis*	0	0	1	1
Halictinae	*Halictus*	5	5	4	7
Halictinae	*Lasioglossum*	61	43	69	122
Halictinae	*Sphecodes*	10	1	21	30
MELITTIDAE					
Melittinae	*Macropis*	1	1	1	2
MEGACHILIDAE					
Megachilinae	*Anthidiellum*	0	1	1	2
Megachilinae	*Anthidium*	3	6	3	10
Megachilinae	*Ashmeadiella*	1	3	0	3
Megachilinae	*Atoposmia*	0	1	0	1
Megachilinae	*Chelostoma*	0	2	3	5
Megachilinae	*Coelioxys*	9	13	10	15
Megachilinae	*Dianthidium*	2	4	1	5
Megachilinae	*Dioxys*	0	1	0	1
Megachilinae	*Heriades*	2	3	3	4
Megachilinae	*Hoplitis*	5	9	6	12
Megachilinae	*Megachile*	24	26	17	38
Megachilinae	*Osmia*	27	52	19	79
Megachilinae	*Protosmia*	0	1	0	1
Megachilinae	*Stelis*	8	9	8	19
APIDAE					
Xylocopinae	*Ceratina*	2	3	4	9
Xylocopinae	*Xylocopa*	0	0	1	1
Nomadinae	*Epeolus*	5	1	11	14

Family/Subfamily	Genus	Number of Recorded Species in Ecozone			
		Prairies	Western Int. Basin	Mixwood Plains	Canada
Nomadinae	*Holcopasites*	3	0	1	5
Nomadinae	*Neolarra*	2	0	0	2
Nomadinae	*Neopasites*	0	2	0	2
Nomadinae	*Nomada*	8	9	31	46
Nomadinae	*Triepeolus*	7	2	6	16
Apinae	*Anthophora*	7	11	2	12
Apinae	*Apis*	1	1	1	1
Apinae	*Bombus*	28	21	19	40
Apinae	*Diadasia*	3	1	0	3
Apinae	*Epeoloides*	1	0	1	1
Apinae	*Eucera*	5	8	0	11
Apinae	*Habropoda*	1	2	0	2
Apinae	*Melecta*	1	3	0	3
Apinae	*Melissodes*	16	8	12	25
Apinae	*Peponapis*	0	0	1	1
Apinae	*Svastra*	0	0	1	1
Apinae	*Xeromelecta*	1	1	0	1
Apinae	*Zacosmia*	1	0	0	1

species. For instance, Hobbs (1954) reported much higher proportions of ground-nesting than cavity-nesting leafcutter bees (*Megachile*) in Alberta, and attributed these differences to fewer nesting sites available for the latter group of species. Extensive cut banks throughout the ecozone provide nesting sites to many vertical nesting species, such as *Anthophora occidentalis*, *A. peritomae* (Torchio 1971) (a new Canadian record, though specimens from the Prairies Ecozone date back to the early 1900s), *Dianthidium curvatum* (Fischer 1951; Michener and Michener 1999), and several leafcutter bees (Sheffield *et al*. 2011*b*), including some of the species that normally nest in pre-existing cavities. Some species occurring in the prairies nest exclusively in sandy, rather than loamy, soils, including *Andrena haynesi* Viereck and Cockerell (LaBerge 1986*a*), several species of *Lasioglossum* (Gibbs 2010; Gibbs *et al*. 2013), and some species of *Megachile* (Table 3).

Most mason bees of the genus *Osmia* also predominantly nest in these pre-existing cavities in wood, but some species will also create nests under rocks or similar structures (Hicks 2009), or are nest excavators (Cane *et al*. 2007; Rightmyer *et al*. 2013). An interesting alternative substrate for nest excavation occurs with *Osmia integra*, which will excavate its nest in cow dung (Cane 2012). Cane *et al*. (2007) and Rightmyer *et al*. (2013) reviewed the nesting biology of many *Osmia* species in North America, and Krombein (1967) reviewed that of cavity-nesting species. That study and others (e.g., Fye 1965; Sheffield *et al*. 2008) have indicated that these cavity-nesting bee species can be encouraged in many habitats through the use of artificial nesting sites. For example, the introduced alfalfa leafcutter bee (*Megachile rotundata*) is raised in manufactured cavities as a managed pollinator of alfalfa (more recently introduced from Saskatchewan for lowbush blueberry pollination in eastern Canada).

Bumble bees typically nest in old rodent burrows, or other similar large cavities capable of supporting an active colony, though unlike other bees, wintering *Bombus* queens will use other sites for hibernation (Alford 1978) (the halictid bees *Halictus rubicundus* (see Yanega 1990) and *Lasioglossum laevissimum* (see Batra 1987) share this strategy, which is apparently uncommon among halictine bees (Batra 1987)). A summary of known nesting habits for North American bumble bees can be found in Kearns and Thomson (2001), though as these authors indicate, much is still unknown. Hobbs (1964, 1965*a*, 1965*b*, 1966*a*, 1966*b*, 1967, 1968) reviewed the nesting habits and ecology of most bumble bees on the prairies. Studies of bee nesting biology and ecology relevant for species occurring in the Prairies Ecozone are summarized in Table 1.

Solitary versus Social Lifestyles

Bees show a range of lifestyles from solitary to highly social, related to the extent of brood care and interactions with offspring and/or other adult bees. In solitary bees, one individual female constructs and provisions the nest with larval food, without contact with her offspring (Michener 2007). All native bees in Canada have a solitary adult phase in their life cycle. For many species, this phase overlaps with the overwintering stage and subsequent spring emergence period. Most bee species are solitary throughout their life. At the opposite end of this spectrum in the Prairies Ecozone are the primitively eusocial species where colony members cooperate in brood care and show reproductive division of labour among overlapping generations. In this group, a single female (queen or foundress) starts a colony each spring and performs all of the associated duties in solitary fashion; later these same duties are performed by daughters, with the foundress committed almost exclusively to egg laying. Thus, a division of labour exists between the foundress and her daughters (Michener 2007). Eusociality exists in only a few groups of native bees within the Prairies Ecozone. It is restricted to halictid bees within the genera *Augochlorella* (Augochlorini) (Packer 1990), *Halictus* and *Lasioglossum* (subgenera *Dialictus*, *Evylaeus*, and *Specodogastra*) (Gibbs 2010; Gibbs *et al*. 2013), and *Bombus* (Apidae) (Table 3). Nesting biology of most bee species has not been studied because nests are seldom found; therefore, information on the sociality of several taxa is typically implied via phylogenetic placement (e.g., Gibbs *et al*. 2013), or is unknown.

Between these two extremes of solitary and eusocial lifestyles exists a range of intermediate levels of social interaction (reviewed in Costa 2006). Some bee species aggregate and may build nests in high densities, but each female lives a solitary existence. Examples include several species within the genus *Colletes* (Colletidae) (Batra 1980), as well as *Dianthidium curvatum* (Megachilidae) (Michener and Michener 1999). Nesting in aggregations is not restricted to solitary bees and has been observed in some primitively eusocial *Lasioglossum* (subgenus *Dialictus*) species, including *L. laevissimum* (Batra 1987). Interspecific nesting aggregations are also known (Batra and Schuster 1977). In communal nesting, as seen in *Andrena accepta* (Rozen 1973) and several species of *Agapostemon* (Halictidae) (Eickwort 1981), several females may share a nest but each one provisions in a solitary fashion (Michener 2007). Communal nesting is facultative, and individuals within the same population may nest in solitary fashion (i.e., away from the communal nests) (Michener 2007). Communal nesting is an alternative strategy to eusociality for tackling some of the same environmental problems (e.g., nest defence), but is likely not a form of pre-social behaviour since individuals remain solitary (Wcislo and Tierney 2009). A true step toward eusociality, subsociality, exists in many species of *Ceratina* (Apidae, Xylocopinae) (Michener 2007), including *C. calcarata* (Rehan and Richards 2010). Subsociality involves parent–offspring interaction, with prolonged parental care instead of mere food storage (Michener 1969, 2007; Wilson 1971), and is probably the simplest form of social behaviour in bees (Rehan and Richards 2010). Other forms of sociality exist in bees (see Michener 1969, 1974, 2007), though their extent in the Prairies Ecozone is not yet known.

Many of the bee species found in the Prairies Ecozone are at the northern-most limits of their ranges, and this distributional pattern may affect life cycles and behaviour (Soucy 2002). Some species may have shorter active seasons with fewer generations per year than do more southern populations. For some halictid bees, sociality may also be affected; Packer *et al*. (1989*a*) and Packer (1990) found that a population of the normally primitively eusocial species *Augochlorella aurata* (as *A. striata*) were solitary or had significantly fewer workers at the northeastern edge of their range (Cape Breton Island, Nova Scotia) than populations farther south. The same may be true in the Canadian Prairies, which is the northwestern edge of the range of this species (Table 3). Social flexibility may be more limited in some species, however. For example, the normally primitively eusocial *Lasioglossum* (*Evylaeus*) *cinctipes*, also studied in Nova Scotia, is at risk of becoming locally extirpated in unfavourable years, as no workers are produced and this species cannot switch to solitary behaviour (Packer *et al*. 1989*a*). *Halictus rubicundus* is another inflexible species and remains social even at the edges of its range (Hogendoorn and Leys 1997) and at high altitudes (Eickwort *et al*. 1996). These observations show how important it is to collect detailed information (e.g., nesting biology, sociality) on native bees to help interpret local abundance patterns and prepare conservation plans.

Parasitic Lifestyle

A parasitic lifestyle in bees refers to instances where the provisions within the nest of non-parasitic species are used to produce the offspring of parasitic taxa. There are two main forms of parasitism that occur in bees, social parasitism and cleptoparasitism (Michener 2007). Social parasitism refers to instances where a mated female social parasite enters the colony of a social species and replaces the queen, with the colony workers subsequently caring for the offspring of the nest invader (Michener 2007). In the Prairies Ecozone, social parasitism is limited to bumble bees of the subgenus *Psithyrus*, which attack bumble bee colonies, and some *Lasioglossum* (subgenus *Dialictus*), which attack other *Dialictus* that are eusocial (see Table 3). Cleptoparasitism occurs when one species (the cleptoparasite) lays its eggs in the nest of another species, usually resulting in the offspring of the host being killed.

Most parasitic bees are not considered important as pollinators, though they may play important roles in structuring bee communities (see Sheffield *et al*. 2013*b*). It is not clear what proportion of the prairie bee fauna are cleptoparasites due to our lack of taxonomic knowledge of the two major taxa of cleptoparasites, *Sphecodes* (Halictidae) and *Nomada* (Apidae) (see "Systematic Review" below) (Fig. 3). The number of cleptoparasitic bee species is probably much higher than has been tallied for the prairies (see Table 2) (recent DNA bar-coding efforts are confirming this; CSS, unpublished data). In other ecozones where these groups have been investigated more intensively, the proportion of cleptoparasitic species has risen dramatically, for example, in the Atlantic Maritime Ecozone (Sheffield *et al*. 2003, 2008, 2009, 2013*a*) and the Mixedwood Plains Ecozone of southern Ontario (Grixti and Packer 2006; Taylor 2007; Richards *et al*. 2011) and Québec (Sheffield and Perron 2014).

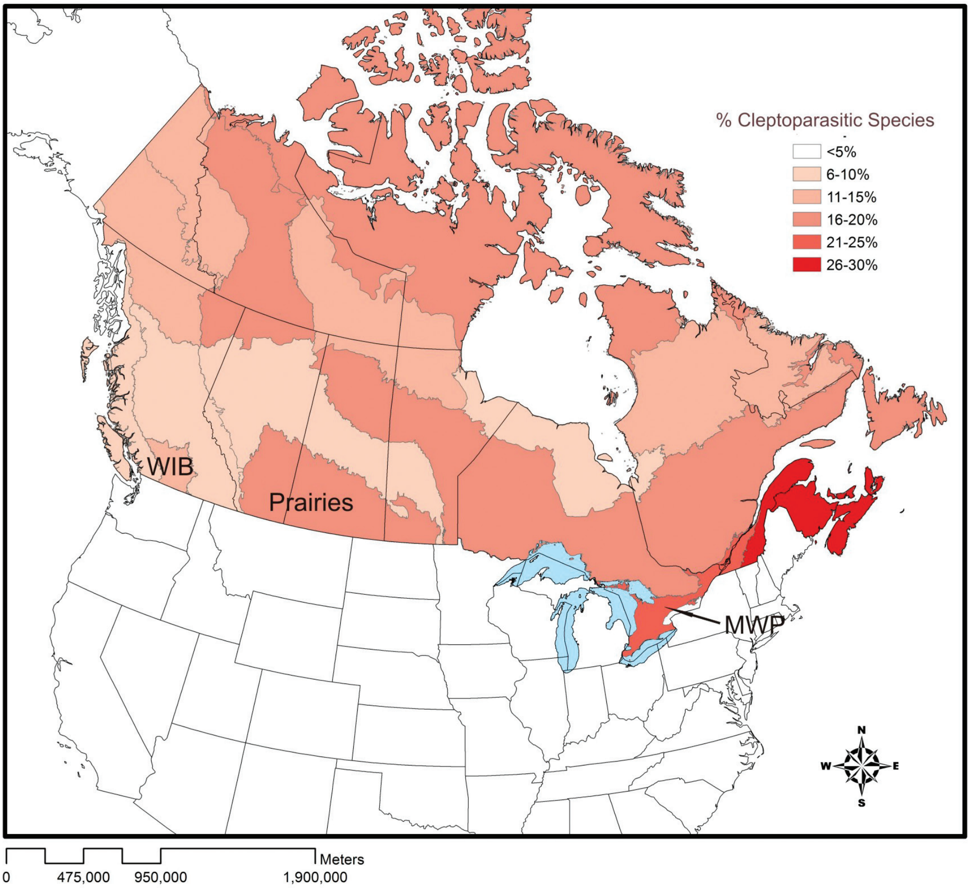

Fig. 3. The percentage of cleptoparasitic bee species within each ecozone in Canada. Darker shades represent higher percentages. Three ecozones containing grasslands are labelled: Prairies, Western Interior Basin (WIB), and Mixedwood Plains (MWP).

The host–cleptoparasite relations of most bee species are not known, though some host association summaries have been published that are of relevance to the Prairies Ecozone. Host information has been reviewed or provided for *Nomada* (Snelling 1986; Alexander 1991), *Epeolus* (Brumley 1965), *Holcopasites* (Hurd and Linsley 1972), *Neolarra* (Shanks 1977), *Zacosmia maculata* (Torchio and Yousef 1968), and *Xeromelecta californica* (Torchio and Trostle 1986). Rozen (1965, 1966) described the biology and immature stages of several nomadine bees, including *Neolarra pruinosa*. Interestingly, none of the *Perdita* hosts listed by Shanks (1977) are known to occur in Canada, suggesting that other cleptoparasite/host relationships probably exist.

Wintering Biology

Most bee species spend the largest proportion of their life cycle in the wintering stage, and some bees may be inactive for up to 11 months (Yanega 1990). Despite this long period of inactivity, little is known about the behavioural and eco-physiological adaptations of bees leading up to and during the winter in temperate zones (Sakagami *et al*. 1981; Hoshikawa *et al*. 1992; Rust 1995). In the Prairies Ecozone, overwintering biology for native bees varies among and within different families, and the stage of development in which a bee spends the winter determines its relative emergence time. For example, most halictid bees (Halictidae) and bumble bees (Apidae, Bombini) overwinter as mated adult females, emerging early in the spring. These taxa contain our only primitively eusocial species with this overwintering strategy, which allows them to start their colony early in the season and exploit floral resources throughout the entire active period. Other groups of bees in the Prairies Ecozone that overwinter as adults are non-social and spend the winter as un-emerged males and females in natal cells. This includes many species of *Colletes*, most *Andrena*, *Osmia*, and most *Nomada* and *Sphecodes*. In contrast, adults of *Ceratina* emerge prior to overwintering, usually within their natal nest, though some may leave and overwinter elsewhere (Rehan and Richards 2010). In adult-wintering bees, the adult stage is the most cold hardy (Sheffield 2008); the comparative wintering physiology of adult bees was discussed by Hoshikawa *et al*. (1992).

Stephen *et al*. (1969) reported that the majority of bees in temperate regions overwinter as "pre-pupae" (= post-defecating larva), which is also the most cold hardy (Sheffield 2008). Bees in the prairies region known to overwinter in this stage include most Colletidae, Panurginae, Megachilidae (excluding *Osmia*), Epeolini, *Andrena* (subgenera *Callandrena*, *Cnemidandrena*) and their *Nomada* cleptoparasites (e.g., Rodeck 1949; Broemeling 1988; Broemeling and Moalif 1988), *Macropis*, *Melissodes*, and *Anthophora* (excluding *A. edwardsii*, which can overwinter as an adult, and is found in British Columbia grasslands; Thorp 1969*b*). These bees fly from June into the summer and autumn, but have also been collected from late May to early June with other spring-emerging genera (e.g., *Osmia*), and so the wintering stage has not been confirmed for all species. Specifically, *Anthrophora ursina*, *Habropoda cineraria*, and the eucerine bee *Eucera frater* (all 2013 additions to the Canadian Prairies fauna; CSS, unpublished data) have been collected early in the season in the Cypress Upland Ecoregion of Saskatchewan (Acton *et al*. 1998) and adjacent prairie ecoregions of Alberta. For at least *E. frater*, the pre-pupal stage is the typical wintering stage, though adults have also been observed in wintered cells, suggesting that this species may not require an obligatory cold (i.e., overwintering) period to transform to the adult stage (Miliczky 1985; studied in Illinois). Of the summer-active bees, only *M. rotundata* (and to a lesser extent, *M. relativa*) has had its cold hardiness or aspects of its diapause/post-diapause development studied in any detail (Krunic 1971; Krunic and Salt 1971; Krunic and Hinks 1972; Undurraga and Stephen 1980; Richards *et al*. 1987; Kemp and Bosch 2000; Buckner *et al*. 2004; Kemp *et al*. 2004; Sheffield 2008).

Some bee species overwinter in more than one stage. Parsivoltinism, where one generation develops and emerges over at least a two-year period (Torchio and Tepedino 1982), is reported for only a few species, but results in more than one overwintering stage. *Osmia tanneri* is an example of a cohort-splitting species in which some individuals in a generation complete development and overwinter as adults (one-year forms), while other individuals in the cohort overwinter as larvae and become adults the next year (two-year forms) (Torchio and Tepedino 1982). Parsivoltinism may increase survivorship of populations during drought and/or other stressful periods, but adults of the one-year forms may destroy larvae (i.e., of the two-year forms) during emergence from nests having cells in linear series. In addition, two-year forms have increased exposure to nest parasites/predators (Torchio and Tepedino 1982). In general, the phenomenon is poorly understood (Minckley *et al*. 2013).

The timing of emergence after wintering also influences feeding patterns, since different plants may bloom at different times. Many of the vernal (spring) emerging species visit early-blooming plants such as *Salix* spp. (Salicaceae) and *Taraxacum* sp. (Asteraceae) and are important pollinators of agricultural crops. For example, bumble bee queens are the most important pollinators of haskap (blue-berried honeysuckle, *Lonicera caerulea,* Caprifoliaceae) in Saskatchewan (SDF, unpublished data). Other important prairie crops requiring insect pollination flower in the summer and many native bees pollinate forage and seed crops, such as alfalfa (*Medicago sativa* L. (Fabaceae)).

Floral Relations

Bees are almost exclusively dependent on floral resources (e.g., pollen, nectar, floral oils) for nutrition. Females of pollen-collecting species have morphological, and often behavioural, adaptations for removing and carrying pollen from flowers (see Thorp

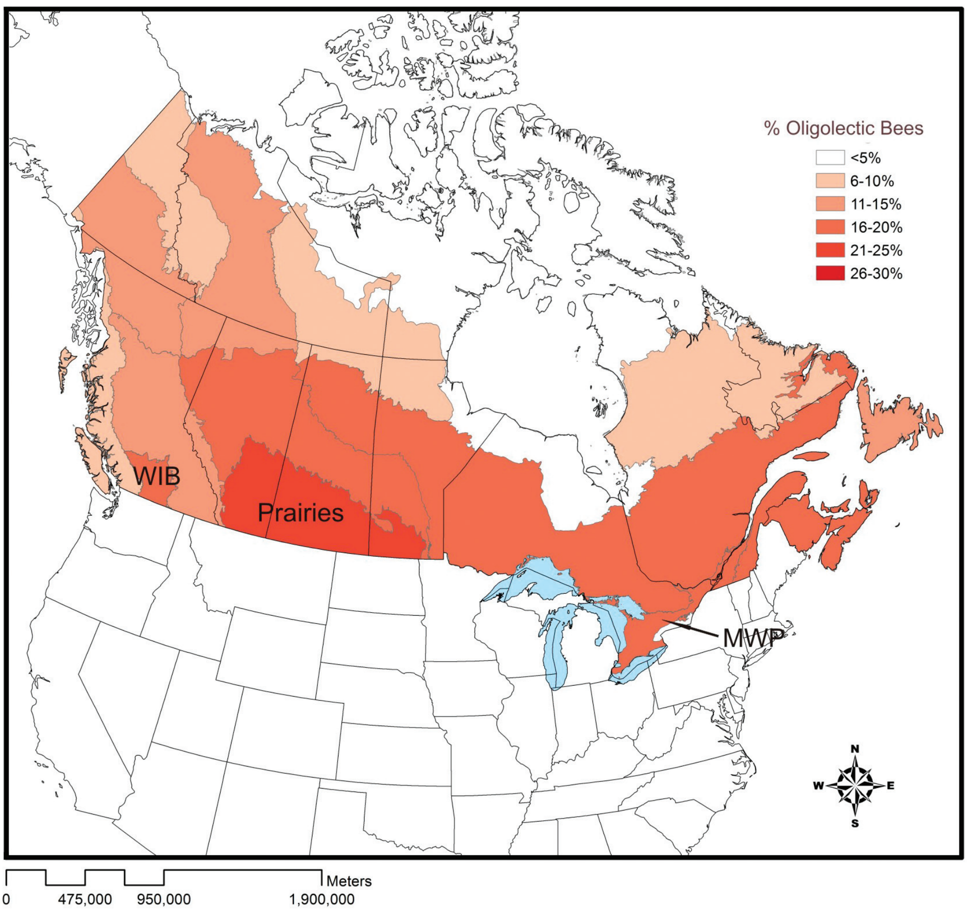

Fig. 4. The percentage of oligolectic bee species within each ecozone in Canada. Darker shades represent higher percentages. Three ecozones containing grasslands are labelled: Prairies, Western Interior Basin (WIB), and Mixedwood Plains (MWP).

1979, 2000; Michener 2007). Females of most non-cleptoparasitic bees have a scopa (i.e., a specialized pollen-carrying area) that is usually located on the hind legs and often also the lateral surfaces of the propodeum, or in Megachilidae, on the ventral surface of the abdomen. Females of *Hylaeus* (Colletidae) carry pollen internally within the crop (Michener 2007). Some *Osmia* from the southeastern United States also have specialized hairs on the face for collecting pollen from nototribic (i.e., dorsally pollinated) flowers (Parker and Tepedino 1982; Rightmyer *et al.* 2011). Behavioural adaptations help the bees to release the pollen. In floral sonication, or "buzz pollination," some bees rapidly vibrate flowers to release pollen from poricidal anthers (i.e., pollen is contained internally and can only be released through a small opening in the anther), and some bee species, though not others, switch strategies in response to the flower's requirements (see Neff and Simpson 1988). In some cases, bees may be able to remove pollen from flowers with poricidal anthers without sonication by manipulating the anthers with their legs (e.g., *Megachile rotundata* on lowbush blueberry, CSS, pers. obs.).

Bees may feed broadly, visiting flowers of many species for nectar, or they may specialize on a single plant species, genus, or family. Dietary specialization, or oligolecty, refers to preferences for pollen only. Specialist bees (oligoleges) that typically visit plants of one species show narrow oligolecty (e.g., bees of the genus *Duforea*; several *Andrena*), whereas those that visit a single plant genus (e.g., *Macropis* bees), or family, show broad oligolecty (e.g., many *Andrena*, *Colletes, Melissodes*) (Michener 2007). The Prairies Ecozone has the highest percentage (23%) of floral specialists in Canada (Fig. 4), though our knowledge of the pollen specificity of many bees is limited, or for many species, entirely lacking (Table 3). In the Prairies Ecozone, oligolecty on species within the Asteraceae is most common, with 54% of the oligoleges preferring this family, almost 11% preferring *Helianthus* pollen (Table 3). Oligolecty on *Salix* (Salicaceae), a spring-flowering genus, accounts for 12% of the oligolectic species in this ecozone (Table 3).

Systematic Review

Nearly half of the bees so far reported from Canada, or 386 species, have been recorded from the Prairies Ecozone (Table 2). This section provides summaries of the systematic knowledge of bees in the Canadian Prairies, including references for keys that are available. Table 3 provides a list of all species known to occur in the Prairies Ecozone of Alberta, Saskatchewan, and Manitoba. A full catalogue of the bees of Canada is currently in preparation (CSS, unpublished data).

Colletidae

This family is represented by two genera, *Colletes* (Colletinae) and *Hylaeus* (Hylaeinae). Several species of *Colletes* are uncommon, and so are rarely collected in Canada. Stephen's (1954) revision for North America is comprehensive, though difficult to use because of the wide geography covered. Mitchell's (1960) keys work for many of the species occurring in the eastern Prairies Ecozone. Bees of the genus *Hylaeus* are typically small black bees that are virtually hairless and wasp-like in appearance due to yellow maculations. *Hylaeus sparsus* is recorded here for the first time from the prairies (i.e., Wood Mountain, Saskatchewan, collected in 2013). Despite multiple revisions by Metz (1911), Mitchell (1960), and Snelling (1966*a*, 1966*b*, 1968, 1970), this group remains problematic taxonomically.

Andrenidae

This family is represented in Canada by two subfamilies, Andreninae and Panurginae, both of which occur in the Prairies Ecozone. *Andrena* is the most speciose genus in Canada and is well represented in the Canadian Prairies. LaBerge (1986*a*) provides a review of the geography of *Andrena* in North America relevant to the Prairies Ecozone, and he and his colleagues reviewed most of the species occurring in North America (LaBerge 1967, 1969, 1971, 1973, 1977, 1980, 1986*b*, 1987, 1989; Ribble 1967, 1968, 1974; LaBerge and Bouseman 1970; LaBerge and Ribble 1972, 1975; Bouseman and LaBerge 1979). Donovan (1977) revised the subgenus *Cnemidandrena*.

Panurgine bees are less common than *Andrena*, though many species are found in the Prairies Ecozone; most show strong affiliation with the Asteraceae. Reviews are available for the genera *Calliopsis* (Shinn 1967; Rozen 1958 for subgenus *Nomadopsis*) and *Pseudopanugus* (Timberlake 1964*a* and 1975 for the subgenus *Heterosarus*), and partial revisions of *Panurginus* Nylander were carried out by Crawford (1926) and Michener (1935). The genus *Perdita* is the largest in North America, though few species are found in the Canadian Prairies. Timberlake has revised the genus in multiple publications (1953, 1954, 1956, 1958, 1960, 1962, 1964*b*, 1968, 1971, 1980), though Mitchell (1960) allows identification of *Perdita* found in the eastern Prairies Ecozone.

Halictidae

Halictid bees, particularly the tribe Halictini, are well represented in the Prairies Ecozone. Two small genera are fairly well-known, and taxonomic treatments from the 1970s are still valid; *Agapostemon* can be identified by using the keys of Roberts (1972, 1973*a*), and *Halictus* can be identified by using Roberts (1973*b*). The genus *Lasioglossum* has received much recent taxonomic coverage in North America. McGinley (1986) reviewed the subgenus *Lasioglossum s.s.*, which includes 10 species in the prairies. Two introduced species, *Lasioglossum* (*Leuchalictus*) *leucozonium* and *L.* (*Leuchalictus*) *zonulum*, have been reported from the Prairies Ecozone (Sheffield *et al*. 2011*a*) since McGinley's treatment. McGinley (2003) and Gibbs *et al.* (2013) reviewed the subgenus *Sphecodogastra*, with Gibbs *et al.* (2013) broadening the group to include many species previously considered part of the subgenus *Evylaeus*. As a result of that study (Gibbs *et al*. 2013), the subgenus *Evylaeus* is greatly reduced, with only one species, *L. cinctipes*, known from Canada and found in the prairies. Gibbs (2010) provided full coverage of the subgenus *Dialictus* (i.e., for all of Canada, 42 species are found in the Prairies Ecoregion). The most problematic halictine taxa are those in the cleptoparasitic genus *Sphecodes*; at least nine species are found in the Prairies Ecoregion, though there are probably several more. *Sphecodes* is badly in need of revision.

The other halictid groups are not very diverse in Canada. The tribe Augochlorini (see Table 3) is scarcely represented in Canada; three genera are represented by one species each (Packer *et al*. 2007). *Augochlorella aurata* is the only species in the prairies, newly recorded in this chapter for Saskatchewan. Four species of *Dufourea* (the only genus of Rophitinae in Canada) are found in the Prairies Ecozone (though one of these species is limited to the Waterton Lakes region of southwestern Alberta and adjacent British Columbia). The Canadian species of *Dufourea* were recently treated by Dumesh and Sheffield (2012). *Dieunomia heteropoda* is the only representative of the Nomiinae.

Melitidae

This family is represented in Canada by only three species in two genera: *Macropis* and *Melitta*. Only one species, *Macropis nuda*, has been recorded from the Prairies Ecozone.

Macropis bees are oligoleges of oil-producing plants of the genus *Lysimachia*, and their distribution is restricted by the floral host (Sheffield *et al*. 2004). Sheffield *et al*. (2004) provide a summary of the relationship of *Macropis* bees with their cleptoparasite, *Epeoloides pilosulus* (Apidae), in Canada. Michener (1938*a*) and Mitchell (1960) can be used to identify species of *Macropis* in Canada, and Michez and Patiny (2005) treated the world species.

Megachilidae

Megachilidae is another diverse group that is well represented on the Canadian Prairies. Most genera of the tribe Osmiini have received taxonomic treatment. The genus *Osmia* is the largest, but the only published taxonomic review for North America (Sandhouse 1939) is out of date. Other important works include Sinha and Michener (1958; subgenus *Melanosmia*, in part), Rust (1974; subgenera *Cephalosmia*, *Helicosmia* (as *Chalcosmia*), and *Osmia*), and White (1952; subgenus *Acanthosmioides*, now considered the "*odontogaster* species group" of *Melanosmia* (Rightmyer *et al*. 2013)). Michener (1938*b*, 1939*a*) revised the genera *Heriades* and *Ashmeadiella*, respectively. The North American *Hoplitis* were treated by Michener (1947) (excluding *H. robusta*), though Mitchell (1962) covers most species found in the Prairies Ecozone. Hurd and Michener (1955) provide keys that work for many non-*Osmia* Osmiini in western Canada.

The tribe Anthidiini is represented in the Prairies Ecozone by the genera *Anthidium* and *Dianthidium* and by the cleptoparasite *Stelis*. Gonzalez and Griswold (2013) revised the *Anthidium* of the Western Hemisphere; Schwarz (1926, 1927) provided keys for *Dianthidium* and *Anthidium*, respectively; Timberlake (1943) also covers *Dianthidium*; and Grigarick and Strange's (1968) work on the Anthidiini of California is also useful for most of western North America. The North American species of *Stelis* are in need of revision, although Mitchell (1962) provides keys for many of the eastern species (several occurring in the Canadian Prairies).

The tribe Megachilini is represented by two genera in North America, both occurring in the Prairies Ecozone. The species of *Megachile* occurring in Canada were recently reviewed by Sheffield *et al*. (2011*b*); most of the 38 species occur in the Prairies Ecozone. Their main cleptoparasite, *Coelioxys*, also Megachilini, was partially reviewed for North America (Mitchell 1973; Baker 1975).

Apidae

The family Apidae is one of our most diverse groups of bees in Canada in terms of the number of species and the number of genera represented. The Xylocopinae is represented in the Canadian Prairies by the genus *Ceratina*; two species are found within the Prairies Ecozone, though only recently confirmed in Saskatchewan. Rehan and Sheffield (2011) provide the most recent account of species of *Ceratina* in eastern North America, though Daly (1973) treats the North American species.

Nomadinae is the only bee subfamily in the Prairies Ecozone whose members are all cleptoparasitic. The diverse, taxonomically difficult genus *Nomada* is the largest group of nomadine bees in Canada, and though a small proportion of the Canadian species have been confirmed in the Canadian Prairies, this is likely a great underestimation. *Nomada* are mostly cleptoparasites of the genus *Andrena* (Andrenidae), though other genera in the region (i.e., *Agapostemon, Halictus, Lasioglossum, Colletes,* and *Eucera*) may also serve as hosts (Michener 2007). A few relevant works are by Cockerell (1903*a*, 1903*b*), Rodeck (1949), Mitchell (1962), Evans (1972), Broemeling (1988), and Broemeling and

Moalif (1988), though the genus is badly in need of revision. *Epeolus* and *Triepeolus* (tribe Epeolini) are summer flying cleptoparasites of *Colletes* and Eucerini (*Eucera, Melissodes*), respectively. Brumley (1965) is the only treatment of the genus *Epeolus* for western North America, though Mitchell (1962) works for some species in the Prairies Ecozone. *Triepeolus* was recently revised by Rightmyer (2008). *Holcopasites* (tribe Ammobatoidini) are cleptoparasites of panurgine bees, particularly the genera *Calliopsis* and *Pseudopanurgus*; Hurd and Linsley (1972) provide keys to the species. *Neolarra* (tribe Neolarrini) are also cleptoparasites of panurgine bees, particularly the genus *Perdita,* found primarily in arid, sandy regions (Michener 1939*b*). Two species occur in the Canadian Prairies, and they can be keyed with Michener (1939*b*) and Shanks (1977).

Within the subfamily Apinae, the tribe Osirini is represented by one species, *Epeoloides pilosulus*, which has not been recorded in western North America for over 60 years. This species, the only representative of the genus in the Western Hemisphere, is a cleptoparasite of *Macropis* and as such is also presumably restricted to within the range of oil-producing *Lysimachia* (Sheffield *et al*. 2004).

The tribe Emphorini is represented by the genus *Diadasia*, all of which are floral specialists. Adlakha (1969) provides a key to the species in America north of Mexico. The eucerine bees (tribe Eucerini) are represented by the genera *Eucera* and *Melissodes*. The species of *Eucera* (as *Synhalonia*) for North America were revised by Timberlake (1969). *Melissodes* are difficult taxonomically, though useful revisions include LaBerge (1956*a*, 1956*b*, 1961; North America) and Mitchell (1962; eastern North America).

The tribe Anthophorini is represented in the Canadian Prairies by the genera *Anthophora* and *Habropoda*, though no keys exist for the species. Cresson (1869) provides a key to some of the species of *Anthophora* in the west, Mitchell (1962) can be used to identify eastern species, and Brooks (1983) provides a detailed account of higher taxonomy. *Habropoda cineraria*, here recorded for the first time from the Canadian Prairies, was only recently collected in Saskatchewan (Cypress Hills) in 2013. The cleptoparasites of Anthophorini, the Melectini, are represented in this ecozone by the genera *Melecta, Xeromelecta*, and *Zacosmia*. *Zacosmia maculata* specifically targets *Anthophora*, subgenus *Heliophila*, another group we record here for the first time in Canada (see Table 3). Hurd and Linsley (1951) provide keys to the species of Melectini occurring in Canada.

The majority of bumble bees (tribe Bombini) recorded for Canada occur in the Prairies Ecozone, and five of these belong to the social parasitic subgenus *Psithyrus*. The keys of Stephen (1957), Thorp *et al*. (1983), Curry (1984), and Koch *et al*. (2012) can be used for identifying most species in the Canadian Prairies, though Milliron (1971, 1973*a*, 1973*b*), Laverty and Harder (1988), and Colla *et al*. (2011) are also useful. A field guide for all of the North American species will soon be available (Williams *et al*., 2014). The introduced European honey bee (*Apis mellifera*), our most important commercial pollinator, is managed in hives across Canada, including the Prairies Ecozone.

Summary

There is much to learn about the patterns of bee diversity in Canada, and recent declines in pollinators and pollination services (e.g., Biesmeijer *et al*. 2006; Potts *et al*. 2010) illustrate the importance of understanding the factors influencing these patterns for maintaining terrestrial ecosystem stability and food production. Although Canada has almost 800 species of bees, much of the country has not been thoroughly surveyed, and so regional treatments, such as this chapter, are critical to increasing the understanding of the national fauna. Taxonomic difficulties provide another impediment to understanding broad-scale patterns in bee diversity, since bees are one of many groups of arthropods requiring further taxonomic study (Gonzalez *et al*. 2013). For example, Gibbs (2010) and Gibbs *et al*. (2013) recently described 20 new species of *Lasioglossum* in Canada, albeit in a taxonomically difficult yet ubiquitous group of bees. Two other major taxa, the cleptoparasite genera *Sphecodes* (Halictidae) and *Nomada* (Apidae), would surely yield similar discoveries. Approximately 28% of all bee species were described by four individuals during the 1800s to early 1900s, using microscopes with limited capability and low numbers of specimens with poor geographical representation (Rasmussen 2012; Gonzalez *et al*. 2013). Thus, bee taxonomy has relied on variation in size, colour, and distribution (Gonzalez *et al*. 2013), with sexes not being associated in many cases (Sheffield and Westby 2007). Gonzalez *et al*. (2013) provide excellent discussion on approaches to remedying the present taxonomic impediment with bees. In Canada, we are increasing our taxonomic knowledge of bees (e.g., Packer *et al*. 2007; Gibbs 2010; Sheffield *et al*. 2011*b*; Dumesh and Sheffield 2012) and other pollinators (e.g., Dombroskie 2011; Miranda *et al*. 2013) through the use of online, image-based interactive journals such as the *Canadian Journal of Arthropod Identification* (e.g., Packer *et al.* 2007; Sheffield *et al.* 2011*b*; Dumesh and Sheffield 2012), initiatives such as the Canadian Pollination Initiative (CANPOLIN; http://www.uoguelph.ca/canpolin/), and molecular tools such as DNA bar-coding. Sheffield *et al*. (2009), using DNA bar-coding, and Vickruck *et al*. (2011), studying nesting ecology, collectively discovered a cryptic species from Canada in an otherwise well-known group of bees; the species was described by Rehan and Sheffield (2011). DNA bar-coding and other molecular techniques (e.g., Gibbs 2009; Sheffield *et al*. 2009), as well as detailed ecological studies (e.g., Vickruck *et al*. 2011), work well with traditional morphological taxonomic research to clarify faunas at many scales.

Compared with many areas of Europe, Canada has little historic or baseline data available to look at bee population trends, with the exception of some bumble bee species (e.g., Colla and Packer 2008; Grixti *et al*. 2009; Cameron *et al*. 2011; Colla *et al*. 2012). There is a lot at stake, as Canada is not immune to the global trend(s) in pollinator declines (e.g., Biesmeijer *et al*. 2006; Potts *et al*. 2010). It is only through digitizing historic collections to provide data for analysis, combined with increased surveying and taxonomic study of bees and other pollinators that we can start to appreciate the diversity of bees in Canada, including all of its ecozones.

Acknowledgements

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Table 3. Bee species of the Prairies Ecozone of Canada, including the provinces in which they are confirmed, nesting habits, lifestyle (e.g., solitary vs. eusocial, cleptoparasite, social parasite), and floral preferences if known (not listed for cleptoparasites). * Indicates a species which in Canada is unique to the Prairies Ecozone. Polylege refers to species with multiple floral hosts. † Indicates a new record for the Prairies Ecozone, †† a new record for Canada.

Taxon	Province	Nesting Notes	Lifestyle	Floral Hosts
Family COLLETIDAE				
Subfamily COLLETINAE				
Colletes aberrans Cockerell, 1897	AB	soil	solitary	polylege
**Colletes albescens* Cresson, 1868	MB	soil	solitary	polylege
Colletes americanus Cresson, 1868	MB	soil	solitary	Asteraceae
**Colletes andrewsi* Cockerell, 1906	SK, MB	soil	solitary	*Heuchera* (Saxifragaceae)
**Colletes brevicornis* Robertson, 1897	MB	soil	solitary	polylege
Colletes compactus Cresson, 1868	SK	soil	solitary	Asteraceae
Colletes consors Cresson, 1868	AB, SK, MB	soil	solitary	*Phacelia* (Boraginaceae)
Colletes fulgidus Swenk, 1904	AB	soil	solitary	Asteraceae
Colletes hyalinus Provancher, 1888	AB, SK, MB	soil	solitary	polylege
Colletes impunctatus Nylander, 1852	AB	soil	solitary	*Gaylussacia* (Ericaceae)
Colletes inaequalis Say, 1837	SK, MB	soil	solitary	polylege
Colletes kincaidii Cockerell, 1898	AB, SK, MB	soil	solitary	polylege
Colletes nigrifrons Titus, 1900	AB, MB	soil	solitary	polylege
**Colletes petalostemonis* Swenk, 1906	AB, MB	soil	solitary	polylege
Colletes phaceliae Cockerell, 1906	AB, SK, MB	soil	solitary	polylege
**Colletes robertsonii* Dalla Torre, 1896	MB	soil	solitary	polylege
**Colletes rufocinctus* Cockerell, 1929	AB	soil	solitary	Asteraceae
Colletes simulans Cresson, 1868	AB, MB	soil	solitary	Asteraceae
**Colletes susannae* Swenk, 1925	AB, MB	soil	solitary	polylege
Colletes willistoni Robertson, 1891	MB	soil	solitary	polylege
**Colletes wilmattae* Cockerell, 1904	MB	soil	solitary	*Petalostemon* (Fabaceae)
Subfamily HYLAEINAE				
Hylaeus (*Prosopis*) *affinis* (Smith, 1853)	AB, SK, MB	cavity	solitary	polylege
Hylaeus (*Hylaeus*) *annulatus* (Linnaeus, 1758)	AB, SK, MB	cavity	solitary	polylege
Hylaeus (*Cephalylaeus*) *basalis* (Smith, 1853)	AB, SK, MB	cavity	solitary	Roseaceae

Taxon	Province	Nesting Notes	Lifestyle	Floral Hosts
Hylaeus (*Prosopis*) *episcopalis* (Cockerell, 1896)	AB	cavity	solitary	polylege
Hylaeus (*Hylaeus*) *leptocephalus* (Morawitz, 1871)	AB, MB	cavity	solitary	Fabaceae
Hylaeus (*Hylaeus*) *mesillae* (Cockerell, 1896)	AB, MB	cavity	solitary	polylege
Hylaeus (*Prosopis*) *modestus* Say, 1837	AB, MB	cavity	solitary	polylege
Hylaeus (*Prosopis*) *nelumbonis* (Robertson, 1890)	MB	cavity	solitary	polylege?
†*Hylaeus* (*Metziella*) *sparsus* (Cresson, 1869)	SK	cavity	solitary	polylege?
Hylaeus (*Hylaeus*) *verticalis* (Cresson, 1869)	AB, MB	cavity	solitary	polylege
Family ANDRENIDAE				
Subfamily ANDRENINAE				
**Andrena* (*Callandrena*) *accepta* Viereck, 1916	AB	soil	communal	Asteraceae
Andrena (*Euandrena*) *algida* Smith, 1853	AB, SK, MB	soil	solitary	polylege
Andrena (*Scrapteropsis*) *alleghaniensis* Viereck, 1907	SK, MB	soil	solitary	polylege (Asteraceae)
Andrena (*Trachandrena*) *amphibola* (Viereck, 1904)	AB	soil	solitary	polylege
Andrena (*Parandrena*) *andrenoides* (Cresson, 1878)	SK, MB	soil	solitary	*Salix* (Salicaceae)
Andrena (*Callandrena*) *asteris* Robertson, 1891	MB	soil	solitary	Asteraceae
Andrena (*Leucandrena*) *barbilabris* (Kirby, 1802)	AB, SK, MB	soil	solitary	polylege
**Andrena* (*Andrena*) *birtwelli* Cockerell, 1901	AB	soil	solitary	*Potentilla* (Rosaceae)
Andrena (*Andrena*) *buckelli* Viereck, 1924	AB	soil	solitary	Fabaceae?
Andrena (*Cnemidandrena*) *canadensis* Dalla Torre, 1896	AB, SK, MB	soil	solitary	*Solidago* (Asteraceae)
Andrena (*Melandrena*) *carlini* Cockerell, 1901	AB, SK, MB	soil	solitary	polylege
**Andrena* (*Cnemidandrena*) *chromotricha* Cockerell, 1899	AB, MB	soil	solitary	Asteraceae
Andrena (*Andrena*) *clarkella* (Kirby, 1802)	AB, SK, MB	soil	solitary	*Salix* (Salicaceae)
**Andrena* (*Cnemidandrena*) *colletina* Cockerell, 1906	AB, SK	soil	solitary	Asteraceae
Andrena (*Cnemidandrena*) *columbiana* Viereck, 1917	AB, SK	soil	solitary	Asteraceae
Andrena (*Melandrena*) *commoda* Smith, 1979	MB	soil	solitary	polylege
Andrena (*Holandrena*) *cressonii* Robertson, 1891	MB	soil	solitary	polylege
Andrena (*Trachandrena*) *cupreotincta* Cockerell, 1901	AB, SK	soil	solitary	polylege
Andrena (*Trachandrena*) *cyanophila* Cockerell, 1906	AB	soil	solitary	polylege
Andrena (*Melandrena*) *dunningi* Cockerell, 1898	MB	soil	solitary	polylege
Andrena (*Tylandrena*) *erythrogaster* (Ashmead, 1890)	AB, SK, MB	soil	solitary	*Salix* (Salicaceae)

Andrena (*Trachandrena*) *forbesii* Robertson, 1891	AB, SK, MB	soil	solitary	polylege
Andrena (*Andrena*) *frigida* Smith, 1853	AB, SK, MB	soil	solitary	*Salix* (Salicaceae)
Andrena (*Euandrena*) *geranii* Robertson, 1891	AB	soil	solitary	*Geranium* (Geraniaceae)
**Andrena* (*Callandrena*) *haynesi* Viereck & Cockerell, 1914	AB, SK	soil	solitary	*Helianthus* (Asteraceae)
Andrena (*Callandrena*) *helianthi* Robertson, 1891	AB, SK, MB	soil	solitary	*Helianthus* (Asteraceae)
Andrena (*Trachandrena*) *hippotes* Robertson, 1895	AB, SK, MB	soil	solitary	polylege
Andrena (*Cnemidandrena*) *hirticincta* Provancher, 1888	AB, SK, MB	soil	solitary	*Solidago* (Asteraceae)
Andrena (*Micrandrena*) *illinoiensis* Robertson, 1891	AB, SK, MB	soil	solitary	*Salix* (Salicaceae)
Andrena (*Scrapteropsis*) *imitatrix* Cresson, 1872	AB, SK, MB	soil	solitary	polylege
Andrena (*Euandrena*) *lawrencei* Viereck & Cockerell, 1914	AB	soil	solitary	polylege
Andrena (*Melandrena*) *lupinorum* Cockerell, 1906	AB, MB	soil	solitary	Fabaceae
Andrena (*Andrena*) *macoupinensis* Robertson, 1900	AB	soil	solitary	*Salix* (Salicaceae)
Andrena (*Trachandrena*) *mariae* Robertson, 1891	AB, SK, MB	soil	solitary	*Salix* (Salicaceae)
Andrena (*Thysandrena*) *medionitens* Cockerell, 1902	AB, SK, MB	soil	solitary	polylege
Andrena (*Micrandrena*) *melanochroa* Cockerell, 1898	SK, MB	soil	solitary	*Fragaria* (Rosaceae)
Andrena (*Micrandrena*) *microchlora* Cockerell, 1922	SK	soil	solitary	Polylege?; (Apiaceae)
Andrena (*Andrena*) *milwaukeensis* Graenicher, 1903	AB. SK, MB	soil	solitary	polylege
Andrena (*Trachandrena*) *miranda* Smith, 1879	AB, SK, MB	soil	solitary	polylege
Andrena (*Simandrena*) *nasonii* Robertson, 1895	MB	soil	solitary	polylege
**Andrena* (*Micrandrena*) *nigrae* Robertson, 1905	AB, SK	soil	solitary	*Salix* (Salicaceae)
Andrena (*Euandrena*) *nigrihirta* (Ashmead, 1890)	AB, SK, MB	soil	solitary	polylege
Andrena (*Melandrena*) *nivalis* Smith, 1853	AB, SK, MB	soil	solitary	polylege
Andrena (*Cnemidandrena*) *nubecula* Smith, 1853	MB	soil	solitary	*Solidago* (Asteraceae)
Andrena (*Andrena*) *perarmata* Cockerell, 1898	AB	soil	solitary	*Salix* (Salicaceae)
Andrena (*Gonandrena*) *persimulata* Viereck, 1917	AB, SK, MB	soil	solitary	*Cornus* (Cornaceae)
Andrena (*Gonandrena*) *platyparia* Robertson, 1895	MB	soil	solitary	*Cornus* (Cornaceae)
Andrena (*Plastandrena*) *prunorum* Cockerell, 1896	AB, SK	soil	solitary	polylege
**Andrena* (*Trachandrena*) *quintilis* Robertson, 1898	MB	soil	solitary	*Amorpha* (Fabaceae)
Andrena (*Melandrena*) *regularis* Malloch, 1917	AB, SK, MB	soil	solitary	polylege
Andrena (*Cnemidandrena*) *robervalensis* Mitchell, 1960	AB, SK, MB	soil	solitary	
Andrena (*Andrena*) *rufosignata* Cockerell, 1902	AB, SK, MB	soil	solitary	polylege

Taxon	Province	Nesting Notes	Lifestyle	Floral Hosts
Andrena (*Trachandrena*) *salicifloris* Cockerell, 1897	AB	soil	solitary	*Salix* (Salicaceae)
Andrena (*Micrandrena*) *salictaria* Robertson, 1905	AB, SK, MB	soil	solitary	*Salix* (Salicaceae)
Andrena (*Scaphandrena*) *scurra* Viereck, 1904	AB	soil	solitary	Brassicaceae
Andrena (*Cnemidandrena*) *scutellinitens* Viereck, 1917	AB	soil	solitary	Asteraceae
Andrena (*Trachandrena*) *sigmundi* Cockerell, 1902	AB, SK, MB	soil	solitary	*Salix* (Salicaceae)
Andrena (*Trachandrena*) *striatifrons* Cockerell, 1897	AB	soil	solitary	*Salix* (Salicaceae)
Andrena (*Cnemidandrena*) *surda* Cockerell, 1910	AB, SK	soil	solitary	Asteraceae
Andrena (*Andrena*) *thaspii* Graenicher, 1903	AB, SK, MB	soil	solitary	polylege
Andrena (*Melandrena*) *transnigra* Viereck, 1904	AB, SK	soil	solitary	polylege
Andrena (*Thysadrena*) *trizonata* Ashmead, 1890	AB	soil	solitary	*Salix* (Salicaceae)
Andrena (*Melandrena*) *vicina* Smith, 1853	AB, SK, MB	soil	solitary	polylege
Andrena (*Andrena*) *vicinoides* Viereck, 1904	AB	soil	solitary	polylege
Andrena (*Parandrena*) *wellesleyana* Robertson, 1897	AB, SK, MB	soil	solitary	*Salix* (Salicaceae)
Andrena (*Simandrena*) *wheeleri* Graenicher, 1904	AB, MB	soil	solitary	polylege
Andrena (*Thysandrena*) *w-scripta* Viereck, 1904	AB, SK, MB	soil	solitary	polylege
Andrena (*Micrandrena*) *ziziae* Robertson, 1891	MB	soil	solitary	*Zizia* (Apiaceae)
Subfamily PANURGINAE; Tribe PROTANDRENINI				
Pseudopanurgus aestivalis (Provancher, 1882)	AB, SK, MB	soil	solitary	Asteraceae
**Pseudopanurgus innuptus* (Cockerell, 1896)	AB, SK	soil	solitary	*Helianthus* (Asteraceae)
**Pseudopanurgus ornatipes* (Cresson, 1872)	MB	soil	solitary	
Pseudopanurgus parvus (Robertson, 1892)	AB, SK, MB	soil	solitary	polylege
**Pseudopanurgus pauper* (Cresson, 1878)	AB	soil	solitary	*Ceanothus* (Rhamnaceae)
**Pseudopanurgus pecki* (Cockerell, 1937)	AB	soil	solitary	
**Pseudopanurgus piercei* (Crawford, 1903)	AB	soil	solitary	
**Pseudopanurgus renimaculatus* (Cockerell, 1896)	AB	soil	solitary	
Pseudopanurgus rudbeckiae (Robertson, 1895)	MB	soil	solitary	Asteraceae
Subfamily Panurginae; Tribe Panurgini				
**Panurginus beardsleyi* (Cockerell, 1904)	AB	soil	solitary	*Sphaeralcea* (Malvaceae)
Panurginus ineptus Cockerell, 1922	SK	soil	solitary	

Subfamily Panurginae; Tribe Perditini				
Perdita (*Cockerellia*) *albipennis* Cresson, 1868	AB, SK, MB	soil	solitary	Asteraceae
**Perdita* (*Perdita*) *bruneri* Cockerell, 1897	AB, MB	soil	solitary	polylege
Perdita (*Perdita*) *halictoides* Smith, 1853	MB	soil	solitary	polylege
Perdita (*Perdita*) *maculigera* Cockerell, 1896	MB	soil	solitary	polylege
Perdita (*Perdita*) *octomaculata* (Say, 1824)	MB	soil	solitary	Asteraceae
**Perdita* (*Perdita*) *perpallida* Cockerell, 1901	AB, MB	soil	solitary	Asteraceae
**Perdita* (*Perdita*) *pretiosa* Timberlake, 1980	SK	soil	solitary	
**Perdita* (*Perdita*) *stottleri* Cockerell, 1896	SK	soil	solitary	Asteraceae
Perdita (*Perdita*) *swenki* Crawford, 1915	AB, SK, MB	soil	solitary	Asteraceae
Subfamily PANURGINAE; Tribe CALLIOPSINI				
Calliopsis (*Calliopsis*) *andreniformis* Smith, 1853	SK	soil	solitary	polylege
**Calliopsis* (*Calliopsima*) *chlorops* Cockerell, 1899	AB	soil	solitary	Asteraceae
**Calliopsis* (*Calliopsima*) *coloradensis* Cresson, 1878	AB, SK, MB	soil	solitary	Asteraceae
*††*Calliopsis* (*Nomadopsis*) *zebrata* Cresson, 1878	SK	soil	solitary	polylege?
Family HALICTIDAE				
Subfamily ROPHITINAE				
Dufourea dilatipes Bohart, 1948	AB	soil	solitary	*Calochortus* (Liliaceae)
Dufourea fimbriata (Cresson, 1878)	AB	soil	solitary	*Potentilla* (Rosaceae)
Dufourea marginata (Cresson, 1878)	AB, SK, MB	soil	solitary	*Helianthus* (Asteraceae)
Dufourea maura (Cresson, 1878)	AB, MB	soil	solitary	*Campanula* (Campanulaceae)
Subfamily NOMIINAE				
**Dieunomia heteropoda* (Say, 1824)	MB	soil	solitary	*Helianthus* (Asteraceae)
Subfamily HALICTINAE; Tribe HALICTINI				
*††*Agapostemon* (*Agapostemon*) *angelicus* Cockerell, 1924	SK	soil	solitary	polylege
Agapostemon (*Agapostemon*) *femoratus* Crawford, 1901	AB, SK	soil	solitary	polylege
*††*Agapostemon* (*Agapostemon*) *melliventris* Cresson, 1874	SK	soil	solitary	polylege
Agapostemon (*Agapostemon*) *obliquus* (Provancher, 1888)	AB	soil	solitary	polylege
Agapostemon (*Agapostemon*) *sericeus* (Forster, 1771)	MB	soil	solitary	polylege
Agapostemon (*Agapostemon*) *splendens* (Lepeletier, 1841)	AB, SK, MB	soil	solitary	polylege
Agapostemon (*Agapostemon*) *texanus* Cresson, 1872	AB, SK, MB	soil	solitary	polylege

Taxon	Province	Nesting Notes	Lifestyle	Floral Hosts
Agapostemon (*Agapostemon*) *virescens* (Fabricius, 1775)	AB, SK, MB	soil	solitary	polylege
Halictus (*Pachyceble*) *confusus* Smith, 1853	AB, SK, MB	soil	eusocial	polylege
Halictus (*Odontalictus*) *ligatus* Say, 1837	AB, SK, MB	soil	eusocial	polylege
Halictus (*Nealictus*) *parallelus* Say, 1837	MB	soil	eusocial	polylege
Halictus (*Protohalictus*) *rubicundus* (Christ, 1791)	AB, SK, MB	soil	variable	polylege
Halictus (*Pachyceble*) *virgatellus* Cockerell, 1901	AB, MB	soil	eusocial	polylege
Lasioglossum (Sphecodogastra) abberans (Crawford, 1903)	AB, SK, MB	soil	solitary	*Oenothera* (Onagraceae)
**Lasioglossum* (*Dialictus*) *abundipunctum* Gibbs, 2010	AB	soil	eusocial?	polylege
Lasioglossum (*Lasioglossum*) *acuminatum* McGinley, 1986	AB	soil	solitary	polylege
Lasioglossum (*Dialictus*) *admirandum* Sandhouse, 1924	MB	soil	eusocial?	polylege
Lasioglossum (Dialictus) *albipenne* (Robertson, 1890)	AB, SK, MB	soil	eusocial?	polylege
Lasioglossum (*Dialictus*) *albohirtum* (Crawford, 1907)	AB, SK	soil	eusocial?	polylege
Lasioglossum (*Lasioglossum*) *athabascense* (Sandhouse, 1933)	AB, SK, MB	soil	solitary	polylege
Lasioglossum (*Evylaeus*) *cinctipes* (Provancher, 1888)	AB	soil	eusocial	polylege
Lasioglossum (*Lasioglossum*) *colatum* (Vachal, 1904)	AB	soil	solitary	polylege
Lasioglossum (*Sphecodogastra*) *cooleyi* (Crawford, 1906)	AB	soil	eusocial	polylege
Lasioglossum (*Lasioglossum*) *coriaceum* (Smith, 1853)	AB, MB	soil	solitary	polylege
Lasioglossum (*Dialictus*) *cressonii* (Robertson, 1890)	AB	rotting wood	eusocial?	polylege
Lasioglossum (*Dialictus*) *dreisbachi* (Mitchell, 1960)	AB	soil	eusocial?	polylege
**Lasioglossum (Dialictus) ebmerellum* Gibbs, 2010	AB	soil	eusocial?	polylege
Lasioglossum (*Lasioglossum*) *egregium* (Vachal, 1904)	AB	soil	solitary	polylege
Lasioglossum (*Hemihalictus*) *foxii* (Robertson, 1895)	MB	sandy soil	solitary/greg.	polylege
**Lasioglossum* (*Dialictus*) *hudsoniellum* (Cockerell, 1919)	AB	soil	eusocial?	polylege
Lasioglossum (*Dialictus*) *imbrex* Gibbs, 2010	AB	soil	eusocial?	polylege
Lasioglossum (*Dialictus*) *imitatum* (Smith, 1853)	SK, MB	soil	eusocial	polylege
Lasioglossum (*Dialictus*) *incompletum* (Crawford, 1907)	AB	soil	social?	polylege
Lasioglossum (*Hemihalictus*) *inconditum* (Cockerell, 1916)	AB, SK, MB	soil	solitary	polectic
Lasioglossum (*Dialictus*) *laevissimum* (Smith, 1853)	AB, SK	soil	eusocial?	polylege
Lasioglossum (*Leuchalictus*) *leucozonium* (Schrank, 1781)	AB, SK, MB	soil	solitary	polylege
Lasioglossum (*Dialictus*) *lineatulum* (Crawford, 1906)	AB, SK, MB	soil	eusocial?	polylege

**Lasioglossum* (*Sphecodogastra*) *lusorium* (Cresson, 1872)	AB	soil	solitary	polylege
Lasioglossum (*Hemihalictus*) *macoupinense* (Robertson 1895)	AB, SK, MB	soil	solitary	polylectic
Lasioglossum (*Dialictus*) *nigroviride* (Graenicher, 1911)	AB, MB	soil	eusocial?	polylege
Lasioglossum (*Sphecodogastra*) *nigrum* (Viereck, 1903)	AB	soil	eusocial?	polylege
Lasioglossum (*Dialictus*) *novascotiae* (Mitchell, 1960)	AB	soil	eusocial?	polylege
**Lasioglossum* (*Dialictus*) *occidentale* (Crawford, 1902)	AB, SK, MB	soil	eusocial?	polylege
**Lasioglossum* (*Dialictus*) *packeri* Gibbs, 2010	AB, SK, MB	soil	eusocial?	polylege
**Lasioglossum* (*Dialictus*) *pallidellum* (Ellis, 1914)	AB	soil	eusocial?	polylege
Lasioglossum (*Lasioglossum*) *paraforbesii* McGinley, 1986	AB, SK, MB	soil	solitary	polylege
Lasioglossum (*Dialictus*) *pavoninum* (Ellis, 1913)	AB, MB	soil	eusocial?	polylege
Lasioglossum (*Hemihalictus*) *pectorale* (Smith 1853)	SK, MB	soil	solitary?	polylege
Lasioglossum (*Dialictus*) *pectoraloides* (Cockerell, 1895)	MB	soil	eusocial?	polylege
Lasioglossum (*Dialictus*) *perpunctatum* (Ellis, 1913)	AB, SK, MB	soil	eusocial?	polylege
Lasioglossum (*Dialictus*) *pictum* (Crawford, 1902)	AB, SK, MB	sandy soil	eusocial?	polylege
Lasioglossum (*Dialictus*) *planatum* (Lovell, 1905)	AB	soil	eusocial?	polylege
Lasioglossum (*Dialictus*) *prasinogaster* Gibbs, 2010	AB	soil	eusocial?	polylege
Lasioglossum (*Dialictus*) *pruinosum* (Robertson, 1892)	AB, SK, MB	soil	eusocial?	polylege
Lasioglossum (*Sphecodgastra*) *quebecense* (Crawford, 1907)	AB	soil	solitary	polylege
Lasioglossum (*Dialictus*) *rufulipes* (Cockerell, 1938)	AB, SK, MB	soil	eusocial?	polylege
Lasioglossum (*Dialictus) ruidosense* (Cockerell, 1897)	AB, SK	soil	eusocial?	polylege
Lasioglossum (*Dialictus*) *sagax* (Sandhouse, 1924)	AB, SK, MB	soil	eusocial?	polylege
**Lasioglossum* (*Dialictus*) *semicaeruleum* (Cockerell, 1895)	AB, SK, MB	soil	eusocial?	polylege
Lasioglossum (*Dialictus*) *sheffieldi* Gibbs, 2010	MB	sandy soil	eusocial?	polylege
Lasioglossum (*Lasioglossum*) *sisymbrii* (Cockerell)	AB, SK	soil	solitary	polylege
**Lasioglossum* (*Dialictus*) *sitocleptum* Gibbs, 2010	AB	soil	social parasite	polylege
Lasioglossum (*Dialictus*) *subversans* Mitchell, 1960	SK	soil	eusocial?	polylege
Lasioglossum (*Dialictus*) *subviridatum* (Cockerell, 1938)	SK	wood	eusocial?	polylege
Lasioglossum (*Dialictus*) *succinipenne* (Ellis, 1913)	AB, SK, MB	soil	eusocial?	polylege
Lasioglossum (*Hemihalictus*) *swenki* (Crawford 1906)	AB, MB	soil	solitary?	polylege
**Lasioglossum* (*Dialictus*) *synthyridis* (Crawford, 1906)	AB, SK	soil	eusocial?	polylege
Lasioglossum (*Dialictus*) *tenax* (Sandhouse, 1924)	SK	soil	variable	polylege

Taxon	Province	Nesting Notes	Lifestyle	Floral Hosts
Lasioglossum (*Dialictus*) *timothyi* Gibbs, 2010	MB	soil	eusocial?	polylege
Lasioglossum (*Lasioglossum*) *trizonatum* (Cresson, 1874)	AB, SK	soil	solitary	polylege
Lasioglossum (*Dialictus*) *versans* (Lovell, 1905)	AB, MB	soil	eusocial?	polylege
Lasioglossum (*Dialictus*) *vierecki* (Crawford, 1904)	MB	soil	eusocial?	polylege
Lasioglossum (*Dialictus*) *zephyrum* (Smith, 1853)	AB, MB	soil	eusocial	polylege
Lasioglossum (*Leuchalictus*) *zonulum* (Smith, 1848)	AB, SK, MB	soil	solitary	polylege
**Sphecodes arroyanus* Cockerell, 1904	AB	soil	cleptoparasite	
**Sphecodes borealis* Cockerell, 1937	SK	soil	cleptoparasite	
Sphecodes clematidis Robertson, 1897	MB	soil	cleptoparasite	
Sphecodes confertus Say, 1837	SK	soil	cleptoparasite	
**Sphecodes lautipennis* Cockerell, 1908	SK	soil	cleptoparasite	
Sphecodes minor Robertson, 1898	AB	soil	cleptoparasite	
†*Sphecodes pecosensis* Cockerell, 1904	SK	soil	cleptoparasite	
**Sphecodes politulus* Cockerell, 1937	SK	soil	cleptoparasite	
**Sphecodes pusillus* Cockerell, 1937	SK	soil	cleptoparasite	
**Sphecodes solidaginis* Cockerell, 1937	SK	soil	cleptoparasite	
Subfamily HALICTINAE; Tribe AUGOCHLORINI				
Augochlorella aurata (Smith, 1853)	MB, SK	soil	solitary/social	polylege
Family MELITTIDAE				
Macropis (*Macropis*) *nuda* (Provancher, 1882)	AB, SK, MB	soil	solitary	*Lysimachia* (Myrsinaceae)
Family MEGACHILIDAE				
Subfamily MEGACHILINAE; Tribe OSMIINI				
†*Ashmeadiella* (*Ashmeadiella*) *cactorum* (Cockerell, 1897)	SK		solitary	polylege
Heriades (*Neotrypetes*) *carinata* Cresson, 1864	AB, SK, MB	cavity	solitary	polylege
Heriades (*Neotrypetes*) *variolosa* (Cresson, 1872)	AB, SK, MB	cavity	solitary	Asteraceae
Hoplitis (*Monumetha*) *albifrons* (Kirby, 1837)	AB, SK, MB	cavity	solitary	polylege
Hoplitis (*Alcidamea*) *pilosifrons* (Cresson, 1864)	AB, SK	cavity	solitary	polylege
Hoplitis (*Alcidamea*) *producta* (Cresson, 1864)	AB, SK, MB	cavity	solitary	polylege
Hoplitis (*Formicapis*) *robusta* (Nylander, 1848)	AB, SK, MB		solitary	polylege
Hoplitis (*Monumetha*) *spoliata* (Provancher, 1888)	AB, SK, MB	cavity	solitary	polylege

Osmia (*Melanosmia*) *albolateralis* Cockerell, 1906	AB		solitary	Fabaceae
Osmia (*Melanosmia*) *atriventris* Cresson, 1864	AB, SK, MB	cavity	solitary	polylege
Osmia (*Melanosmia*) *bucephala* Cresson, 1864	AB	cavity	solitary	polylege
Osmia (*Melanosmia*) *densa* Cresson, 1864	AB		solitary	polylege
Osmia (*Melanosmia*) *distincta* (Cresson, 1864)	MB		solitary	*Penstemon* (Plantaginaceae)
**Osmia* (*Melanosmia*) *grindeliae* (Cockerell, 1910)	AB		solitary	
Osmia (*Melanosmia*) *inermis* (Zetterstedt, 1838)	AB, MB	under stone	solitary	polylege?; *Vaccinium* (Ericaceae)
Osmia (*Melanosmia*) *integra* Cresson, 1878	AB, SK, MB	dung; soil	solitary	polylege
**Osmia* (*Melanosmia*) *inurbana* Cresson, 1878	AB, MB		solitary	polylege
Osmia (*Melanosmia*) *juxta* Cresson, 1864	AB		solitary	polylege
Osmia (*Osmia*) *lignaria* Say, 1837	AB, SK, MB	cavity	solitary	polylege
Osmia (*Melanosmia*) *longula* Cresson, 1864	SK	under stone	solitary	*Astragalus* (Fabaceae)
Osmia (*Melanosmia*) *nanula* Cockerell, 1897	AB		solitary	
Osmia (*Melanosmia*) *nigrifrons* Cresson, 1878	AB		solitary	
Osmia (*Melanosmia*) *nigriventris* (Zetterstedt, 1838)	AB. MB		solitary	
**Osmia* (*Melanosmia*) *nigrobarbata* Cockerell, 1916	SK	ground	solitary	*Astragalus* (Fabaceae)
Osmia (*Melanosmia*) *pentstemonis* Cockerell, 1906	AB		solitary	*Penstemon* (Plantaginaceae)
Osmia (*Melanosmia*) *physariae* Cockerell, 1907	AB. SK. MB		solitary	
Osmia (*Melanosmia*) *proxima* Cresson, 1864	AB		solitary	polylege
Osmia (*Melanosmia*) *pumila* Cresson, 1864	MB		solitary	
Osmia (*Melanosmia*) *pusilla* Cresson, 1864	AB		solitary	polylege
Osmia (*Melanosmia*) *sculleni* Sandhouse, 1939	AB, MB		solitary	*Hackelia* (Boraginaceae)
Osmia (*Melanosmia*) *sedula* Sandhouse, 1924	AB		solitary	
Osmia (*Melanosmia*) *simillima* Smith, 1853	AB, SK, MB	cavity (mud)	solitary	polylege
Osmia (*Melanosmia*) *tersula* Cockerell, 1912	AB	cavity	solitary	polylege
Osmia (*Helicosmia*) *texana* Cresson, 1872	AB, SK	cavity	solitary	Asteraceae
Osmia (*Melanosmia*) *trevoris* Cockerell, 1897	AB		solitary	
Subfamily MEGACHILINAE; Tribe ANTHIDIINI				
Anthidium (*Anthidium*) *clypeodentatum* Swenk, 1914	MB	cavity	solitary	Fabaceae
Anthidium (*Anthidium*) *porterae* Cockerell, 1900	AB		solitary	polylege

Taxon	Province	Nesting Notes	Lifestyle	Floral Hosts
Anthidium (*Anthidium*) *tenuiflorae* Cockerell, 1907	AB, SK	cavity; b/n rocks	solitary	*Phacelia* (Boraginaceae)
**Dianthidium* (*Dianthidium*) *curvatum* (Smith, 1854)	AB	soil	solitary	
Dianthidium (*Dianthidium*) *pudicum* (Cresson, 1879)	AB	cavities, rocks	solitary	polylege
Stelis (*Stelis*) *foederalis* Smith, 1854	SK		cleptoparasite	
Stelis (*Stelis*) *labiata* (Provancher, 1888)	AB, MB		cleptoparasite	
Stelis (*Stelis*) *lateralis* Cresson, 1864	AB, SK, MB		cleptoparasite	
Stelis (*Stelis*) *montana* Cresson, 1864	AB		cleptoparasite	
Stelis (*Stelis*) *nitida* (Cresson, 1878)	AB		cleptoparasite	
†*Stelis* (*Stelis*) *permaculata* Cockerell, 1898	SK		cleptoparasite	
Stelis (*Stelis*) *rubi* (Cockerell, 1898)	AB		cleptoparasite	
Stelis (*Stelis*) *subemarginata* Cresson, 1878	MB		cleptoparasite	
Subfamily MEGACHILINAE; Tribe MEGACHILINI				
Coelioxys (*Synocoelioxys*) *alternata* Say, 1837	AB, SK, MB		cleptoparasite	
**Coelioxys* (*Xerocoelioxys*) *edita* Cresson, 1872	AB		cleptoparasite	
Coelioxys (*Boreocoelioxys*) *funeraria* Smith, 1854	AB, SK, MB		cleptoparasite	
Coelioxys (*Xerocoelioxys*) *grindeliae* Cockerell, 1900	AB, SK		cleptoparasite	
Coelioxys (*Boreocoelioxys*) *moesta* Cresson, 1864	AB, SK, MB		cleptoparasite	
Coelioxys (*Boreocoelioxys*) *octodentata* Say, 1824	AB, MB		cleptoparasite	
Coelioxys (*Boreocoelioxys*) *porterae* Cockerell, 1900	AB, SK, MB		cleptoparasite	
Coelioxys (*Boreocoelioxys*) *rufitarsis* Smith, 1854	AB, SK, MB		cleptoparasite	
Coelioxys (*Coelioxys*) *sodalis* Cresson, 1878	AB, SK, MB		cleptoparasite	
**Megachile* (*Megachiloides*) *anograe* Cockerell, 1908	AB	sandy soil	solitary	*Opuntia* (Cactaceae); *Oenothera* (Onagraceae)
Megachile (*Litomegachile*) *brevis* Say, 1837	SK	cavity	solitary	polylege
**Megachile* (*Megachiloides*) *casadae* Cockerell, 1898	AB	soil	solitary	polylege?
Megachile (*Megachile*) *centuncularis* (Linnaeus, 1758)	AB, SK, MB	cavity; soil	solitary	polylege
Megachile (*Xanthosarus*) *circumcincta* (Kirby, 1802)	AB, SK, MB	soil	solitary	polylege
**Megachile* (*Xanthosarus*) *dentitarsus* Sladen, 1919	AB, SK	soil	solitary	polylege
**Megachile* (*Xanthosarus*) *fortis* Cresson, 1872	AB, SK, MB	soil	solitary	Asteraceae
Megachile (*Xanthosarus*) *frigida* Smith, 1853	AB, SK, MB	cavity; wood	solitary	polylege
Megachile (*Xanthosarus*) *gemula* Cresson, 1878	AB, SK, MB	wood	solitary	polylege

Megachile (*Megachile*) *inermis* Provancher, 1888	AB, SK, MB	cavity	solitary	polylege
Megachile (*Megachile*) *lapponica* Thomson, 1872	AB, SK, MB	cavity	solitary	polylege
Megachile (*Xanthosarus*) *latimanus* Say, 1823	AB, SK, MB	soil	solitary	polylege
Megachile (*Litomegachile*) *lippiae* Cockerell, 1900	AB	soil	solitary	polylege
**Megachile* (*Megachiloides*) *manifesta* Cresson, 1878	AB	soil	solitary	polylege
Megachile (*Xanthosarus*) *melanophaea* Smith, 1853	AB, SK, MB	soil	solitary	Fabaceae
Megachile (*Megachile*) *montivaga* Cresson, 1878	AB, SK, MB	soil	solitary	polylege
Megachile (*Argyropile*) *parallela* Smith, 1853	AB, SK	soil; cavity	solitary	Asteraceae?
Megachile (*Xanthosarus*) *perihirta* Cockerell, 1898	AB, SK, MB	soil	solitary	Asteraceae
Megachile (*Sayapsis*) *pugnata* Say, 1837	AB, MB	cavity	solitary	polylege
Megachile (*Megachile*) *relativa* Cresson, 1878	AB, SK, MB	cavity	solitary	polylege
Megachile (*Eutricharaea*) *rotundata* (Fabricius, 1787)	AB, SK, MB	cavity	solitary	polylege
**Megachile* (*Megachiloides*) *sublaurita* Mitchell, 1927	AB	soil	solitary	*Sphaeralcea* (Malvaceae)
Megachile (*Litomegachile*) *texana* Cresson, 1878	SK, MB	soil	solitary	polylege
Megachile (*Megachiloides*) *wheeleri* Mitchell, 1927	AB, SK	soil	solitary	polylege
Family APIDAE				
Subfamily XYLOCOPINAE				
Ceratina (*Zadontomerus*) *calcarata* Robertson, 1900	MB	pithy stems	subsocial	polylege
Ceratina (*Zadontomerus*) *dupla* Say, 1837	MB	pithy stems	subsocial	polylege
Subfamily NOMADINAE; Tribe NOMADINI				
Nomada articulata Smith, 1854	AB	soil	cleptoparasite	
Nomada bella Cresson, 1863	AB	soil	cleptoparasite	
Nomada cressonii Robertson, 1893	MB	soil	cleptoparasite	
Nomada cuneata (Robertson, 1903)	MB	soil	cleptoparasite	
Nomada lehighensis Cockerell, 1903	AB	soil	cleptoparasite	
**Nomada snowii* Cresson, 1878	AB, SK	soil	cleptoparasite	
Nomada vicina Cresson, 1863	SK	soil	cleptoparasite	
**Nomada vincta* Say, 1837	AB, SK, MB	soil	cleptoparasite	
Subfamily NOMADINAE; Tribe EPEOLINI				
**Epeolus ainsliei* Crawford, 1932	AB, MB	soil	cleptoparasite	
**Epeolus compactus* Cresson, 1878	AB	soil	cleptoparasite	

Taxon	Province	Nesting Notes	Lifestyle	Floral Hosts
Epeolus interruptus Robertson, 1900	SK, MB	soil	cleptoparasite	
**Epeolus lutzi* Cockerell, 1921	AB	soil	cleptoparasite	
Epeolus minimus (Robertson, 1902)	AB, MB	soil	cleptoparasite	
**Triepeolus balteatus* Cockerell, 1921	AB	soil	cleptoparasite	
**Triepeolus concavus* (Cresson, 1878)	AB	soil	cleptoparasite	
**Triepeolus dacotensis* (Stevens, 1919)	AB	soil	cleptoparasite	
**Triepeolus helianthi* (Robertson, 1897)	AB	soil	cleptoparasite	
**Triepeolus obliterates* Graenicher, 1911	SK	soil	cleptoparasite	
Triepeolus paenepectoralis Viereck, 1905	AB	soil	cleptoparasite	
**Triepeolus subalpinus* Cockerell, 1910	AB, SK	soil	cleptoparasite	
Subfamily NOMADINAE; Tribe AMMOBATOIDINI				
**Holcopasites heliopsis* (Robertson, 1897)	AB	soil	cleptoparasite	
**Holcopasites pulchellus* (Cresson, 1878)	AB, SK	soil	cleptoparasite	
**Holcopasites stevensi* Crawford, 1915	AB, SK, MB	soil	cleptoparasite	
Subfamily NOMADINAE; Tribe NEOLARRINI				
**Neolarra pruinosa* Ashmead, 1890	AB	soil	cleptoparasite	
**Neolarra vigilans* (Cockerell, 1895)	AB, SK	soil	cleptoparasite	
Subfamily APINAE; Tribe OSIRINI				
Epeoloides pilosulus (Cresson, 1878)	SK, MB	soil	cleptoparasite	
Subfamily APINAE; Tribe EMPHORINI				
**Diadasia australis* (Cresson, 1878)	AB, MB	soil	solitary	*Opuntiai* (Cactaceae)
Diadasia diminuta (Cresson, 1878)	AB	soil	solitary	*Sphaeralcea* (Malvaceae)
**Diadasia enavata* (Cresson, 1872)	SK	soil	solitary	*Helianthus* (Asteraceae)
Subfamily APINAE; Tribe EUCERINI				
**Eucera* (*Synhalonia*) *atriventris* (Smith, 1854)	SK	soil	solitary	polylege
†*Eucera* (*Synhalonia*) *frater* (Cresson, 1878)	SK	soil	solitary	polylege
Eucera (Synhalonia) fulvitarsis (Cresson, 1878)	AB	soil	solitary	polylege
**Eucera (Synhalonia) hamata* (Bradley, 1942)	SK	soil	solitary	polylege
**Eucera (Synhalonia) speciosa* (Cresson, 1878)	AB	soil	solitary	*Oenothera* (Onagraceae)

Melissodes (*Eumelissodes*) *agilis* Cresson, 1878	AB, SK MB	soil	solitary	*Helianthus* (Asteraceae)
**Melissodes* (*Eumelissodes*) *confusa* Cresson, 1878	AB, SK, MB	soil	solitary	Asteraceae
**Melissodes* (*Eumelissodes*) *coreopsis* Robertson, 1905	AB	soil	solitary	*Helianthus* (Asteraceae)
Melissodes (*Eumelissodes*) *druriella* (Kirby, 1802)	AB, SK, MB	soil	solitary	Asteraceae
Melissodes (*Eumelissodes*) *illata* Lovell and Cockerell, 1906	AB, SK, MB	soil	solitary	Asteraceae
**Melissodes* (*Callimelissodes*) *lupina* Cresson, 1878	AB	soil	solitary	Asteraceae
Melissodes (*Eumelissodes*) *lutulenta* LaBerge, 1961	AB, SK	soil	solitary	Asteraceae
Melissodes (*Eumelissodes*) *menuachus* Cresson, 1868	AB, SK	soil	solitary	Asteraceae
Melissodes (*Eumelissodes*) *microsticta* Cockerell, 1905	AB, SK	soil	solitary	Asteraceae
Melissodes (*Eumelissodes*) *pallidisignata* (Cockerell, 1905)	AB, SK, MB	soil	solitary	Asteraceae
**Melissodes* (*Eumelissodes*) *perlusa* Cockerell, 1925	AB, MB	soil	solitary	*Helianthus* (Asteraceae)
Melissodes (*Heliomelissodes*) *rivalis* Cresson, 1872	AB, SK, MB	soil	solitary	*Cirsium* (Asteraceae)
Melissodes (*Eumelissodes*) *semilupina* Cockerell, 1905	AB	soil	solitary	Asteraceae
**Melissodes* (*Eumelissodes*) *snowii* Cresson, 1878	AB, MB	soil	solitary	Asteraceae
**Melissodes* (*Eumelissodes*) *subagilis* Cockerell, 1905	AB	soil	solitary	*Grindelia* (Asteraceae)
Melissodes (*Eumelissodes*) *subillata* LaBerge, 1961	SK, MB	soil	solitary	Asteraceae
Subfamily APINAE; Tribe ANTHOPHORINI				
Anthophora (*Melea*) *bomboides* Kirby, 1838	AB, SK, MB	soil	solitary	polylege
Anthophora (*Melea*) *occidentalis* Cresson, 1869	AB, SK, MB	soil	solitary	polylege
††*Anthophora* (*Heliophila*) *peritomae* Cockerell, 1905	AB, SK	soil	solitary	*Grindelia* (Asteraceae)
Anthophora (*Lophanthophora*) *porterae* Cockerell, 1900	AB	soil	solitary	polylege
Anthophora (*Clisodon*) *terminalis* Cresson, 1869	AB, SK, MB	pithy stems	solitary	polylege
†*Anthophora* (*Lophanthophora*) *ursina* Cresson, 1869	SK	soil	solitary	polylege
††*Anthophora* (*Mystacanthophora*) *walshii* Cresson, 1869	SK	soil	solitary	polylege
†*Habropoda cineraria* (Smith, 1879)	SK	soil	solitary	polylege
Subfamily APINAE; Tribe MELECTINI				
Melecta (*Melecta*) *thoracica* Cresson, 1875	AB		cleptoparasite	
Xeromelecta (*Melectomorpha*) *californica* (Cresson, 1878)	AB, SK		cleptoparasite	
**Zacosmia maculata* (Cresson, 1879)	AB		cleptoparasite	
Subfamily APINAE; Tribe BOMBINI				
Bombus (*Subterraneobombus*) *appositus* Cresson, 1878	AB, SK		eusocial	polylege

Taxon	Province	Nesting Notes	Lifestyle	Floral Hosts
Bombus (*Bombias*) *auricomus* (Robertson, 1903)	AB, SK		eusocial	polylege
Bombus (*Pyrobombus*) *bifarius* Cresson, 1878	AB, MB		eusocial	polylege
Bombus (*Psithyrus*) *bohemicus* (Seidl, 1838)	AB, SK, MB		social parasite	
Bombus (*Subterraneobombus*) *borealis* Kirby, 1837	AB, SK, MB		eusocial	polylege
Bombus (*Pyrobombus*) *bimaculatus* Cresson, 1863	MB		eusocial	polylege
Bombus (*Pyrobombus*) *centralis* Cresson, 1864	AB, SK, MB		eusocial	polylege
Bombus (*Psithyrus*) *citrinus* (Smith, 1854)	MB		social parasite	
Bombus (*Thoracobombus*) *fervidus* (Fabricius, 1798)	AB, SK, MB		eusocial	polylege
Bombus (*Psithyrus*) *flavidus* Eversmann, 1852	AB, SK, MB		social parasite	
Bombus (*Pyrobombus*) *flavifrons* Cresson, 1863	AB, SK, MB		eusocial	polylege
Bombus (*Pyrobombus*) *frigidus* Smith, 1854	AB, SK, MB		eusocial	polylege
Bombus (*Cullumanobombus*) *griseocollis* (DeGeer, 1773)	AB, SK, MB		eusocial	polylege
Bombus (*Pyrobombus*) *huntii* Greene, 1860	AB, SK, MB		eusocial	polylege
Bombus (*Psithyrus*) *insularis* (Smith, 1861)	AB, SK, MB		social parasite	
Bombus (*Pyrobombus*) *mixtus* Cresson, 1878	AB, SK, MB		eusocial	polylege
Bombus (*Bombias*) *nevadensis* Cresson, 1874	AB, SK, MB		eusocial	polylege
Bombus (*Bombus*) *occidentalis* Greene, 1858	AB, SK		eusocial	polylege
Bombus (*Thoracobombus*) *pensylvanicus* (DeGeer, 1773)	AB, MB		eusocial	polylege
Bombus (*Pyrobombus*) *perplexus* Cresson, 1863	AB, SK, MB		eusocial	polylege
Bombus (*Cullumanobombus*) *rufocinctus* Cresson, 1863	AB, SK, MB		eusocial	polylege
Bombus (*Pyrobombus*) *sandersoni* Franklin, 1913	SK, MB		eusocial	polylege
Bombus (*Pyrobombus*) *sitkensis* Nylander, 1848	AB, SK		eusocial	polylege
Bombus (*Psithyrus*) *suckleyi* Greene, 1860	AB, SK, MB		social parasite	
Bombus (*Pyrobombus*) *sylvicola* Kirby, 1837	AB, SK, MB		eusocial	polylege
Bombus (*Pyrobombus*) *ternarius* Say, 1837	AB, SK, MB		eusocial	polylege
Bombus (*Bombus*) *terricola* Kirby, 1837	AB, SK, MB		eusocial	polylege
Bombus (*Pyrobombus*) *vagans* Smith, 1854	AB, SK, MB		eusocial	polylege
Subfamily APINAE; Tribe APINI				
Apis (*Apis*) *mellifera* Linnaeus, 1758	AB, SK, MB	hive	eusocial	polylege

References

Acton, D.F., Padbury, G.A., and Stushnoff, C.T. 1998. The Ecoregions of Saskatchewan. Saskatchewan Environment and Resource Management/Canadian Plains Research Centre, University of Regina, Regina, Saskatchewan.

Adlakha, R.L. 1969. A Systematic Revision of the Bee Genus *Diadasia* Patton in America North of Mexico (Hymenoptera: Anthophoridae). Ph.D. thesis, University of California, Davis.

Alexander, B. 1991. *Nomada* phylogeny reconsidered (Hymenoptera: Anthophoridae). Journal of Natural History, **25:** 315–330.

Alford, D.V. 1978. The Life of the Bumblebee. Davis-Poynter, London, U.K.

Ascher, J., and Pickering, J. 2014. Bee Species Guide (Hymenoptera: Apoidea: Anthophila) [online]. Available from http://www.discoverlife.org/mp/20q?guide=Apoidea_species&flags=HAS [accessed 19 March 2014].

Baker, J.R. 1975. Taxonomy of five Nearctic subgenera of *Coelioxys* (Hymenoptera: Megachilidae). University of Kansas Science Bulletin, **50:** 649–730.

Batra, S.W.T. 1980. Ecology, behavior, pheromones, parasites and management of the sympatric vernal bees *Colletes inaequalis, C. thoracicus* and *C. validus*. Journal of the Kansas Entomological Society, **53:** 509–538.

Batra, S.W.T. 1987. Ethology of the vernal eusocial bee, *Dialictus laevissimus* (Hymenoptera: Halictidae). Journal of the Kansas Entomological Society, **60:** 100–108.

Batra, S.W.T. 1990. Bionomics of a vernal solitary bee *Andrena* (*Scrapteropsis*) *alleghaniensis* Viereck in the Adirondacks of New York (Hymenoptera: Andrenidae). Journal of the Kansas Entomological Society, **63:** 260–266.

Batra, S.W.T., and Schuster, J.C. 1977. Nests of *Centris*, *Melissodes*, and *Colletes* in Guatemala (Hymenoptera: Apoidea). Biotropica, **9:** 135–138.

Biesmeijer, J.C., Roberts, S.P.M., Reemer, M., Ohlemüller, R., Edwards, M., Peeters, T., Schaffrs, A.P., Potts, S.G., Kleukers, R., Thomas, C.D., Settele, J., and Kunin, W.E. 2006. Parallel declines in pollinators and insect-pollinated plants in Britain and the Netherlands. Science, **313:** 351–354.

Bohart, G.E., and Youssef, N.N. 1976. The biology and behavior of *Evylaeus galpinsiae* Cockerell (Hymenoptera: Halictidae). Wasmann Journal of Biology, **34:** 185–234.

Bouseman, J.K., and LaBerge, W.E. 1979. A revision of the genus *Andrena* of the western hemisphere. Part IX. Subgenus *Melandrena*. Transactions of the American Entomological Society, **104:** 275–389.

Broemeling, D.K. 1988. A revision of the *Nomada* subgenus *Nomadita* of North America (Hymenoptera: Anthophoridae). Pan-Pacific Entomologist, **64:** 321–344.

Broemeling, D.K., and Moalif, A.S. 1988. A revision of the *Nomada* subgenus *Pachynomada* (Hymenoptera: Anthophoridae). Pan-Pacific Entomologist, **63:** 201–227.

Brooks, R.W. 1983. Systematics and bionomics of *Anthophora*: the *bomboides* group and species groups of the New World (Hymenoptera: Apoidea, Anthophoridae). University of California Publications in Entomology, **98:** 1–86.

Brumley, R.L. 1965. A Revision of the Bee Genus *Epeolus* Latreille of Western America North of Mexico. MSc thesis, Utah State University, Logan.

Buckner, J.S., Kemp, W.P., and Bosch, J. 2004. Characterization of triacylglycerols from overwintering prepupae of the alfalfa pollinator *Megachile rotundata* (Hymenoptera: Megachilidae). Archives of Insect Biochemistry and Physiology, **57:** 1–14.

Cameron S.A., Lozier, J.D., Strange, J.P., Koch, J.B., Cordes, N., Solter, L.F., and Griswold, T.L. 2011. Patterns of widespread decline in North American bumble bees. Proceedings of the National Academy of Sciences of the United States of America, **108:** 662–667.

Cameron, S.A., Whitfield, J.B., Hulslander, C.L., Cresko, W.A., Isenberg, S.B. and King, R.R. 1996. Nesting biology and foraging patterns of the solitary bee *Melissodes rustica* (Hymenoptera: Apidae) in northwest Arkansas. Journal of the Kansas Entomological Society, **69:** 260–273.

Cane, J.H. 2012. Dung pat nesting by the solitary bee, *Osmia* (*Acanthosmioides*) *integra* (Megachilidae: Apiformes). Journal of the Kansas Entomological Society, **85:** 262–264.

Cane, J.H., Griswold, T., and Parker, F.D. 2007. Substrates and materials used for nesting by North American *Osmia* bees (Hymenoptera: Apiformes: Megachilidae). Annals of the Entomological Society of America, **100:** 350–358.

Clement, S.L. 1973. The nesting biology of *Melissodes* (*Eumelissodes*) *rustica* (Say), with a description of the larva (Hymenoptera: Anthophoridae). Journal of the Kansas Entomological Society, **46:** 516–525.

Clement, S.L. 1974. A note on the nesting biology of *Dianthidium pudicum pudicum* (Cresson) (Hymenoptera: Megachilidae). Pan-Pacific Entomologist, **50:** 87–88.

Cockerell, T.D.A. 1903*a*. Bees of the genus *Nomada* from California. Proceedings of the Academy of Natural Sciences of Philadelphia, **55:** 559–579.
Cockerell, T.D.A. 1903*b*. North American bees of the genus *Nomada*. Proceedings of the Academy of Natural Sciences of Philadelphia, **55:** 580–614.
Colla, S.R., Gadallah, F., Richardson, L., Wagner, D., and Gall, L. 2012. Assessing declines of North American bumble bees (*Bombus* spp.) using museum specimens. Biodiversity and Conservation, **21:** 3585–3595.
Colla, S.R., and Packer, L. 2008. Evidence for decline in eastern North American bumblebees (Hymenoptera: Apidae), with special focus on *Bombus affinis* Cresson. Biodiversity and Conservation, **17:** 1379–1391.
Colla, S., Richardson, L., and Williams, P. 2011. Guide to the Bumble Bees of the Eastern United States. USDA Forest Service/Pollinator Partnership, San Francisco, California.
Costa, J.T. 2006. The Other Insect Societies. Belknap Press of Harvard University, Cambridge, Massachusetts.
Crawford, J.C. 1926. North American bees of the genus *Panurginus*. Proceedings of the Entomological Society of Washington, **28:** 207–214.
Cresson, E.T. 1869. A list of the North American species of the genus *Anthophora,* with descriptions of new species. Transactions of the American Entomological Society, **2:** 289–293.
Curry, P.S. 1984. Bumble Bees of Saskatchewan (Hymenoptera: Apidae): A Survey of Their Geographic Distribution. Saskatchewan Museum of Natural History. Contribution No. 5. Saskatoon, Saskatchewan.
Custer, C.P., and Hicks, C.H. 1927. Nesting habits of some anthidiine bees. Biological Bulletin, **52:** 258–277.
Daly, H.V. 1973. Bees of the genus *Ceratina* in America north of Mexico (Hymenoptera: Apoidea). University of California Publications in Entomology, **74:** 1–113.
Danks, H.V. (*Editor*) 1979. Canada and Its Insect Fauna. Memoirs of the Entomological Society of Canada, **108:** 1–573.
Dombroskie, J.J. 2011. A matrix key to families, subfamilies and tribes of Lepidoptera of Canada [online]. Canadian Journal of Arthropod Identification, **17**. doi:10.3752/cjai.2011.17.
Donovan, B.J. 1977. A revision of North American bees of the subgenus *Cnemidandrena* (Hymenoptera: Andrenidae). University of California Publications in Entomology, **81:** 1–107.
Dumesh, S., and Sheffield, C.S. 2012. Bees of the genus *Dufourea* Lepeletier (Hymenoptera: Halictidae: Rophitinae) of Canada [online]. Canadian Journal of Arthropod Identification, **20**. doi:10.3752/cjai.2012.20.
Ecological Stratification Working Group. 1995. A National Ecological Framework for Canada. Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research and Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch. Ottawa/Hull, Ontario. (Map.).
Eickwort, G.C. 1977*a*. Observations on nest aggregations of the bees *Diadasia olivacea* and *D. diminuta* (Hymenoptera: Anthophoridae). Journal of the Kansas Entomological Society, **50:** 1–17.
Eickwort, G.C. 1977*b*. Aspects of the nesting biology and descriptions of immature stages of *Perdita octomaculata* and *P. halictoides* (Hymenoptera: Andrenidae). Journal of the Kansas Entomological Society, **50:** 577–599.
Eickwort, G.C. 1981. Aspects of the nesting biology of five Nearctic species of *Agapostemon* (Hymenoptera: Halictidae). Journal of the Kansas Entomological Society, **54:** 337–351.
Eickwort, G.C., Eickwort, J.M., Gordon, J., Eickwort, M.A., and Wcislo, W.T. 1996. Solitary behavior in a high-altitude population of the social sweat bee *Halictus rubicundus* (Hymenoptera: Halictidae). Behavioral Ecology and Sociobiology, **38:** 227–233.
Eickwort, G.C., Matthews, R.W., and Carpenter, J. 1981. Observations on the nesting behavior of *Megachile rubi* and *M. texana* with a discussion of the significance of soil nesting in the evolution of megachilid bees (Hymenoptera: Megachilidae). Journal of the Kansas Entomological Society, **54:** 557–570.
Evans, D.L. 1972. A revision of the subgenus *Holonomada* of the genus *Nomada* (Hymenoptera: Anthophoridae). Wasmann Journal of Biology, **30:** 1–34.
Federal, Provincial and Territorial Governments of Canada. 2010. Canadian Biodiversity: Ecosystem Status and Trends 2010. Canadian Councils of Resource Ministers. Ottawa, Ontario.
Fischer, R.L. 1951. Observations on the nesting habits of megachilid bees. Journal of the Kansas Entomological Society, **24:** 46–47.
Fye, R.E. 1965. Biology of Apoidea taken in trap nests in northwestern Ontario (Hymenoptera). The Canadian Entomologist, **97:** 863–877.
Gibbs, J. 2009. Integrative taxonomy identifies new (and old) species in the *Lasioglossum* (*Dialictus*) *tegulare* (Robertson) species group. Zootaxa, **2032:** 1–38.
Gibbs, J. 2010. Revision of the metallic species of *Lasioglossum* (*Dialictus*) in Canada (Hymenoptera, Halictidae, Halictini). Zootaxa, **2591:** 1–382.
Gibbs, J., Packer, L., Dumesh, S., and Danforth, B.N. 2013. Revision and reclassification of *Lasioglossum* (*Evylaeus*), *L.* (*Hemihalictus*) and *L.* (*Sphecodogastra*) in eastern North America (Hymenoptera: Apoidea: Halictidae). Zootaxa, **3672:** 1–117.

Gonzalez, V.H., and Griswold, T.L. 2013. Wool carder bees of the genus *Anthidium* in the Western Hemisphere (Hymenoptera: Megachilidae): diversity, host plant associations, phylogeny, and biogeography. Zoological Journal of the Linnean Society, **168:** 221–425.

Gonzalez, V.H., Griswold, T., and Engel, M.S. 2013. Obtaining a better taxonomic understanding of native bees: where do we start? Systematic Entomology, **38:** 645–653.

Grigarick, A.A., and Strange, L.A. 1968. The pollen-collecting bees of the Anthidiini of California (Hymenoptera: Megachilidae). Bulletin of the California Insect Survey, **9:** 1–113.

Grixti, J.C., and Packer, L. 2006. Changes in the bee fauna (Hymenoptera: Apoidea) of an old field site in southern Ontario, revisited after 34 years. The Canadian Entomologist, **138:** 147–164.

Grixti, J.C., Wong, L.T., Cameron, S.A., and Favret, C. 2009. Decline of bumble bees (*Bombus*) in the North American Midwest. Biological Conservation, **142:** 75–84.

Hicks, B. 2009. Observations of the nest structure of *Osmia inermis* (Hymenoptera: Megachilidae) from Newfoundland, Canada. Journal of the Acadian Entomological Society, **5:** 12–18.

Hobbs, G.A. 1954. Ecology of species of *Megachile* Latreille in the mixed prairie region of southern Alberta with special reference to pollination of alfalfa. Ecology, **35:** 453–462.

Hobbs, G.A. 1964. Ecology of species of *Bombus* Latr. (Hymenoptera: Apidae) in southern Alberta. I. Subgenus *Alpinobombus* Skor. The Canadian Entomologist, **96:** 1465–1470.

Hobbs, G.A. 1965*a*. Ecology of species of *Bombus* Latr. (Hymenoptera: Apidae) in southern Alberta. II. Subgenus *Bombias* Robt. The Canadian Entomologist, **97:** 120–128.

Hobbs, G.A. 1965*b*. Ecology of species of *Bombus* Latr. (Hymenoptera: Apidae) in southern Alberta. III. Subgenus *Cullumanobombus* Vogt. The Canadian Entomologist, **97:** 1293–1302.

Hobbs, G.A. 1966*a*. Ecology of species of *Bombus* Latr. (Hymenoptera: Apidae) in southern Alberta. IV. Subgenus *Fervidobombus* Skorikov. The Canadian Entomologist, **98:** 33–39.

Hobbs, G.A. 1966*b*. Ecology of species of *Bombus* Latr. (Hymenoptera: Apidae) in southern Alberta. V. Subgenus *Subterraneobombus* Vogt. The Canadian Entomologist, **98:** 288–294.

Hobbs, G.A. 1967. Ecology of species of *Bombus* (Hymenoptera: Apidae) in southern Alberta. VI. Subgenus *Pyrobombus*. The Canadian Entomologist, **99:** 1271–1292.

Hobbs, G.A. 1968. Ecology of species of *Bombus* (Hymenoptera: Apidae) in southern Alberta. VII. Subgenus *Bombus*. The Canadian Entomologist, **100:** 156–164.

Hobbs, G.A., Nummi, W.O., and Virostek, J.F. 1961. *Anthophora occidentalis* Cress. (Hymenoptera: Apidae) and its associates at a nesting site in southern Alberta. The Canadian Entomologist, **93:** 142–148.

Hogendoorn, K., and Leys, R. 1997. Life-cycle of *Halictus rubicundus* Christ (Hymenoptera: Halictidae) in the Netherlands: comparison of two populations. Journal of the Kansas Entomological Society, **70:** 347–352.

Hoshikawa, K., Katagiri, C., and Sakagami, S.F. 1992. Sugar accumulation in hibernating adult bees: an example of the unique energy reservoir for hibernation. Comparative Biochemistry and Physiology, **103B:** 41–45.

Hurd, P.D. 1979. Superfamily Apoidea. *In* Catalog of Hymenoptera in America North of Mexico, Vol. 2: Apocrita (Aculeata). *Edited by* K. Krombein, P.D. Hurd, Jr., D.R. Smith, and B.D. Burks. Smithsonian Institution Press, Washington, D.C. pp. 1741–2209.

Hurd, P.D., and Linsley, E.G. 1951. The melectine bees of California (Hymenoptera: Anthophoridae). Bulletin of the California Insect Survey, **1:** 119–140.

Hurd, P.D., and Linsley, E.G. 1972. Parasitic bees of the genus *Holcopasites* Ashmead (Hymenoptera: Apoidea). Smithsonian Contributions to Zoology, **114:** 1–41.

Hurd, P.D., and Michener, C.D. 1955. The megachiline bees of California (Hymenoptera: Megachilidae). Bulletin of the California Insect Survey, **3:** 1–247.

Javorek, S.K., and Grant, M.C. 2011. Trends in Wildlife Habitat Capacity on Agricultural Land in Canada, 1986–2006. Canadian Biodiversity: Ecosystem Status and Trends 2010, Technical Thematic Report No. 14. Canadian Councils of Resource Ministers, Ottawa, Ontario.

Jenkins, D.A., and Matthews, R.W. 2004. Cavity-nesting Hymenoptera in disturbed habitats of Georgia and South Carolina: nest architecture and seasonal occurrence. Journal of the Kansas Entomological Society, **77:** 203–214.

Johnson, M.D. 1981. Observations on the biology of *Andrena* (*Melandrena*) *dunningi* Cockerell (Hymenoptera: Andrenidae). Journal of the Kansas Entomological Society, **54:** 32–40.

Kearns, C.A., and Thomson, J.D. 2001. The Natural History of Bumblebees. A Sourcebook for Investigation. University Press of Colorado, Boulder.

Kemp, W.P., and Bosch, J. 2000. Development and emergence of the alfalfa pollinator *Megachile rotundata* (Hymenoptera: Megachilidae). Annals of the Entomological Society of America, **93:** 904–911.

Kemp, W.P., Bosch, J., and Dennis, B. 2004. Oxygen consumption during the life cycles of the prepupa wintering bee *Megachile rotundata* and the adult-wintering bee *Osmia lignaria* (Hymenoptera: Megachilidae). Annals of the Entomological Society of America, **97:** 161–170.

Kevan, P.G., and Baker, H.G. 1983. Insects as flower visitors and pollinators. Annual Review of Entomology, **28:** 407–453.

Koch, J., Strange, J., and Williams, P. 2012. Guide to Bumble Bees of the Western United States. USDA Forest Service/Pollinator Partnership, San Francisco, California.

Krombein, K.V. 1967. Trap-nesting Wasps and Bees: Life Histories, Nests, and Associates. Smithsonian Press; Washington, D.C.

Krunic, M.D. 1971. Influence of food on the cold-hardiness of *Megachile rotundata* (F.). Canadian Journal of Zoology, **49:** 863–865.

Krunic, M.D., and Hinks, C.F. 1972. The effect of temperature and of temperature pretreatment on diapause and on the synchronization of adult emergence in *Megachile rotundata* (Hymenoptera: Megachilidae). The Canadian Entomologist, **104:** 889–893.

Krunic, M.D., and Salt, R.W. 1971. Seasonal changes in glycerol content and supercooling points of *Megachile rotundata* (F.) and *M. relativa* Cress. Canadian Journal of Zoology, **49:** 663–666.

LaBerge, W.E. 1956*a*. A revision of the bees of the genus *Melissodes* in North and Central America. Part I (Hymenoptera, Apidae). University of Kansas Science Bulletin, **37:** 911–1194.

LaBerge, W.E. 1956*b*. A revision of the bees of the genus *Melissodes* in North and Central America. Part II (Hymenoptera, Apidae). University of Kansas Science Bulletin, **38:** 533–578.

LaBerge, W.E. 1961. A revision of the bees of the genus *Melissodes* in North and Central America. Part III (Hymenoptera, Apidae). University of Kansas Science Bulletin, **42:** 283–663.

LaBerge, W.E. 1967. A revision of the bees of the genus *Andrena* of the western hemisphere. Part I. *Callandrena*. (Hymenoptera: Andrenidae). Bulletin of the University of Nebraska State Museum, **7:** 1–316.

LaBerge, W.E. 1969. A revision of the bees of the genus *Andrena* of the western hemisphere. Part II. *Plastandrena, Aporandrena, Charitandrena*. Transactions of the American Entomological Society, **95:** 1–47.

LaBerge, W.E. 1971. A revision of the bees of the genus *Andrena* of the western hemisphere. Part IV. *Scrapteropsis, Xiphandrena* and *Rhapandrena*. Transactions of the American Entomological Society, **97:** 441–520.

LaBerge, W.E. 1973. A revision of the bees of the genus *Andrena* of the western hemisphere. Part VI. Subgenus *Trachandrena*. Transactions of the American Entomological Society, **99:** 235–371.

LaBerge, W.E. 1977. A revision of the bees of the genus *Andrena* of the western hemisphere. Part VIII. Subgenera *Thysandrena, Dasyandrena, Psammandrena, Rhacandrena, Euandrena, Oxyandrena*. Transactions of the American Entomological Society, **103:** 1–143.

LaBerge, W.E. 1980. A revision of the bees of the genus *Andrena* of the western hemisphere. Part X. Subgenus *Andrena*. Transactions of the American Entomological Society, **106:** 395–525.

LaBerge, W.E. 1986*a*. The zoogeography of *Andrena* Fabricius (Hymenoptera: Andrenidae) of the western Hemisphere. *In* The Prairie: Past, Present and Future. Proceedings of the Ninth North American Prairie Conference, Moorhead, Minnesota, 29 July–1 August 1984. *Edited by* G.K. Clambey and R.H. Pemble. Tri-College University, North Dakota State University, Fargo. pp. 110–115.

LaBerge, W.E. 1986*b*. A revision of the bees of the genus *Andrena* of the western hemisphere. Part XI. Minor subgenera and subgeneric key. Transactions of the American Entomological Society, **111:** 441–567.

LaBerge, W.E. 1987. A revision of the bees of the genus *Andrena* of the western hemisphere. Part XII. Subgenera *Leucandrena, Ptilandrena, Scoliandrena*, and *Melandrena*. Transactions of the American Entomological Society, **112:** 191–248.

LaBerge, W.E. 1989. A revision of the bees of the genus *Andrena* of the western hemisphere. Part XIII. Subgenera *Simandrena* and *Taeniandrena*. Transactions of the American Entomological Society, **115:** 1–56.

LaBerge, W.E., and Bouseman, J.K. 1970. A revision of the bees of the genus *Andrena* of the western hemisphere. Part III. *Tylandrena*. Transactions of the American Entomological Society, **96:** 543–605.

LaBerge, W.E., and Isakson, O.W. 1963. The nests of *Lasioglossum* (*Chloralictus*) *zephyrus* (Smith) in Wyoming (Hymenoptera, Halictidae). Entomological News, **74:** 113–116.

LaBerge, W.E., and Ribble, D.W. 1966. The nests and larvae of two species of *Agapostemon* (Hymenoptera: Halictidae). Journal of the Kansas Entomological Society, **39:** 467–472.

LaBerge, W. E., and Ribble, D.W. 1972. A revision of the bees of the genus *Andrena* of the western hemisphere. Part V. *Gonandrena*, *Geissandrena*, *Parandrena, Pelicandrena*. Transactions of the American Entomological Society, **98:** 271–358.

LaBerge, W. E., and Ribble, D.W. 1975. A revision of the bees of the genus *Andrena* of the western hemisphere. Part VII. Subgenus *Euandrena*. Transactions of the American Entomological Society, **101:** 371–446.

Laverty, T.M., and Harder, L.D. 1988. The bumble bees of eastern Canada. The Canadian Entomologist, **120:** 965–987.

Linsley, E.G. 1943. Notes on the habits of *Melecta sierrae* Linsley. Pan-Pacific Entomologist, **19:** 160.

Linsley, E.C., and MacSwain, J.W. 1957. The nesting habits, flower relationships, and parasites of some North American species of *Diadasia* (Hymenoptera: Anthophoridae). Wasmann Journal of Biology, **15:** 199–235.

Linsley, E.G., MacSwain, J.W., and Raven, P.H. 1963. Comparative behavior of bees and Onagraceae II. *Oenothera* bees of the Great Basin. University of California Publications in Entomology, **33:** 25–50.
McGinley, R.J. 1986. Studies of Halictinae (Apoidea: Halictidae), I. Revision of New World *Lasioglossum* Curtis. Smithsonian Contributions to Zoology, **429:** 1–294.
McGinley, R.J. 2003. Studies of Halictinae (Apoidea: Halictidae), II. Revision of *Sphecodogastra* Ashmead, floral specialists of Onagraceae. Smithsonian Contributions to Zoology, **610:** 1–55.
Metz, C.W. 1911. A revision of the genus *Prosopis* in North America. Transactions of the American Entomological Society, **37:** 85–156.
Michener, C.D. 1935. Some Pacific coast *Panurginus* (Hymen., Apoidea). The Canadian Entomologist, **67:** 275–278.
Michener, C.D. 1938*a*. A review of the American bees of the genus *Macropis* (Hymen., Apoidea). Psyche, **45:** 133–135.
Michener. C.D. 1938*b*. American bees of the genus *Heriades*. Annals of the American Entomological Society, **31:** 514–531.
Michener, C.D. 1939*a*. A revision of the genus *Ashmeadiella* (Hymen., Megachilidae). American Midland Naturalist, **22:** 1–84.
Michener, C.D. 1939*b*. A revision of the genus *Neolarra* (Hymenoptera: Nomadidae). Transactions of the American Entomological Society, **65:** 347–362.
Michener, C.D. 1947. A revision of the American species of *Hoplitis*. Bulletin of the American Museum of Natural History, **89:** 257–318.
Michener, C.D. 1969. Comparative social behavior of bees. Annual Review of Entomology, **14:** 299–342.
Michener, C.D. 1974. The Social Behavior of the Bees: A Comparative Study. Belknap Press of Harvard University Press, Cambridge, Massachusetts.
Michener, C.D. 1979. Biogeography of the bees. Annals of the Missouri Botanical Garden, **66:** 277–347.
Michener, C.D. 2007. The Bees of the World, 2nd ed. Johns Hopkins University Press, Baltimore, Maryland.
Michener, G.R., and Michener, C.D. 1999. Mating behavior of *Dianthidium curvatum* (Hymenoptera: Megachilidae) at a nest aggregation. University of Kansas Natural History Museum Special Publication, **24:** 37–43.
Michez, D., and Patiny, S. 2005. World revision of the oil-collecting bee genus *Macropis* Panzer 1809 (Hymenoptera: Apoidea: Melittidae) with a description of a new species from Laos. Annales de la Société Entomologique de France, **41:** 15–28.
Miliczky, E.R. 1985. Observations of the nesting biology of *Tetralonia hamata* Bradley with a description of its mature larva (Hymenoptera: Anthophoridae). Journal of the Kansas Entomological Society, **58:** 686–700.
Miliczky, E.R. 1988. Observations on the bionomics of the bee *Andrena* (*Tylandrena*) *erythrogaster* Ashmead (Hymenoptera: Andrenidae) with notes on *A*. (*Micrandrena*) *personata* Robertson and *A*. (*Holandrena*) *cressonii* Robertson. Illinois Natural History Survey Biological Notes, **130:** 1–18.
Miliczky, E. 1991. Observations on the nesting biology of three species of panurgine bees (Hymenoptera: Andrenidae). Journal of the Kansas Entomological Society, **64:** 80–87.
Miliczky, E. 2000. Nesting biology of the bee *Melissodes* (*Eumelissodes*) *microsticta* Cockerell in Washington State (Hymenoptera: Apidae). Pan-Pacific Entomologist, **76:** 184–196.
Miliczky, E. 2008. Observations on the nesting biology of *Andrena* (*Plastrandrena*) *prunorum* Cockerell in Washington State (Hymenoptera: Andrenidae). Journal of the Kansas Entomological Society, **81:** 110–121.
Miliczky, E.R., Mayer, D.F., and Lunden, J.D. 1990. Notes on the nesting biology of *Andrena* (*Melandrena*) *nivalis* Smith (Hymenoptera: Andrenidae). Journal of the Kansas Entomological Society, **63:** 166–174.
Miliczky, E.R., and Osgood, E.A. 1995. Bionomics of *Andrena* (*Melandrena*) *vicina* Smith in Maine and Washington, with new parasite records for *A*. (*M*.) *regularis* Malloch and a review of *Melandrena* biology. Journal of the Kansas Entomological Society, **68:** 51–66.
Milliron, H.E. 1971. A monograph of the western hemisphere bumblebees (Hymenoptera: Apidae; Bombinae) I. The genera *Bombus* and *Megabombus* subgenus *Bombias*. Memoirs of the Entomological Society of Canada, **82:** 1–80.
Milliron, H.E. 1973*a*. A monograph of the western hemisphere bumblebees (Hymenoptera: Apidae; Bombinae) II. The genus *Megabombus* subgenus *Megabombus*. Memoirs of the Entomological Society of Canada, **89:** 81–237.
Milliron, H.E. 1973*b*. A monograph of the western hemisphere bumblebees (Hymenoptera: Apidae; Bombinae) III. The genus *Pyrobombus* subgenus *Cullumanobombus*. Memoirs of the Entomological Society of Canada, **91:** 239–333.
Minckley, R.L., Roulston, T.H., and Williams, N.M. 2013. Resource assurance predicts specialist and generalist bee activity in drought. Proceedings of the Royal Society B, **280:** 20122703. doi:10.1098/rspb.2012.2703.
Miranda, G.F.G, Young, A.D., Locke, M.M., Marshall, S.A., Skevington, J.H., and Thompson, F.C. 2013. Key to the genera of Nearctic Syrphidae [online]. Canadian Journal of Arthropod Identification, **23**. doi:10.3752/cjai.2013.23.

Mitchell, T.B. 1960. Bees of the eastern United States. Vol. I. North Carolina Agricultural Experiment Station Technical Bulletin, **141:** 1–538.

Mitchell, T.B. 1962. Bees of the eastern United States. Vol. II. North Carolina Agricultural Experiment Station Technical Bulletin, **152:** 1–557.

Mitchell, T.B. 1973. A Subgeneric Revision of the Bees of the Genus *Coelioxys* of the Western Hemisphere. Contribution from the Department of Entomology, North Carolina State University, Raleigh.

Moure, J.S., and Hurd, P.D., Jr. 1987. An Annotated Catalog of the Halictid Bees of the Western Hemisphere (Hymenoptera: Halictidae). Smithsonian Institution Press, Washington, D.C.

Neff, J.L., and Simpson, B.B. 1988. Vibratile pollen-harvesting by *Megachile mendica* Cresson (Hymenoptera, Megachilidae). Journal of the Kansas Entomological Society, **61:** 242–244.

Neff, J.L., and Simpson, B.B. 1991. Nest biology and mating behavior of *Megachile fortis* in central Texas (Hymenoptera: Megachilidae). Journal of the Kansas Entomological Society, **64:** 324–336.

Norden, B.B., and Scarbrough, A.G. 1979. Nesting biology of *Andrena* (*Larandrena*) *miserabilis* Cresson and description of the prepupa (Hymenoptera: Andrenidae). Brimleyana, **2:** 141–146.

Ollerton, J., Winfree, R., and Tarrant, S. 2011. How many flowering plants are pollinated by animals? Oikos, **120:** 321–326.

Packer, L. 1990. Solitary and eusocial nests in a population of *Augochlorella striata* (Provancher) (Hymenoptera; Halictidae) at the northern edge of its range. Behavioral Ecology and Sociobiology, **27:** 339–344.

Packer, L. 1992. The social organization of *Lasioglossum* (*Dialictus*) *laevissimum* (Smith) in southern Alberta. Canadian Journal of Zoology, **70:** 1767–1774.

Packer, L. 1994. *Lasioglossum* (*Dialictus*) *tenax* (Sandhouse) (Hymenoptera: Halictidae) as a solitary sweat bee. Insectes Sociaux, **41:** 309–313.

Packer, L., Genaro, J.A., and Sheffield C.S. 2007. The bee genera of Eastern Canada [online]. Canadian Journal of Arthropod Identification, **3**. doi:10.3752/cjai.2007.03.

Packer, L., Jessome, V., Lockerbie, C., and Sampson, B. 1989*a*. The phenology and social biology of four sweet bees in a marginal environment: Cape Breton Island. Canadian Journal of Zoology, **67:** 2871–2877.

Packer, L., and Knerer, G. 1986. An analysis of variation in the nest architecture of *Halictus ligatus* in Ontario. Insectes Sociaux, **33:** 190–205.

Packer, L., and Owen, R.E. 1989. Notes on the biology of *Lasioglossum* (*Evylaeus*) *cooleyi* (Crawford), an eusocial halictine bee (Hymenoptera: Halictidae). The Canadian Entomologist, **121:** 431–438.

Packer, L., Sampson, B., Lockerbie, C., and Jessome, V. 1989*b*. Nest architecture and brood mortality in four species of sweat bee (Hymenoptera; Halictidae) from Cape Breton Island. Canadian Journal of Zoology, **67:** 2864–2870.

Parker, F.D., and Tepedino, V.J. 1982. A nest and pollen-collection records of *Osmia sculleni* Sandhouse, a bee with hooked hairs on the mouthparts (Hymenoptera: Megachilidae). Journal of the Kansas Entomological Society, **55:** 329–334.

Parker, F.D., Tepedino, V.J., and Bohart, G.E. 1981. Notes on the biology of a common sunflower bee, *Melissodes* (*Eumelissodes*) *agilis* Cresson. Journal of the New York Entomological Society, **89:** 43–52.

Potts, S.G., Biesmeijer, J.C., Kremen, C., Neumann, P., Schweiger, O., and Kunin, W.E. 2010. Global pollinator declines: trends, impacts and drivers. Trends in Ecology and Evolution, **25:** 345–353.

Rajotte, E.G. 1979. Nesting, foraging and pheromone response of the bee *Colletes validus* Cresson and its association with lowbush blueberries. (Hymenoptera: Colletidae) (Ericaceae: *Vaccinium*). Journal of the Kansas Entomological Society, **52:** 349–361.

Rasmussen, C. 2012. Joseph Vachal (1838–1911): French entomologist and politician. Zootaxa, **3443:** 1–52.

Rau, P. 1928. The nesting habits of the little carpenter-bee, *Ceratina calcarata*. Annals of the Entomological Society of America, **21:** 380–397.

Rehan, S.M., and Richards, M.H. 2010. Nesting biology and subsociality in Ceratina calcarata (Hymenoptera: Apidae). The Canadian Entomologist, **142:** 65–74.

Rehan, S.M., and Sheffield, C.S. 2011. Morphological and molecular delineation of a new species in the *Ceratina dupla* species-group (Hymenoptera: Apidae) of eastern North America. Zootaxa, **2873:** 35–50.

Ribble, D.W. 1967. The monotypic North American subgenus *Larandrena* of *Andrena* (Hymenoptera: Apoidea). Bulletin of the University of Nebraska State Museum, **6:** 27–42.

Ribble, D.W. 1968. Revisions of two subgenera of *Andrena*: *Micrandrena* Ashmead and *Derandrena*, new subgenus (Hymenoptera: Apoidea). Bulletin of the University of Nebraska State Museum, **8:** 237–394.

Ribble, D.W. 1974. A revision of the bees of the genus *Andrena* of the western hemisphere, subgenus *Scaphandrena*. Transactions of the American Entomological Society, **100:** 101–189.

Richards, K.W., and Kevan, P.G. 2002. Aspects of bee biodiversity, crop pollination, and conservation in Canada. *In* Pollinating Bees—The Conservation Link Between Agriculture and Nature. *Edited by* P. Kevan and V.L. Imperatriz Fonseca. Ministry of Environment, Brasília, Brazil. pp. 77–94.

Richards, K.W., Whitfield, G.H., and Schaalje, G.B. 1987. Effects of temperature and duration of winter storage on survival and period of emergence for the alfalfa leafcutter bee (Hymenoptera: Megachilidae). Journal of the Kansas Entomological Society, **60:** 70–76.
Richards, M.H., Rutgers-Kelly, A., Gibbs, J., Vickruck, J.L., Rehan, S.M., and Sheffield, C. 2011. Bee diversity in naturalizing patches of Carolinian grasslands in southern Ontario. The Canadian Entomologist, **143:** 279–299.
Rightmyer, M.G. 2008. A review of the cleptoparasitic bee genus *Triepeolus* (Hymenoptera: Apidae). Part I. Zootaxa, **1710:** 1–170.
Rightmyer, M.G., Deyrup, M., Ascher, J.S., and Griswold, T. 2011. *Osmia* species (Hymenoptera, Megachilidae) from the southeastern United States with modified facial hairs: taxonomy, host plants, and conservation status. ZooKeys, **148:** 257–278. doi:10.3897/zookeys.148.1497.
Rightmyer, M.G., Griswold, T., and Brady, S.G. 2013. Phylogeny and systematics of the bee genus *Osmia* (Hymenoptera: Megachilidae) with emphasis on North American *Melanosmia*: subgenera, synonymies and nesting biology revisited. Systematic Entomology, **38:** 561–576. doi:10.1111/syen.12013.
Riley, J.L., Green, S.E., and Brodribb. 2007. A Conservation Blueprint for Canada's Prairies and Parklands. Nature Conservancy of Canada, Toronto, Ontario.
Roberts, R.B. 1972. Revision of the bee genus *Agapostemon* (Hymenoptera: Halictidae). University of Kansas Science Bulletin, **49:** 437–590.
Roberts, R.B. 1973*a*. Bees of the northwestern American: *Agapostemon* (Hymenoptera: Halictidae). Agricultural Experiment Station, Oregon State University Technical Bulletin, **125:** 1–23.
Roberts, R.B. 1973*b*. Bees of the northwestern American: *Halictus* (Hymenoptera: Halictidae). Agricultural Experiment Station, Oregon State University Technical Bulletin, **126:** 1–34.
Rodeck, H.G. 1949. North American bees of the genus *Nomada*, subgenus *Callinomada* (Hymenoptera: Apoidea). Annals of the Entomological Society of America, **42:** 174–186.
Rozen, J.G. 1958. Monographic study of the genus *Nomadopsis* Ashmead (Hymenoptera: Andrenidae). University of California Publications in Entomology, **15:** 1-202.
Rozen, J.G. 1965. Biological notes on the cuckoo bee genera *Holcopasites* and *Neolarra* (Hymenoptera: Apoidea). Journal of the New York Entomological Society, **73:** 87–91.
Rozen, J.G. 1966. The larvae of the Anthophoridae (Hymenoptera: Apoidea). Part II. The Nomadinae. American Museum Novitates, **2244:** 1–44.
Rozen, J.G. 1973. Biology notes on the bee *Andrena accepta* Viereck (Hymenoptera, Andrenidae). Journal of the New York Entomological Society, **81:** 54–61.
Rozen, J.G., and Jacobson, N.R. 1980. Biology and immature stages of *Macropis nuda*, including comparisons to related bees (Apoidea, Melittidae). American Museum Novitates, 2702: 1–11.
Rust, R.W. 1974. The systematics and biology of the genus *Osmia*, subgenera *Osmia*, *Chalcosmia*, and *Cephalosmia* (Hymenoptera: Megachilidae). Wasmann Journal of Biology, **32:** 1–93.
Rust, R.W. 1995. Adult overwinter mortality in *Osmia lignaria propinqua* Cresson (Hymenoptera: Megachilidae). Pan-Pacific Entomologist, **71:** 121–124.
Sakagami, S.F., Tanno, K., and Enomoto, O. 1981. Cold resistance of the small carpenter bee *Ceratina flavipes* restudied. Low Temperature Science, **39B:** 1–7.
Sandhouse, G.A. 1939. The North American bees of the genus *Osmia* (Hymenoptera: Apoidea). Memoirs of the Entomological Society of Washington, **1:** 1–163.
Schrader, M.N., and LaBerge, W.E. 1978. The nest biology of the bees *Andrena* (*Melandrena*) *regularis* Malloch and *Andrena* (*Melandrena*) *carlini* Cockerell (Hymenoptera: Andrenidae). Illinois Natural History Survey Biological Notes, **108:** 1–24.
Schwarz, H.F. 1926. North American *Dianthidium, Anthidiellum*, and *Paranthidium*. American Museum Novitates, **226:** 1–25.
Schwarz, H.F. 1927. North American bees of the genus *Anthidium*. American Museum Novitates, **252:** 1–22.
Scoggan, H.J. 1978. The Flora of Canada. Part 1. General Survey. National Museum of Natural Sciences Publications in Botany, No. 7(1). National Museums of Canada, Ottawa, Ontario.
Shanks, S.S. 1977. A revision of the cleptoparasitic bee genus *Neolarra* (Hymenoptera: Anthophoridae). Wasmann Journal of Biology, **35:** 212–246.
Sheffield, C.S. 2008. Summer bees for spring crops? Potential problems with *Megachile rotundata* (Fab.) (Hymenoptera: Megachilidae) as a pollinator of lowbush blueberry (Ericaceae). Journal of the Kansas Entomological Society, **81:** 276–287.
Sheffield, C.S., Dumesh, S., and Cheryomina, M. 2011*a*. *Hylaeus punctatus* (Hymenoptera: Colletidae), a bee species new to Canada with a review of other non-native species. Journal of the Entomological Society of Ontario, **142:** 29–43.
Sheffield, C.S., Hebert, P.D.N., Kevan, P.G., and Packer, L. 2009. DNA barcoding a regional bee (Hymenoptera: Apoidea) fauna and its potential for ecological studies. Molecular Ecology Resources, **9**(Suppl. 1): 196–207.

Sheffield, C.S., Kevan, P.G., Pindar, A., and Packer, L. 2013*a*. Bee (Hymenoptera: Apoidea) diversity within apple orchards and old fields habitats in the Annapolis Valley, Nova Scotia, Canada. The Canadian Entomologist, **145:** 94–114.

Sheffield, C.S., Kevan, P.G., Smith, R.F., Rigby, S.M., and Rogers, R.E.L. 2003. Bee species of Nova Scotia, Canada, with new records and notes on bionomics and floral relations (Hymenoptera: Apoidea). Journal of the Kansas Entomological Society, **76:** 357–384.

Sheffield, C.S., Kevan, P.G., Westby, S.M., and Smith, R.F. 2008. Diversity of cavity-nesting bees (Hymenoptera: Apoidea) within apple orchards and wild habitats in the Annapolis Valley, Nova Scotia, Canada. The Canadian Entomologist, **140:** 235–249.

Sheffield, C.S., and Perron, J.-M. 2014. Annotated catalogue of the bees described by Léon Provancher (Hymenoptera: Apoidea: Apiformes). The Canadian Entomologist, in press. doi:10.4039/tce.2013.64.

Sheffield, C.S., Pindar, A., Packer, L., and Kevan, P.G. 2013*b*. The potential of cleptoparasitic bees as indicator taxa for assessing bee communities. Apidologie, **44:** 501–510.

Sheffield, C.S., Ratti, C., Packer, L., and Griswold, T. 2011*b*. Leafcutter and mason bees of the genus Megachile Latreille (Hymenoptera: Megachilidae) in Canada and Alaska [online]. Canadian Journal of Arthropod Identification, **18**. doi:10.3752/cjai.2011.18.

Sheffield, C.S., Rigby, S.M., Smith, R.F., and Kevan, P.G. 2004. The rare cleptoparasitic bee *Epeoloides pilosula* (Hymenoptera: Apoidea: Apidae) discovered in Nova Scotia, Canada, with distributional notes. Journal of the Kansas Entomological Society, **77:** 161–164.

Sheffield, C.S., and Westby, S.M. 2007. The male of *Megachile nivalis* Friese, with an updated key to the subgenus *Megachile* s. str. (Hymenoptera: Megachilidae) in North America. Journal of Hymenoptera Research, **16:** 178–191.

Shinn, A.F. 1967. A revision of the bee genus *Calliopsis* and the biology and ecology of *C. andreniformis* (Hymenoptera, Andrenidae). University of Kansas Science Bulletin, **46:** 753–936.

Shorthouse, J.D. 2010. Ecoregions of Canada's prairie grasslands. *In* Arthropods of Canadian Grasslands, Vol. 1: Ecology and Interactions in Grassland Habitats. *Edited by* J.D. Shorthouse and K.D. Floate. Biological Survey of Canada, Ottawa, Ontario. pp. 53–81.

Sinha, R.N., and Michener, C.D. 1958. A revision on the genus *Osmia*, subgenus *Centrosmia* (Hymenoptera: Megachilidae). University of Kansas Science Bulletin, **39:** 275–303.

Snelling, R.R. 1966*a*. Studies on North American bees of the genus *Hylaeus*. 1. Distribution of the western species of the subgenus *Prosopis* with descriptions of new forms (Hymenoptera: Colletidae). Los Angeles County Museum, Contributions in Science, **98:** 1–18.

Snelling, R.R. 1966*b*. Studies on North American bees of the genus *Hylaeus*. 3. The Nearctic subgenera (Hymenoptera: Colletidae). Bulletin of the Southern California Academy of Science, **65:** 164–175.

Snelling, R.R. 1968. Studies on North American bees of the genus *Hylaeus*. 4. The subgenera *Cephalylaeus*, *Metziella* and *Hylaeana* (Hymenoptera: Colletidae). Los Angeles County Museum, Contributions in Science, **144:** 1–6.

Snelling, R.R. 1970. Studies on North American bees of the genus *Hylaeus*. 5. The subgenera *Hylaeus*, s. str. and *Paraprosopis* (Hymenoptera: Colletidae). Los Angeles County Museum, Contributions in Science, **180:** 1–59.

Snelling, R.R. 1986. Contributions toward a revision of the New World nomadine bees. A partitioning of the genus *Nomada* (Hymenoptera: Anthophoridae). Los Angeles County Museum, Contributions in Science, **376:** 1–32.

Soucy, S.L. 2002. Nesting biology and socially polymorphic behavior of the sweat bee *Halictus rubicundus* (Hymenoptera: Halictidae). Annals of the Entomological Society of America, **95:** 57–65.

Stephen, W.P. 1954. A revision of the bee genus *Colletes* in America north of Mexico. University of Kansas Science Bulletin, **36:** 149–527.

Stephen, W.P. 1957. Bumble bees of western North America (Hymenoptera: Apoidea). Agricultural Experiment Station, Oregon State College Technical Bulletin, **40:** 1–163.

Stephen, W.P., Bohart, G.E., and Torchio, P.F. 1969. The Biology and External Morphology of Bees. Agricultural Experiment Station, Oregon State University, Corvallis.

Taylor, A.N. 2007. Bee Communities as Bioindicators for Oak Savannah Restoration. M.Sc. thesis, York University, Toronto, Ontario.

Thorp, R.W. 1969*a*. Systematics and ecology of bees of the subgenus *Diandrena* (Hymenoptera: Andrenidae). University of California Publications in Entomology, **52:** 1–146.

Thorp, R.W. 1969*b*. Ecology and behavior of *Anthophora edwardsii*. American Midland Naturalist, **82:** 321–337.

Thorp, R.W. 1979. Structural, behavioral, and physiological adaptations of bees (Apoidea) for collecting pollen. Annals of the Missouri Botanical Garden, **66:** 788–812.

Thorp, R.W. 2000. The collection of pollen by bees. Plant Systematics and Evolution, **222:** 211–223.

Thorp, R.W., Horning, D.S., Jr., and Dunning, L.L. 1983. Bumble bees and cuckoo bumble bees of California. Bulletin of the California Insect Survey, **23:** 1–79.

Timberlake, P.H. 1943. Racial differentiation in Nearctic species of *Dianthidium* (Hymenoptera, Apoidea). Journal of the New York Entomological Society, **51:** 71–110.
Timberlake, P.H. 1953. Bees of the genus *Perdita* in the collection of the University of Kansas. University of Kansas Science Bulletin, **35:** 961–985.
Timberlake, P.H. 1954. A revisional study of the bees of the genus *Perdita* F. Smith, with special reference to the fauna of the Pacific coast, Part I. University of California Publications in Entomology, **9:** 345–432.
Timberlake, P.H. 1956. A revisional study of the bees of the genus *Perdita* F. Smith, with special reference to the fauna of the Pacific coast, Part II. University of California Publications in Entomology, **11:** 247–350.
Timberlake, P.H. 1958. A revisional study of the bees of the genus *Perdita* F. Smith, with special reference to the fauna of the Pacific coast, Part III. University of California Publications in Entomology, **14:** 303–410.
Timberlake, P.H. 1960. A revisional study of the bees of the genus Perdita F. Smith, with special reference to the fauna of the Pacific coast, Part IV. University of California Publications in Entomology, **17:** 1–156.
Timberlake, P.H. 1962. A revisional study of the bees of the genus *Perdita* F. Smith, with special reference to the fauna of the Pacific coast, Part V. University of California Publications in Entomology, **28:** 1–124.
Timberlake, P.H. 1964*a*. Some new species of *Pseudopanurgus* of the subgenus *Heterosarus* Robertson (Hymenoptera, Apoidea). American Museum Novitates, **2185:** 1–26.
Timberlake, P.H. 1964*b*. A revisional study of the bees of the genus *Perdita* F. Smith, with special reference to the fauna of the Pacific coast, Part VI. University of California Publications in Entomology, **28:** 125–388.
Timberlake, P.H. 1968. A revisional study of the bees of the genus *Perdita* F. Smith, with special reference to the fauna of the Pacific coast, Part VII. University of California Publications in Entomology, **49:** 1–196.
Timberlake, P.H. 1969. A contribution to the systematics of North American species of *Synhalonia* (Hymenoptera, Apoidea). University of California Publications in Entomology, **57:** 1–76.
Timberlake, P.H. 1971. Supplementary studies on the systematics of the genus *Perdita*. University of California Publications in Entomology, **66:** 1–63.
Timberlake, P.H. 1975. The North American species of *Heterosarus* Robertson (Hymenoptera, Apoidea). University of California Publications in Entomology, **77:** 1–56.
Timberlake, P.H. 1980. Supplementary studies on the systematics of the genus *Perdita*, Part II. University of California Publications in Entomology, **85:** 1–65.
Torchio, P.F. 1971. The biology of *Anthophora* (*Micranthophora*) *peritomae* Cockerell (Hymenoptera: Apoidea, Anthophoridae). Los Angeles County Museum, Contributions in Science, **206:** 1–14.
Torchio, P.F. 1984. The nesting biology of *Hylaeus bisinuatus* Forster and development of its immature forms (Hymenoptera: Colletidae). Journal of the Kansas Entomological Society, **57:** 276–297.
Torchio, P.F., and Tepedino, V.J. 1982. Parsivoltinism in three species of *Osmia* bees. Psyche, **89:** 221–238.
Torchio, P.F., and Trostle, G.E. 1986. Biological notes on *Anthophora urbana urbana* and its parasite, *Xeromelecta californica* (Hymenoptera: Anthophoridae), including descriptions of late embryogenesis and hatching. Annals of the American Entomological Society, **79:** 434–447.
Torchio, P.F., Trostle, G.E., and Burdick, D.J. 1988. The nesting biology of *Colletes kincaidii* Cockerell (Hymenoptera: Colletidae) and development of its immature forms. Annals of the Entomological Society of America, **81:** 605–625.
Torchio, P.F., and Youssef, N.N. 1968. The biology of *Anthophora* (*Micranthophora*) *flexipes* and its cleptoparasite, *Zacosmia maculata*, including a description of the immature stages of the parasite (Hymenoptera: Apoidea, Anthophoridae). Journal of the Kansas Entomological Society, **41:** 289–302.
Undurraga, J.M., and Stephen, W.P. 1980. Effect of temperature on development and survival in postdiapausing leafcutting bee pupae (*Megachile rotundata* (F.)). II. Low temperature. Journal of the Kansas Entomological Society, **53:** 677–682.
Vickruck, J.L., Rehan, S.M., Sheffield, C.S., and Richards, M.H. 2011. Nesting biology and barcode analysis of two cryptic species within *Ceratina dupla*, with comparisons to *C. calcarata* (Hymenoptera: Apidae: Xylocopinae). The Canadian Entomologist, **143:** 254–262.
Wcislo, W.T., and Tierney, S.M. 2009. The evolution of communal behavior in bees and wasps: an alternative to eusociality. *In* Organization of Insect Societies from Genome to Sociocomplexity. *Edited by* J. Gadau and J. Fewell. Harvard University Press, Cambridge, Massachusetts. pp. 148–169.
Westrich, P. 1996. Habitat requirements of central European bees and the problems of partial habitats. *In* The Conservation of Bees. *Edited by* A. Matheson, S.L. Buchmann, C. O'Toole, P. Westrich, and I.H. Williams. Linnean Society and International Bee Research Association and Academic Press, London, U.K. pp. 1–16.
White, J.R. 1952. A revision of the genus *Osmia*, subgenus *Acanthosmioides* (Hymenoptera, Megachilidae). University of Kansas Science Bulletin, **35:** 219–307.
Williams, P.H., Thorp, R.W., Richardson, L., and Colla, S.R. 2014. Bumble Bees of North America: An Identification Guide. Princeton University Press, Princeton, New Jersey. In press.
Wilson, E.O. 1971. The Insect Societies. Belknap Press of Harvard University Press, Cambridge, Massachusetts.
Yanega, D. 1990. Philopatry and nest founding in a primitively social bee, *Halictus rubicundus* Behavioral Ecology and Sociobiology, **27:** 37–42.

Subject Index

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Taxonomic Index; listed alphabetically by family within each order

Arthropods of Canadian Grasslands (Volume 4): Biodiversity and Systematics, Part 2

Edited by **Donna J. Giberson and Héctor A. Cárcamo**

Arthropods of Canadian Grasslands (Volume 4): Biodiversity and Systematics, Part 2 is the fourth volume in the series that provides an overview of Canada's grasslands and its associated insects, mites, spiders, and their close relatives.

Volume 1, *Ecology and Interactions in Grasslands Habitats* (Shorthouse and Floate 2010), reviews the ecological attributes and interactions of arthropods in natural grasslands. Volume 2, *Inhabitants of a Changing Landscape* (Floate 2011), focuses on anthropogenic effects on grasslands and their arthropod fauna with a focus on agro-ecosystems. Volume 3, *Biodiversity and Systematics Part 1* (Cárcamo and Giberson 2014) opens with an overview of the biogeography of arthropods of Canadian grasslands, and provides a taxonomic summary, including checklists, of selected taxa of Myriapoda (e.g., millipedes and centipedes), Arachnida (mites and spiders), Collembola, and Insecta.

Volume 4, *Biodiversity and Systematics*, *Part 2* continues the taxonomic review of grassland arthropods, with special reference to the Lepidoptera (moths and butterflies), Coleoptera (four beetle groups), Diptera (the robberflies) and Hymenoptera (ants, ichneumons, braconids, and bees).

With the publication of *Arthropods of Canadian Grasslands*, the Biological Survey of Canada hopes to increase awareness of the plight of Canada's grasslands, to draw attention to their associated grasslands, and to provide a baseline reference to support future studies of arthropods in these environments.
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Donna J. Giberson is a professor with the Department of Biology at the University of Prince Edward Island in Charlottetown, PEI, where she teaches courses in entomology, ecology and scientific writing. For most of her research career, she has concentrated on the ecology, life histories and distribution of aquatic insects, especially from the Prairies, Maritimes, and the Canadian Arctic.

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Front cover images: Red Deer River valley west of Bindloss, Alberta (Photo: Mark Oliver). Boxed figures from left to right: (1) *Bombus ternarius* on *Glycyrrhiza lepidota*); (2) *Cicindela decemnotata* Say, Sandy Point, Alberta, September 7, 2012; (3) tiger swallowtail, *Papilio canadensis*: Moose Mountain Prov. Park; June 03, 2007; (4) ants, prob *Lasius* sp: Wisimin; October 01, 2007; (5) darkling beetle, *Eleodes*: Spruce Woods Prov. Park; June 07, 2007; (6) male *Efferia coulee,* a common spring robber fly in the BC interior grasslands from the Chilcotin Plateau to the Okanagan and Similkameen valleys. Photo credits: (1) C. Sheffield; (2) J. Acorn; (3) H. Goulet; (4) H. Goulet; (5) H. Goulet; (6) R. Cannings.

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