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

Edited by  Donna J. Giberson
University of Prince Edward Island

and

Héctor A. Cárcamo
Agriculture and Agri-Food Canada

Biological Survey of Canada Monograph Series No. 6 (2014)
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.

Donna Giberson
Charlottetown, Prince Edward Island

Héctor Cárcamo
Lethbridge, Alberta
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:

“It 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 acetarsenite), 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

Clark, G.H., and Malte, M.O. 1913. Fodder and Pasture Plants, with Illustrations by Norman Criddle.
fodderpasturepla1913cana/fodderpasturepla1913cana.pdf [accessed 24 January 2014].

Claassen, P.W. 1924. New species of North American Capniidae (Plecoptera). The Canadian Entomologist,


Roughley, R.E. 2000. Aweme, Manitoba—an important historical grasslands site. Arthropods of Canadian

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

As in Volume 3, we are immensely grateful for the many experts who were willing to share their knowledge of grassland arthropods. We recognize the monumental amount of work that has gone into these chapters and thank everyone who participated in this project, including authors, our tireless copy editor (Barbara Every, BioMedical Editor, St. Albert, Alberta), our colleagues, and our families. Donna would particularly like to thank Pat for his support and advice throughout the project, and Héctor thanks his wife Rosa and daughter Karla for their understanding and support throughout this project. Many reviewers contributed their time to improve the content of the chapters, particularly in proofing the spellings of the species names in the checklists; our sincere thanks to them. We thank Vincent Hervet for proofing the French translations of the abstracts and Pat Bouchard for his administrative advice and handling the financial aspects. Finally, we benefited immensely from the expertise of Kevin Floate, who generously shared his time and provided insightful advice at every stage of the planning and execution of these volumes.
## Contents

Preface ........................................................................................................................................ v

Dedication .................................................................................................................................... vii

Acknowledgements .................................................................................................................... x

List of Contributors ................................................................................................................... xiii

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

Chapter 2
Click Beetles and Wireworms (Coleoptera: Elateridae) of Alberta, Saskatchewan, and Manitoba ................................................................. 87
W. G. van Herk and R. S. Vernon

Chapter 3
Darkling Beetles (Coleoptera: Tenebrionidae) of Canadian Grasslands .......... 119
P. Bouchard and Y. Bousquet

Chapter 4
Weevils (Coleoptera: Dryophthoridae, Brachyceridae, Curculionidae) of the Prairies Ecozone in Canada ................................................................. 143
R. S. Anderson, P. Bouchard, and H. Douglas

Chapter 5
Moths and Butterflies of the Prairies Ecozone in Canada .......................... 169

Chapter 6
Moths and Butterflies (Lepidoptera) of the Peace River Region: Case Study of a Disjunct Grassland Fauna ................................................................. 241
B. C. Schmidt, F. A. H. Sperling, and A. D. Macaulay

Chapter 7
The Robber Flies (Diptera: Asilidae) of Western Canadian Grasslands ............ 269
R. A. Cannings

Chapter 8
An Annotated List of Ants (Hymenoptera: Formicidae) from the Grasslands of Alberta and Saskatchewan ................................................................. 299
J. R. N. Glasier and J. H. Acorn

Chapter 9
Ichneumonidae (Hymenoptera) of the Canadian Prairies Ecozone: A Review .... 317
M. D. Schwarzfeld
Chapter 10
Annotated Checklist of Braconidae (Hymenoptera)
in the Canadian Prairies Ecozone .................................................. 399

Chapter 11
The Bees (Hymenoptera: Apoidea, Apiformes) of the
Prairies Ecozone with Comparisons to other Grasslands of Canada .......... 427
C. S. Sheffield, S. D. Frier, and S. Dumesh

Subject Index ................................................................................................. 469

Taxonomic Index; listed alphabetically by family within each order .................. 475
List of Contributors

Acorn, John H.  
Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada, T6G 2H1

Anderson, Robert S.  
Canadian Museum of Nature, P.O. Box 3443, Station D, Ottawa, Ontario, Canada, K1P 6P4

Anweiler, Gary G.  
University of Alberta, E.H. Strickland Entomological Museum, Department of Biological Sciences, Edmonton, Alberta, Canada, T6G 2E3

Bird, Charles D.  
P.O. Box 22, Erskine, Alberta, Canada, T0C 1G0

Bouchard, Patrice  
Canadian National Collection of Insects, Arachnids and Nematodes, Agriculture and Agri-Food Canada, 960 Carling Ave., K.W. Neatby bldg., Ottawa, Ontario, Canada, K1A 0C6

Bousquet, Yves  
Canadian National Collection of Insects, Arachnids and Nematodes, Agriculture and Agri-Food Canada, 960 Carling Ave., K.W. Neatby bldg., Ottawa, Ontario, Canada, K1A 0C6

Cannings, Robert A.  
Royal British Columbia Museum, 675 Belleville Street, Victoria, British Columbia, V8W 9W2

Cárcamo, Héctor  
Agriculture and Agri-Food Canada, Lethbridge Research Centre, 5403 - 1 Avenue South, P.O. Box 3000, Lethbridge, Alberta, Canada, T1J 4B1

Douglas, Hume  
Entomology, Ottawa Plant Laboratories, Canadian Food Inspection Agency, Building 18, 960 Carling Avenue, Ottawa, Ontario, Canada, K1A 0C6

Dumesh, Sheila  
York University, Biology Department, 4700 Keele Street, Toronto, ON, M3J 1P3

Floate, Kevin D.  
Agriculture and Agri-Food Canada, Lethbridge Research Centre, 5403 - 1 Avenue South, P.O. Box 3000, Lethbridge, Alberta, Canada, T1J 4B1

Frier, S. Danae  
University of Regina, Department of Biology, 3737 Wascana Parkway, Regina, Saskatchewan, S4S 0A2

Glasier, James R.N.  
Department of Renewable Resources, University of Alberta, Edmonton, Alberta, T6G 2H1

Holliday, Neil J.  
Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada, R3T 2N2

Lafontaine, J. Donald  
Canadian National Collection of Insects, Arachnids and Nematodes, Agriculture and Agri-Food Canada, 960 Carling Ave., K.W. Neatby bldg., Ottawa, Ontario, Canada, K1A 0C6

Landry, Jean-François  
Canadian National Collection of Insects, Arachnids and Nematodes, Agriculture and Agri-Food Canada, 960 Carling Ave., K.W. Neatby bldg., Ottawa, Ontario, Canada, K1A 0C6

Macaulay, A. Douglas  
Government of Alberta, Alberta Agriculture and Rural Development, 6547 Sparrow Drive, Leduc, Alberta, T9E 7C7

Pohl, Gregory R.  
Natural Resources Canada, Northern Forestry Centre, 5320 - 122 St., Edmonton, Alberta, Canada, T6H 3S5

Pollock, Darren A.  
Department of Biology, Eastern New Mexico University, Station 33, 1500 S Ave K, Portales, New Mexico, U.S.A., 88130
Roughley, Robert E.
Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada, R3T 2N2 (Deceased)

Schmidt, B. Christian
Canadian Food Inspection Agency, Canadian National Collection of Insects, Arachnids and Nematodes, Agriculture and Agri-Food Canada, 960 Carling Ave., K.W. Neatby bldg., Ottawa, Ontario, Canada, K1A 0C6

Schwarzel, Marla D.
University of Northern British Columbia, 3333 University Way, Prince George, British Columbia, V2N 4Z9

Sharanowski, Barbara J.
Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada, R3T 2N2

Sheffield, Cory S.
Royal Saskatchewan Museum, 2340 Albert Street, Regina, Saskatchewan, S4P 2V7

Sperling, Felix A.H.
Department of Biological Sciences, University of Alberta, CW 405 Biological Sciences Building, Edmonton, Alberta, Canada, T6G 2E9

Stjernberg, Anita
Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada, R3T 2N2

van Herk, Willem G.
Pacific Agri-Food Research Centre, Agriculture and Agri-Food Canada, 6947 #7 Hwy, Agassiz, British Columbia

Vernon, Robert S.
Pacific Agri-Food Research Centre, Agriculture and Agri-Food Canada, 6947 #7 Hwy, Agassiz, British Columbia

Wanigasekara, R.W.M.U.M.
Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada, R3T 2N2

Zhang, Y. Miles
Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada, R3T 2N2