Newsletter

Arthropods of Canadian Grasslands

Number 6 **2000**

Contents

The Grasslands Newsletter of the Biological Survey of Canada (Terrestrial Arthropods) supports the Survey's grasslands project by providing information relevant to the study of grassland arthropods in Canada.

Aweme, Manitoba, is an area of mixed-grass prairie made famous by the insect collecting of Norman Criddle between about 1905 and 1930. Read about the history, current status, vegetation and insects of this area on page 6.

Contributions welcome

Please consider submitting items to the Grasslands Newsletter

Grassland site descriptions

Current research - project reports

Short news items

Feature articles

Grassland species accounts

Selected publications

Contributions such as these, as well as other items of interest to students of grasslands and their arthropods, are welcomed by the editor. The Newsletter appears annually in March; final copy deadline is February 15.

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The web site of the Biological Survey is at: http://www.biology.ualberta.ca/esc.hp/bschome.htm
The site will be modified and expanded during the year 2000

Grasslands news

Grassland project moves forward

The Grasslands Project of the Biological Survey of Canada is moving forward again now that many Canadian entomologists are no longer so involved in the Survey's major project on the Yukon Territory.

The Grasslands Newsletter has therefore recommenced, and this issue includes information on future plans for the project (see p. 3).

A tool for protecting biodiversity in B.C.

A powerful new tool now exists to help find ways to protect biodiversity in the South Okanagan valley, an area of British Columbia that is under great pressure from growth, urbanization, viticulture, and other uses. Indeed, this fragile landscape contains almost half of B.C.'s threatened and endangered species of plants and animals. With its hot, dry summers, mild winters, diverse landforms and proximity to the deserts of the western United States, the area contains unique assemblages of species. Some of them depend upon a single habitat type and so are at risk of extirpation. Some others have already disappeared.

The *Habitat Atlas for Wildlife at Risk in the South Okanagan and Lower Similkameen* provides detailed maps of the region's diverse habitats, identifies where populations at risk are to be found and in what concentrations, outlines the most significant risks for each and ranks species on a scale ranging from very common to critically imperiled.

It results from efforts by the Vancouver Foundation, the Habitat Conservation Fund, the Okanagan Region Wildlife Heritage Fund Society, the B.C. Environment Ministry, and the Nature Trust of B.C. Contributors include Richard and Syd Cannings, Geoff Scudder, Ted Lea and others.

In addition to habitat information, the Atlas outlines management considerations for those who find rare and endangered species on their property, provides profiles on the needs and characteristics of each species and sets out conservation strategies for the region, including roles for private land owners and non-government organizations. It therefore fosters collaborative environmental protection by diverse private and public interests.

[A full citation appears on p. 24. For more details see also Stephen Hume. 1999. Okanagan is home to many rare species. Vancouver Sun. Saturday, May 8, 1999, p. B3. See also the article on p. 15 of this newsletter.]

Ecological Reserve, Osoyoos, B.C.
(R.A. Cannings)

Endangered montane grasslands receive protected status

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The Whaleback is over 250 kilometres of windswept grassy ridges, clusters of Douglas fir and limber pine trees, and moist valleys, located approximately 150 kilometres southwest of Calgary. It is the largest tract of montane landscape in Alberta that remains relatively intact and roadless. Other montane regions in the province include the heavily developed eastern slopes of the Waterton/Castle region, the Crowsnest Pass, the Bow Valley, and the Athabasca Valley near Jasper. The montane makes up less than 1% of Alberta's landbase.

The Whaleback's montane landscapes include grassland, 575-year-old limber pine, 400-year-old Douglas fir, lodgepole pine and white spruce forests. The protected area is situated at the juncture of three of Alberta's six Natural Regions. Hence, it includes both the most northern and southern distributions for many species. More than 80 species of birds are estimated to breed in the area and many other species use the region when migrating. The area provides winter grazing for thousands of elk from December to May.

Whaleback receives protected status

On May 11, 1999, the Alberta government announced protected status for 28,300 hectares of Alberta's renowned Whaleback region, through its Special Places program. Protected status was achieved with the donation of more than 11,600 hectares of petroleum and natural gas development rights by BP Amoco to the Nature Conservancy of Canada. Under an agreement with all parties involved, the Nature Conservancy will retain these rights until 2004, when they will be returned to the provincial government and not be re-issued.

The Whaleback's new designation means that no commercial timber harvesting, no mining, no new road development, and no tourism facility development will be permitted in the region. However, the area will remain open to recreation and grazing use. Indeed, a well-managed grazing agreement with ranchers was a condition of the Whaleback's new status and ranchers will play an active role towards this end.

As recommended by the local planning committee, a portion of the west side of the region will provide ATV and snowmobile recreation, on existing trails. Hunting and fishing will continue in the area. Only designated trails will be open to off-road vehicles, on a restrictive basis to be detailed in the management plan.

Full details are available on the Internet at:

Government press release - http://www.gov.ab.ca/acn/199905/7648.html

Response by CPAWS - http://www.cpaws.org/press/whaleback-990511.html

Photographs of the Whaleback - http://www.gov.ab.ca/env/parks/sp_places/whaleback/images/

Grasslands project action

Recently the scope and organization of the grasslands project of the Biological Survey were given particular attention (for earlier developments see p. 4). Work on this large and important project can be moved forward actively now that major efforts to characterize the Yukon fauna—involving many of the same participants—have come to fruition with publication of the Survey's book *Insects of the Yukon*.

During 1999, some basic requirements for reconstituting the project were identified by the Scientific Committee for the Biological Survey and by an enlarged grasslands subcommittee. Possible outputs were considered that would allow the scientific community interested in grasslands across the country to push forward the knowledge of these habitats.

A range of possible products was evaluated to decide what might be the best mix in terms of timing and intensity, including major scientific publications, smaller products such as workshops or symposia, and more limited outputs such as individual species accounts or a newsletter, as well as such things as a scientific prospectus for the project. Some ideas for funding possibilities were also explored.

It was decided to foster the following potential outputs (not necessarily in chronological order):

- A major volume with a focus on diversity, species inventory and zoogeography, including multiple sites and habitats.
- A major volume with a focus on ecological and habitat associations.
- A baseline framework for grasslands, providing a sound scheme by which to classify or identify the different types of grasslands. This idea is being pursued by Dr. Joe Shorthouse, for example by contacting relevant botanical experts.
- An informal conference at the 2000 joint meeting of the Entomological Society of Canada, the Entomological Society of America, and the Société d'entomologie du Québec, which will allow ideas to be exposed and developed and the project made known more widely. Dr. Terry Wheeler is planning this program element.
- A symposium at the 2001 ESC meeting, providing a published initial scientific synthesis on various subjects, also as a basis for further development. Dr. Terry Wheeler and the subcommittee will plan for this symposium.
- An annual grasslands newsletter, to disseminate information, encourage cooperation and develop ideas, edited by Dr. Hugh Danks.
- A prospectus for the project, which will give a scientific outline of the rationales and plans for the project and underpin its development. Dr. Joe Shorthouse and Dr. Terry Wheeler are preparing an initial draft of this prospectus.
- A more generalized prospectus, which might help to support funding enquiries, for example (also in preparation by Drs. Shorthouse and Wheeler).
- A list of current research projects, which will help in seeking contributors and planning for the informal conference and the symposium, as well as encouraging cooperation. Dr. Kevin Floate is preparing this list (see current entries on p. 13).
- Other items to be developed when more of the basic planning and work has been done would include development of information for the Survey's web page and proposals for funding, as well as more detailed outlines for the major future publications.

The members of the grasslands subcommittee are: V.M. Behan-Pelletier; H.V. Danks; K.D. Floate (co-chair); D.J. Larson; R.E. Roughley;

G.G.E. Scudder; I.M. Smith; J.D. Shorthouse; T.A. Wheeler (co-chair); and D. Wrubleski.

Members of the subcommittee, and especially the co-chairs*, invite your comments and participation in the revitalized grasslands project of the Biological Survey.

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Origin of the grasslands project of the Biological Survey of Canada

From the earliest days of the Biological Survey project, one recognized priority was to learn more about the arthropods of Canadian grasslands, because the faunas of these important habitats are surprisingly inadequately known. The grasslands project was launched to try to catalyse and coordinate relevant work in these areas, for example by identifying sites that represent "undisturbed" grassland habitats, characterizing the faunas of different kinds of habitats (in selected arthropod groups), and also comparing them with the faunas of modified habitats.

The Biological Survey's grasslands project was initiated officially for the "Prairies" in 1979. Dr. Gordon Pritchard prepared a list of undisturbed prairie sites (1980). Interest was generated by a special interest group at the Banff Annual Meeting of the Entomological Society of Canada (1981), organized by Dr. John Spence and Dr. Pritchard. Subsequent efforts by Dr. Spence (with Mr. Rob Cannings) led to the production of a Grasslands Newsletter, which commented especially on current field activities. Some preliminary work was carried out to prepare a format in which to characterize selected grassland sites, and the work of characterization was started by Mr. Cannings among others. Later Dr. Geoff Scudder, who was carrying out studies in grasslands especially in B.C., took over leadership of the project. Initially, interest was kept alive by occasional issues of the Grasslands Newsletter, pending completion of the Yukon Project, which involved many of the potential contributors to a grasslands project. When the Yukon project experienced delays, this also slowed the Grasslands work. Subsequently, Dr. Bert Finnamore initiated several projects on grasslands, studying such sites as CFB Suffield (1994–) and Grasslands National Park (1996–). Dr. Scudder continued with his long-standing studies of grassland arthropods in British Columbia, and Dr. Roughley studied sites in Manitoba (1994–). The sorting, distribution, and identification of material from these places is in progress. In 1995, Dr. Finnamore became chair of the Survey's Grasslands subcommittee. At about the same time, he prepared a brief published by the Survey about the use of grassland arthropods in ecosystem management. He pursued funding for his projects on grasslands in Canada and elsewhere. He also cooperated with the Ecological Monitoring and Assessment Network (EMAN), helping to develop detailed sampling protocols and carrying out work related to the prairie ecozone. Some limited Scientific Committee discussions of the grasslands project were held during this period, and in 1999 a major effort was made to move the project forward more broadly (see p. 3), including the continuation of this newsletter.

Selected publications from the Survey's grasslands project and on Canadian grasslands arthropods

1980. D.M. Lehmkuhl. Temporal and Spatial Changes in the Canadian Insect Fauna - Patterns and explanation: the prairies. pp. 1145–1159 in J.A. Downes (Ed.), Temporal and Spatial Changes in the Canadian Insect Fauna. *The Canadian Entomologist* 112 (11).

1983–1990. Grasslands Newsletters nos. 1–5 (see p. 21)

1983. Project update. *Newsletter of the Biological Survey of Canada (Terrestrial Arthropods)* 2(2): 41.

1987. Project update. *Newsletter of the Biological Survey of Canada (Terrestrial Arthropods)* 6(1): 7–8.

1993. G.G.E. Scudder. Geographic distribution and biogeography of representative species of xeric grassland-adapted Nearctic Lygaeidae in western North America (Heteroptera: Lygaeidae). pp. 75–113 in G.E. Ball and H.V. Danks (Eds.), Systematics and Entomology: Diversity, Distribution, Adaptation and Application. *Memoirs of the Entomological Society of Canada 165.*

1996. A.T. Finnamore. The advantages of using arthropods in ecosystem management. A brief from the Biological Survey of Canada (Terrestrial Arthropods). 10 pp.

1996. Contributions in A.T. Finnamore (Ed.), the SAGE project. A workshop report on terrestrial arthropod sampling protocols for graminoid ecosystems. http://www.cciw.ca/eman-temp/reports/publications/sage/intro.html

1997. Contributions (especially on Heteroptera and Cicadellidae) in H.V. Danks and J.A. Downes (Eds.), Insects of the Yukon. Biological Survey of Canada (Terrestrial Arthropods), Ottawa. (Biological Survey Monograph Series No. 2, 1034 pp.) (see p. 23)

1998. Project update; Results from grasslands: aculeate wasps from CFB Suffield. *Newsletter of the Biological Survey of Canada (Terrestrial Arthropods)* 17 (2): 44–57.

1999. A.T. Finnamore and D. Buckle. Arthropod component report: The stinging wasps (Hymenoptera: Chrysidoidea, Vespoidea, Apoidea) and spiders (Araneae). Canadian Wildlife Service. 197 pp.

Fact file

Relatively little remains of many natural grassland habitats on the prairies. For example, it is estimated that about 20-27% of rough fescue habitats, less than 13% of the aspen parkland, between 1 and 5% of plains fescue, and less than 1% of the tall-grass prairie has escaped cultivation or other disturbance.

Aweme, Manitoba – An important historical grasslands site

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Introduction

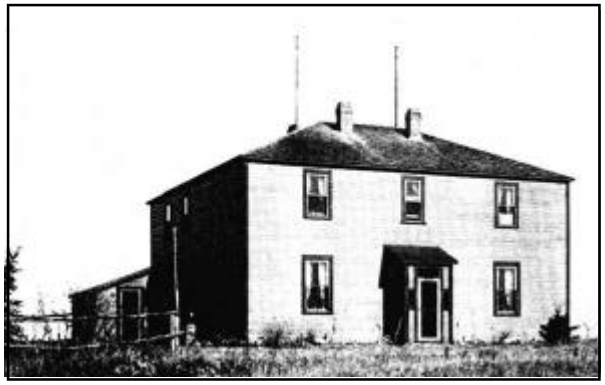
Aweme is a locality no longer found on most maps of Manitoba or Canada. It consists of two quarter sections of land (Township/Range = NE 32-8-16W and SE5-9-16W) located at 49E43' N and 99E36' W. It is to the west of the junction of the Souris and Assiniboine rivers and lies in the Prairies Ecozone about 40 km southwest of Brandon. Aweme is the name of the Criddle and Vane homesteads which were established in 1882. An area near Aweme is considered to be the largest remnant of the mixed-grass prairie remaining in Manitoba. Previously mixed-grass prairie was the most extensive grassland type in North America comprising 38% of North American grasslands (Lauenroth 1979).

History of the area

Most entomologists have come across specimens from Aweme, MB. The collecting locality is almost synonymous with a single collector, Norman Criddle (1875-1933), although many other collectors (e.g. Ralph Bird, R.B. Handford, R.M. White, J.B. Wallis) visited the site or worked at it for extended periods of time and all of Norman's brothers were collectors. An appreciation of the respect and high regard for Norman Criddle can be gained from examining his biographies. Biographies of Norman Criddle were published by Gibson and Crawford (1933), Lloyd (1933), Hungerford (1934), Lawrence (1934), Palmer (1934), Bird (1955), Wallis (1955) Scott (1970, 1972), Spalding (1971), and Riegert (1989). How many of us will earn or deserve biographical sketches by at least ten authors spread over 50 years? Norman Criddle was a general naturalist with a particular interest in insects. The list of his scientific papers (Gibson and Crawford 1933) is assigned to the following subject headings: Entomology, Ornithology, Botany, Mammology and Wild Life, and Miscellaneous. He worked as an entomologist from 1913 until his death in 1933. During much of his career he was involved with economic entomology, particularly detailed studies of grasshopper outbreaks and methods for their control.

Norman Criddle
(From Report of International Great Plains Crop Pest Committee, Fargo, 1928)

What makes Aweme an important historical grassland site is that we have a continuous record of collecting over a relatively long time period and this collecting record is accompanied by voucher specimens. Norman Criddle was not a taxonomist but he was an avid collector and because



Criddle house - St. Albans 1907
(S. Kohler)

he knew the insects of the region, anything that was new or different was collected and was sent to the appropriate specialist. Because of this practice, his material is spread throughout most of the major insect collections of the world. Norman Criddle's most enduring legacy is associated with his insect collecting. The majority of his specimens are accompanied by only locality, date and collector but his collecting notes are stored at the Manitoba Public Archives in Winnipeg. Many records of insects for Aweme were published in the Entomological Record of the Proceedings of the Entomological Society of Ontario. The first record was published in 1905 and records continued in that journal through 1932. Previously unpublished records of specimens collected by the Criddles continue to this day (e.g. Pollock 1999: Rhiphoridae, *Pelecotoma flavipes* (Melsh.) as a "new" record for Manitoba based on specimens collected by E. Criddle and N. Criddle in 1916 and 1924). Perhaps the most significant holdings of insects are deposited in the Canadian National Collection [CNCI] in Ottawa and in the J.B. Wallis Museum [JBWM] of Entomology at the University of Manitoba in Winnipeg (which now contains the Agriculture Canada collections formerly held at Brandon and Winnipeg). However, significant holdings and type specimens can be found in virtually any museum which had a taxonomic specialist during Criddle's era. For instance, many new taxa of beetles were described from Aweme by H.C. Fall whose collection is at the Museum of Comparative Zoology, Harvard University, Boston, MA.

The area which Norman Criddle considered to be Aweme was relatively large and not restricted simply to grasslands around his home locality. A common practice of many collectors of his era was to use one locality label for a region. For instance, according to an unpublished manuscript of one of Norman's contemporaries, J.B. Wallis, an annotation of 16E on the collecting label indicates that the specimen was taken at a locality now known as the Devil's Punch Bowl in Spruce Woods Provincial Park. Therefore the label, Aweme, probably covers a circumference of 10 km out from the actual homestead and includes the river bank of the Assiniboine River, springs and fens which are tributaries, and parts of what are now Canadian Forces Base Shilo military base, and Spruce Woods Provincial Park.

The social life of the area and of the Criddle and Vane families is described by Scott (1971), A. Criddle (1973, 1975), and P. Criddle (1978). The main Criddle residence, named St. Albans and built in 1906, became the main social and cultural centre of the surrounding area. The English Victorian lifestyle of the partriarch, Percy Criddle, was imported into pioneer Manitoba. Today we can only marvel at the emphasis on sports, arts, culture and science overlain on a farming venture which could only be considered as eking out an existence. There was a golf course and tennis courts on a farm where initially "...the sandy

St. Albans 1998

soil with plenty of sub-surface moisture [was] producing the best wheat in Manitoba. Grasshoppers, dry weather and winds changed this. The grasshoppers cleaned off all growth of grain on the fields, dry weather permitted the high winds to blow all the sandy top soil away right down to the gravelly hard pan, and the settlers gave up the fight and moved away. But the Criddles stayed." (Wallis 1955, p. 48). Interesting summaries of biological information about Aweme specifically can be found in Bird (1927) and it is used in a more general format by Bird (1961) as well as many other papers.

Current status

The Criddle family lived at Aweme from 1882 until 1960. From 1960 to 1974 this land went through a number of owners. In 1974 it was acquired by the Province of Manitoba and it has been administered by the Parks Branch. Until 1996 it was considered vacant crown land with a classification that identified it as a unique/rare site for wildlife, with no agriculture permitted. The Criddle homestead is increasingly surrounded by large blocks of centre-pivot irrigation for potato production, which has become the dominant form of agriculture in the surrounding sandy soils. The homestead is becoming an island of habitat and there was much concern about the future of the site. A request from a former landowner to buy back the land in 1996 precipitated a flurry of activity. A letter-writing campaign by Friends of Spruce Woods Park, the Departments of Botany and Entomology of the University of Manitoba, the Entomological Society of Canada, and the Biological Survey of Canada (Terrestrial Arthropods) convinced the Province of Manitoba to maintain Aweme as a heritage site and it has remained a part of Spruce Woods Provincial Park. Unfortunately this block is isolated from the main unit of Spruce Woods, making effective administration of the Criddle homestead a difficult task for Park authorities. The feasibility of development of Aweme as a historical and ecological site is being examined by the Friends of the Spruce Woods Park and the Natural Resources Department.

Collecting permits

Collecting permits are required for collecting at the Criddle homestead. They are available from Manitoba Natural Resources, 4th Floor, 258 Portage Avenue, Winnipeg, Manitoba, R3C 0B6.

Site description

The paleoecology of southern Manitoba was dominated during the late Pleistocene and Holocene by Glacial Lake Agassiz and most of the land forms of the area are remnants of old lake shorelines and beaches. Details of the geological and vegetational history of the area can be inferred from papers in Mayer-Oakes (1967). The postglacial, geophysical history of southern Manitoba is summarized in Teller and Last (1981).

The flora of Manitoba is documented by Scoggan (1957). The native vegetation of Aweme is described in Bird (1927) and Coupland (1950). Various studies have documented changes in the vegetation, particularly the Europeanization of the flora due to agriculture and the effect of the military tanks associated with the Shilo military base. Some papers that contain information about the recent vegetation and disturbance (agriculture, fire and military tank traffic) of the Aweme area are McKernan, (1984), Wilson and Shay (1987), Gorrie and Shay (1988). Wilson and Belcher (1989), Shay et al. (1989 and in press), Kunec and Shay (1990), Wilson and Shay (1990), and Shay (1995a, b). Some of these papers are unpublished reports but many of them contain species lists for selected sites in the Aweme area. The actual homestead area is located between sites 6 and 10.

The vegetation of Aweme is dominated by the shortgrass *Bouteloua gracilis* (HBK.) Lag. (Buffalo grass), a sedge, *Carex obtusata* Lilj., and the midheight bunchgrasses *Stipa spartea* Trin. (Porcupine Grass) and *Andropogon scoparius* Michx. (Wiregrass) as well as the somewhat taller *Koelaria cristata* Pers. (June Grass) In undisturbed areas the creeping evergreen shrub, *Juniperus horizontalis* Moench (Creeping Juniper), is common and there are a number of com-

mon forbs such as *Artemesia frigida* Willd. (Prairie Sagewort), *Cerastium arverse* L. (Field Chickweed) and *Galium boreale* L. (Northern bedstraw).

The invasive weed, leafy spurge *Euphorbia esula* L., is a problem on the property and it rapidly colonizes disturbed areas. Although this area is a release site for flea beetles (*Aphthona* spp. , Coleoptera: Chrysomelidae) used as a biological control agent (Shay 1995a), the area is treated occasionally with broadleaf herbicides. The European flora, predominantly invading from abandoned agricultural areas, is composed of *Poa pratensis* (Blue Grass) and *Bromus inermis* (Brome Grass). These two introduced grasses are taller than the native prairie species and affect them negatively. Brome grass appears to be a very poor habitat for insects (Roughley, pers. obs.) reinforcing the long-held observation that many things appropriate for agriculture are not appropriate for conservation.

From vegetation analysis, it appears that certain areas directly to the north and south of St. Albans are undisturbed, unploughed fescue prairie. The remainder of the area appears to have been cultivated. Compared to an earlier photographs of St. Albans, the site is now more treed. Trembling aspen in particular is becoming more dominant and increasingly is overgrowing the prairie.

Insect fauna

For many years our knowledge of the insect fauna of Manitoba was synonymous with our knowledge of the insect fauna of Aweme. It remains true that the majority of the insect fauna recorded from Manitoba is known only from or was first recorded from Aweme. It is not possible, at the present time, to list the insects collected at Aweme; but a few examples indicate the nature of the insect fauna of Manitoba.

Pollock and Roughley (unpubl.) have surveyed all published records of Carabidae (incl. cicindelines) of Aweme and supplemented this by examining all of the holdings of the JBWM and CNC for records from Aweme. This combined effort generated a list of 190 species and subspecies of ground beetles from Aweme, which represents 54% of the 350 species of Carabidae known from the province (Bousquet 1991). This result suggests that some of the insects known from Aweme are fairly widespread throughout the Province of Manitoba and many are widespread across Can-

University of Manitoba agroecology students taking samples at Aweme, summer 1999
(N. Holliday)

ada. Some species are western species with their eastern limits at Aweme; some species are eastern species with their western limits at Aweme; other species are prairie species with their northern limit at Aweme.

The distributions of certain other species are much more restricted. *Quedius (Megaquedius) manitobensis* (Casey) (Coleoptera:Staphylinidae) was described from Aweme. It is an interesting example of the collecting abilities of the Criddles. It is currently known only from Aweme and Calgary, Alberta. The few specimens from Aweme were collected in July, 1910, May, 1918, and November, 1927 (Smetana 1971). These specimens were probably extracted from the nest or dung chambers of the northern pocket gopher, *Thomomys talpoides*. During the 1980's, entomologists from the Department of Entomology at the University of Manitoba made a number of forays to collect this insect and other pocket gopher inquilines such as *Foxella ignota* (Baker) (Siphonaptera: Ceratophyllidae). In each case we abandoned our attempts after much searching and digging and at about 2 m in depth. Our problem was that we did not know how to find the appropriate habitat; when we asked local mammalogists about the depth, position and appearance of a pocket gopher nest chamber they said that the only published reports of attempts to dig up nests were made by Norman and Stuart Criddle. Also associated with these burrows are the scarab beetles *Aphodius talpoides* (Brown) and *A. peculiosus* Schmidt, which are still known only from Manitoba and Aweme in Canada. The anthicid beetle, *Notoxus manitoba* Chandler, is known only from the male holotype (Chandler 1982) collected at Aweme by Norman Criddle in 1924.

Other species found at Aweme appear to be at the northern limit of their range. The northernmost record of the stink bug, *Chlorochroa belfragei* (Stål), is Aweme (Scudder and Thomas 1987). There are sporadic records of this species south through North Dakota and South Dakota to Nebraska and east to Illinois. It was formerly listed as a candidate species for endangered or threatened species status but it is now considered to be a species of management concern in North Dakota (http://www.greatplains.org/npresource/distr/others/ nddagner/ species/ chlobel.htm). The Manitoba oakworm, *Anisota manitobensis* McDunnough (Lepidoptera: Saturniidae), is known only from southern Manitoba and extreme northern Minnesota (Tuskes et al. 1996). Type specimens were collected by Norman Criddle at Aweme and were described by McDunnough (1921). This very handsome moth is confined to bur oak habitats and is rarely encountered. The species has been extirpated from many areas of southern Manitoba by intensive agriculture and habitat destruction.

A somewhat different biogeographic pattern is emerging from studies of other groups of insects. A moth, *Pyla arenaeola* Balogh & Wilterding (1998) (Lepidoptera: Pyralidae), is a resident of sand dunes and it feeds on the leaves of bearberry, *Arctostaphylos uva-ursi* (L.) Sprengel (Ericaceae). Despite the widespread distribution of its holarctic host, this pyralid apparently is restricted to a few localities with loose, sandy soils. Documented localities include the dunes of the Great Lakes and Aweme. The disjunct Manitoba record may seem problematic until it is realized that Aweme is located in a region of fossil Pleistocene sand dunes which formed at the delta of the Assiniboine River where it entered glacial Lake Agassiz (Dubois 1976, Teller 1984). Therefore the southern shoreline of Lake Agassiz may have provided a biogeographic corridor between the dunes of the Assiniboine delta and those of the Great Lakes shoreline when glacial Lake Agassiz drained southeastwards into the Great Lakes. A similar biogeographic pattern could be inferred for the winter stonefly, *Capnura manitoba* (Claassen) (Plecoptera: Capniidae) (Burton 1985). This species occurs in a Sphagnum spring-fen located on the margin of the Assiniboine River ca. 3 km SSW of St. Albans. The type locality is Aweme but the known distribution is decidedly eastern.

Most records are from Ontario and Quebec, extending north to Ungava Bay, east to the Gaspé Peninsula and southeastward into New England (Hitchcock 1974). The Aweme record is separated from the closest eastern record by more than 1000 km (Nelson and Baumann 1987, fig. 50, p. 23).

Concluding statement

I admit an inordinate fondness for Aweme. Is it the feeling of being at a historically important locality? Is it the ghosts of past entomologists collecting, thinking and discovering knowledge about insects? Is it the feeling of having the wind in your hair out on the prairie? Is it a day away from telephones and e-mail? Yes.

Acknowledgements

I would like to thank Jason Diehl for help with editing the map of the Aweme area. Helpful discussions about Aweme and highly enjoyable collecting trips to the Aweme area with Don Henne, Bill Gallaway, Terry Galloway, Darren Pollock and many others over the years have helped create a feeling about a special place with many fond memories. Many other people from the Department of Entomology have assisted in one form or another with this article. Jennifer Shay, Department of Botany, University of Manitoba, provided a list of references about the flora. Spencer Sealy, Department of Zoology, University of Manitoba, provided access to a helpful bibliography of bird studies. Thanks to Dr. Darren Pollock for his assistance and persistence with scanning various photographs for this article. Most of all I should acknowledge Norman Criddle who created the story.

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Synopsis of some past and ongoing research projects on grassland arthropods

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Alaska

Of leafhoppers and mammoths: Holocene and Pleistocene life in Alaska - K.G.A. Hamilton (Eastern Cereal and Oilseed Research Centre, Agriculture and Agri-Food Canada, Ottawa, ON), S.F. MacLean, Jr. and Y.J. Kwon [*in prep.*]

British Columbia

Effect of livestock grazing on ground-dwelling arthropods in a bunchgrass ecosystem in southern BC - G.G.E. Scudder (Department of Zoology, University of British Columbia, Vancouver, BC)

Recovery of ground-dwelling arthropods following fire in a bunchgrass ecosystem in southern BC - G.G.E. Scudder

Habitat restoration and change in ground-dwelling arthropod diversity in a bunchgrass ecosystem in southern BC - G.G.E. Scudder

Diversity of robber flies (Diptera: Asilidae) in grasslands of British Columbia - R.A. Cannings (Royal British Columbia Museum, Victoria, BC).

Alberta

Post-fire recovery of arthropod assemblages in the Porcupine Hills - K. White (University of Lethbridge [MSc.]), R. Cartar (University of Lethbridge)

Arthropods associated with cattle dung in southern Alberta - K. Floate (Lethbridge Research Centre, Agriculture and Agri-Food Canada, Lethbridge, AB)

Galling arthropods on cottonwoods of prairie rivers - K. Floate

Recovery of arthropod assemblages after grassland fires [Porcupine Hills and CFB Suffield] - D.L. Johnson (Lethbridge Research Centre, Agriculture and Agri-Food Canada, Lethbridge, AB)

Stinging wasps and spiders at CFB Suffield - A.T. Finnamore (Provincial Museum of Alberta, Edmonton, AB)

Soil mite communities of fescue grassland in Alberta. M.J. Clapperton, W.D. Willms, D.A. Kanashiro (Lethbridge Research Centre, Agriculture and Agri-Food Canada, Lethbridge, AB) and V. Behan-Pelletier (Eastern Cereal and Oilseed Research Centre, Agriculture and Agri-Food Canada, Ottawa, ON).

Arthropod survey of Waterton Lakes National Park with an emphasis on Vespidae (Hymenoptera) - R. Longair (Department of Biological Sciences, University of Calgary, Calgary, AB).

Saskatchewan

Arthropod survey of Grasslands National Park - Entomological Society of Saskatchewan

Arthropod survey of Grasslands National Park - A.T. Finnamore

Coleoptera of prairie ponds - D.J. Larson (Department of Biology, Memorial University of Newfoundland, St. John's, NF)

Invertebrates of prairie ponds and rivers - D. Parker (AquaTax Consulting, Saskatoon, SK).

Manitoba

Biodiversity of tallgrass prairie: the use of fire as a biodiversity and conservation management tool for insects and plants, St. Charles Rifle Range, Winnipeg - R.E. Roughley, D. Pollock, (Department of Entomology, University of Manitoba, Winnipeg, MB), Bruce Ford (Department of Botany, University of Manitoba).

Ground beetles of Aweme, Manitoba; A comparison of historical records to the modern assemblage - D. Pollock and R.E. Roughley

Ground beetles of tallgrass prairie pastures at Gardenton, MB - D. Pollock & Xie Weiping (Department of Entomology, University of Manitoba, Winnipeg, MB).

Diversity of Agromyzidae (Diptera) in tallgrass prairie habitats in Canada - V. Crecco (Department of Natural Resource Sciences, McGill University, Ste-Anne-de-Bellevue, QC).

Ontario

Leafhopper evidence for origins of northeastern relict prairies (Insecta: Homoptera: Cicadellidae) - K.G.A. Hamilton [1994. *In* Proceedings of the 13th Annual North American Prairie Conference. pp. 61-70.]

Evaluation of Leafhoppers and their relatives (Insecta: Homoptera: Auchenorrhyncha) as Indicators of Prairie Preserve Quality - K.G.A. Hamilton [1995. *In* Proceedings of the 14th Annual North American Prairie Conference. pp. 211-226.]

Leafhoppers (Insecta: Homoptera: Cicadellidae) as indicators of endangered ecosystems - K.G.A. Hamilton ['*in press*' for Canadian Council on Endangered Areas Conference Proceedings.]

Leafhopper and planthopper endemism in Pacific Northwest grasslands (Rhynchota: Homoptera: Cicadellidae and Delphacidae) - K.G.A. Hamilton [*in prep.*].

Arthropods associated with alvar habitats in southern Ontario - P. Bouchard and T.A. Wheeler (Department of Natural Resource Sciences, McGill University, Ste-Anne-de-Bellevue, QC).

Yukon

Diversity and zoogeography of Diptera (Brachycera) associated with relic grasslands in the southern Yukon - S. Boucher and T.A. Wheeler

True bugs (Heteroptera) of the Yukon - G.G.E. Scudder. [1997. *In* Danks, H.V. and J.A. Downes (Eds.), Insects of the Yukon. Biological Survey of Canada Monograph 2, pp. 241–336]

Leafhoppers (Homoptera: Cicadellidae) of the Yukon: dispersal and endemism - K.G.A. Hamilton. [1997. *in* Danks, H.V. and J.A. Downes (Eds.), Insects of the Yukon. Biological Survey of Canada Monograph 2, pp. 337-375]

Canada-wide

Diversity and zoogeography of Chloropidae in Canadian grasslands - T.A. Wheeler

Diversity of the phytophagous Diptera community in Canadian grasslands - T.A. Wheeler

Comparative studies of the Heteroptera diversity in grassland ecosystems in Canada - G.G.E. Scudder

The genus *Efferia* (Diptera: Asilidae) in Canadian grasslands - R.A. Cannings

Diversity of robber flies (Diptera: Asilidae) in grasslands of the Canadian Great Plains - R.A. Cannings

Cynipid Galls on the Wild Roses of Canada's Grassland: distribution and habitats of host roses, biology of each gall, host specificity, and composition of component communities of inquilines and parasitoids. [includes sites in AB, SK and MB] - J.D. Shorthouse (Department of Biology, Laurentian University, Sudbury, ON).

Short-horned bugs (Homoptera-Auchenorrhyncha) - K.G.A. Hamilton [*In preparation for:* I.M. Smith (Ed.), Assessment of Species Diversity in the Prairies Ecozone - *electronic publication on CD-ROM*].

Arthropod species at risk and livestock grazing in the South Okanagan of British Columbia

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Introduction

The antelope-brush ecosystem of the South Okanagan is one of the most endangered ecosystems in Canada (Scudder 1980; Durance 1992; Schluter et al. 1995). Contained within the Bunchgrass biogeoclimatic zone in the Southern Interior of British Columbia (Meidinger and Pojar 1991), it is a fragile ecosystem, in which over half of this shrub-steppe habitat has been totally destroyed (Schluter et al. 1995). Less than 9% of this habitat that now remains is relatively undisturbed (Redpath 1990), and only survives now in mostly isolated patches on hillsides.

This very small fragmented habitat contains a number of endangered and vulnerable vertebrate species (MELP 1999). Over a dozen endemic invertebrates are known only from this area. In addition, there are over 250 potentially rare species; 80 or so of these occur here and nowhere else in Canada (Scudder 1992, 1994, 1996; Cannings and Cannings 1995). With respect to invertebrate biodiversity, the Thompson-Okanagan Valley is both a rarity and richness hotspot in British Columbia (Scudder 1998).

There are also a large number of rare plants in the South Okanagan. Hence, it is an area of great conservation interest, and a South Okanagan ecosystem recovery team has been established by the Committee on the Recovery of Nationally Endangered Wildlife (RENEW 1999).

The goals for this recovery team are to maintain a sufficient amount and diversity of habitat to

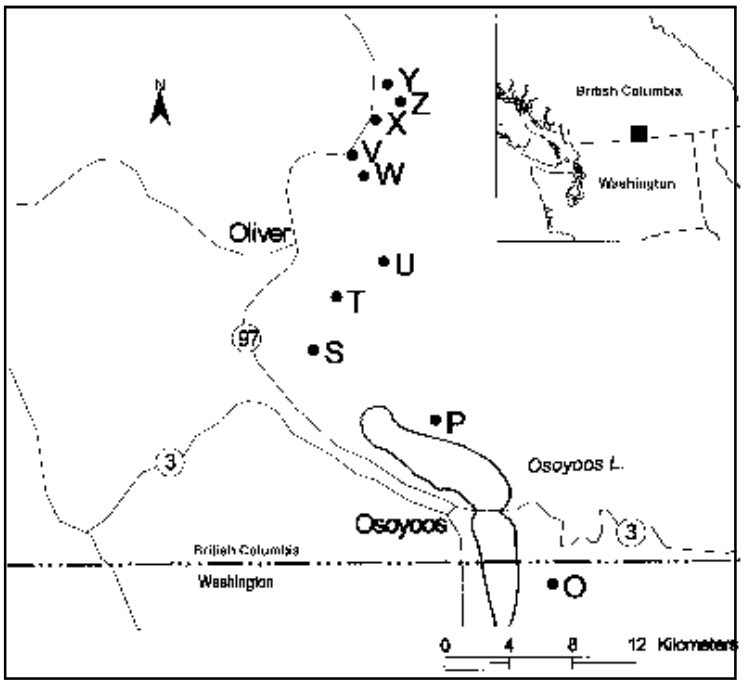

Figure 1. Sites in the South Okanagan studied for some invertebrates at risk.

sustain ecosystem function in the South Okanagan, to maintain viable populations of all native species, and to manage the South Okanagan ecosystem so as to balance the ecological, economic and social needs of local communities (RENEW 1999).

An ecosystem recovery plan is being developed. Associated with this is an irreplaceability / complementarity analysis for species at risk in the area (Warman and Sinclair 1999), and an 'Integrated Landscape Planning and Assessment' program of research (Olson + Olson 1998). Although the distribution of the vertebrate species at risk is fairly well known, and a habitat atlas for these has been prepared (MELP 1999), no such mapping could be done for the invertebrates at risk. This was because there was no comprehensive survey and analysis of the distribution and habitat requirements for the invertebrates at risk.

A collaborative research program was thus initiated in this antelope-brush community, aimed at characterizing this shrub-steppe habitat, describing its biotic composition, and assessing the distribution of some of the arthropod components at risk. Because much of the land is privately owned, and subject to livestock grazing, replicate sample sites were established in areas with differing grazing history, to see if such grazing had a major influence on the distribution of species.

Sample sites

In 1994, 10 study sites were established within the antelope-brush (*Purshia tridentata*) community in the South Okanagan, and their soil and vegetation analyzed. Three sites were in habitats without recent (previous 20 years) livestock grazing, 3 were in sites which had heavy livestock grazing, and 4 were in sites which had been grazed by livestock in the recent past (previous 5-10 years), but were then left ungrazed by livestock. All sites were subject to wildlife (bighorn sheep or deer) grazing.

Table 1 lists the sites, arranged in a ungrazed to grazed sequence. Figure 1 shows their relative geography: grazed and ungrazed study sites were interspersed, all were on sandy or gravely soils, at approximately the same elevation and on the east side of the valley, so climates were very similar. Site P has since been converted to vineyard.

Sampling methodology

Twenty-five pitfall traps for capturing ground-dwelling arthropods were set up at each site at the beginning of May 1994. Five rings of 5 traps were placed at 50 m intervals along vegetation transects. Trap circles had a diameter of 10 m and traps were placed in a pentagonal pattern at the periphery. Each trap consisted of two 450 ml

Table 1. List of sites studied in the antelope-brush ecosystem in the South Okanagan, and their livestock grazing history UG = ungrazed over previous 20+ years; G = originally grazed, but not grazed in previous 5-10 years; HG = heavily grazed to 1996.

Field & Map Designation	Location & Name	Geo-reference	Elevation (m)	Livestock grazed condition
V	BC, Osoyoos IRI 'Brights Winery'	49°13'N 119°32'W	336	UG
Z	BC, Vaseux Cr. 'Kennedy bench'	49°16'N 119°30'W	452	UG
O	WA, Oroville Osoyoos L.	48°58'N 119°25'W	355	UG
S	BC, Osoyoos Wildlife Reserve, Black Sage Rd.	49°07'N 119°33'W	353	G
Y	BC, Vaseux Cr. 'CWS bench'	49°16'N 119°30'W	370	G
X	BC, Vaseux Cr. 'Kennedy flats'	49°15'N 119°31'W	340	G
T	BC, Osoyoos IRI 'Inkaneep'	49°09'N 119°32'W	370	G
U	BC, Oliver, IRI 'Watertower'	49°10'N 119°31'W	475	HG
W	BC, Osoyoos IRI 'Nr. Mud L.'	49°13'N 119°31'W	340	HG
P	BC, Osoyoos IRI E. Osoyoos L.	49°04'N 119°29'W	355	HG

plastic beakers (beer mugs), with top diameter of 8.5 cm and depth 11 cm. One beaker was set in the ground with top level with the soil surface. The second beaker, snug fitting into the first, was half filled with 50% propylene glycol. This second beaker could be removed for emptying, without disturbing the soil or litter once traps had been set up.

Traps were covered with a 23 cm square piece of 0.5 cm or 0.25 cm thick, grey opaque sheet of plastic, supported on four 15 cm long pieces of 2.5 cm square aluminum tubing, placed at right angles in an 'X' around the rim of the trap. Wooden covers and supports could not be used, because past experience had shown that they were quickly consumed by the Western subterranean termite (*Reticulotermes hesperus* Banks). Traps were left *in situ* until the end of October 1995, being emptied once each month, but left undisturbed overwinter (October 1994 to April 1995). Sample collections were strained, preserved in 70% ethanol, and later processed in the laboratory. Arthropods were sorted to major taxonomic groups, and counted. Each group is now being sorted to species, identified and counted, but potentially rare species have been extracted from each sample, and these results are discussed below. Species listed in Scudder (1994, 1996) were used as the guide for this purpose.

Results

Twelve monthly samples from each site were obtained over the 2-year period. The number of arthropods in the 120 samples totalled over 350,000 specimens. Thirty-two potentially rare species were recorded, almost half of which were spiders. Because the spider samples have not yet been fully processed, these are excluded from further consideration.

Of the 17 species belonging to other taxa, 8 species (Table 2) have been selected to represent the main distribution patterns found (Table 3). They fall into three groups.

Group 1. The cydnid *Dallasiellus discrepans* and the seed bugs *Neosuris castanea* and *Sisamnes claviger* occurred in all sites sampled, although *N. castanea* was not collected at site V, and was not very frequent elsewhere. The other two species occurred in good numbers.

Group 2. The seed bugs *Cordillonotus stellatus* (Fig. 2) and *Peritrechus pilosulus* occurred only in the ungrazed sites and were extremely rare. Only one specimen of each was collected each year. Each species occurred only at a single ungrazed site.

Group 3. The solpugid *Eremobates* sp., the ground dwelling mantid *Litaneutria minor* and the cicadellid, *Unoka* sp. were found only in the heavily livestock grazed sites with a lot of bare ground. Although only one specimen of the mantid was captured at site W, the other two species were relatively common, and occurred at all the heavily grazed sites. The *Unoka* also occurred at two of the recently grazed sites.

Table 2. List of some species at risk in the South Okanagan

Solpugida
- Eremobatidae
  - *Eremobates* sp. (probably *E. gladiolus* Muma)

Dictuoptera
- Mantidae
  - *Litaneutria minor* (Scudder)

Hemiptera
- Cicadellidae
  - *Unoka* sp.n.
- Cydnidae
  - *Dallasiellus discrepans* (Uhler)
- Rhyparochromidae
  - *Cordillonotus stellatus* Scudder
  - *Neosuris castanea* (Barber)
  - *Peritrechus pilosulus* Scudder sp.n.
  - *Sisamnes claviger* (Uhler)

Discussion

It is evident that the 3 species recorded at virtually all sites are not specifically tied to the state of the antelope-brush habitat. All three of these species have been collected occasionally in other bunchgrass habitats adjacent to the South Okanagan valley, in pitfall trapping in subsequent years. However, they are very rare in these other locations. Provided some antelope-brush habitat can be saved in the South Okanagan, these species should remain secure.

Both *Cordillonotus stellatus* and *Peritrechus pilosulus* are known from just a single site each, and additional pitfall trapping over the last 5 years has failed to detect them elsewhere. They appear to be confined to ungrazed sites, and are extremely rare. From a conservation point of view, these two sites have thus a 100% irreplaceability value (Pressey et al. 1994). They would have to be included in any conservation network aimed at protecting all species at risk in the South Okanagan.

All three species listed from the heavily livestock grazed sites have been captured in additional pitfall-trapping research in the South Okanagan. However, this additional research has confirmed that they are confined to antelope-brush habitats that are disturbed and have a lot of bare ground. Our research has therefore shown that some disturbed areas must be maintained in any conservation landscape network if these species are to be protected.

Evidently, the western inter-montane bunchgrass ecosystems did not evolve with large bovid grazers, and so are not well structured to withstand livestock grazing (Milchunas et al. 1988). They are thus quite different to the short grass prairie steppe, which is one of the grasslands least responsive to grazing (Milchunas et al. 1998).

The natural disturbance regime in these inter-montane grasslands was originally fire initiated. Fire is now largely suppressed, but is being reconsidered as a management tool.

Table 3. Occurrence of some invertebrates at risk in sites studied in the South Okanagan.

Site name and abbreviation	'Brights Winery'	'Kennedy bench'	Oroville	Black Sage Rd.	'CWS' bench	'Kennedy flats'	'Inkaneep'	'Westertower'	'Nr. Mud L.'	Osoyoos L.
Grazing History	Ungrazed →					Heavily grazed				
	V	Z	O	S	Y	X	T	U	W	P
Species										
Dallasiellus discrepans (Uhler)	●	●	●	●	●	●	●	●	●	●
Neosuris castanea (Barber)		●	●	●	●	●	●	●	●	●
Sisamnes claviger (Uhler)	●	●	●	●	●	●	●	●	●	●
Cordillonotus stellatus Scudder		●								
Peritrechus pilosulus Scudder sp.n.	●									
Eremobates sp.								●	●	●
Litaneutria minor (Scudder)									●	
Unoka sp. n.						●	●	●	●	●

My research has shown that both fire and livestock grazing provide the habitat characteristics required by some of the invertebrate species at risk in the antelope-brush community in the South Okanagan. Both could be used as management tools.

Thus, in order to conserve the full complement of arthropods at risk in the bunchgrass ecosystem, the landscape conservation network being planned must maintain a mosaic of habitats, with some disturbance regime. Isolated reserves or protected areas will not suffice if all are left as mature “climax” communities. All seral stages in the ecosystem cycle must be maintained in the area, so that any conservation network will need to be managed with this in mind. How this should or can be accomplished in an area involving stewardship on private lands still remains to be determined.

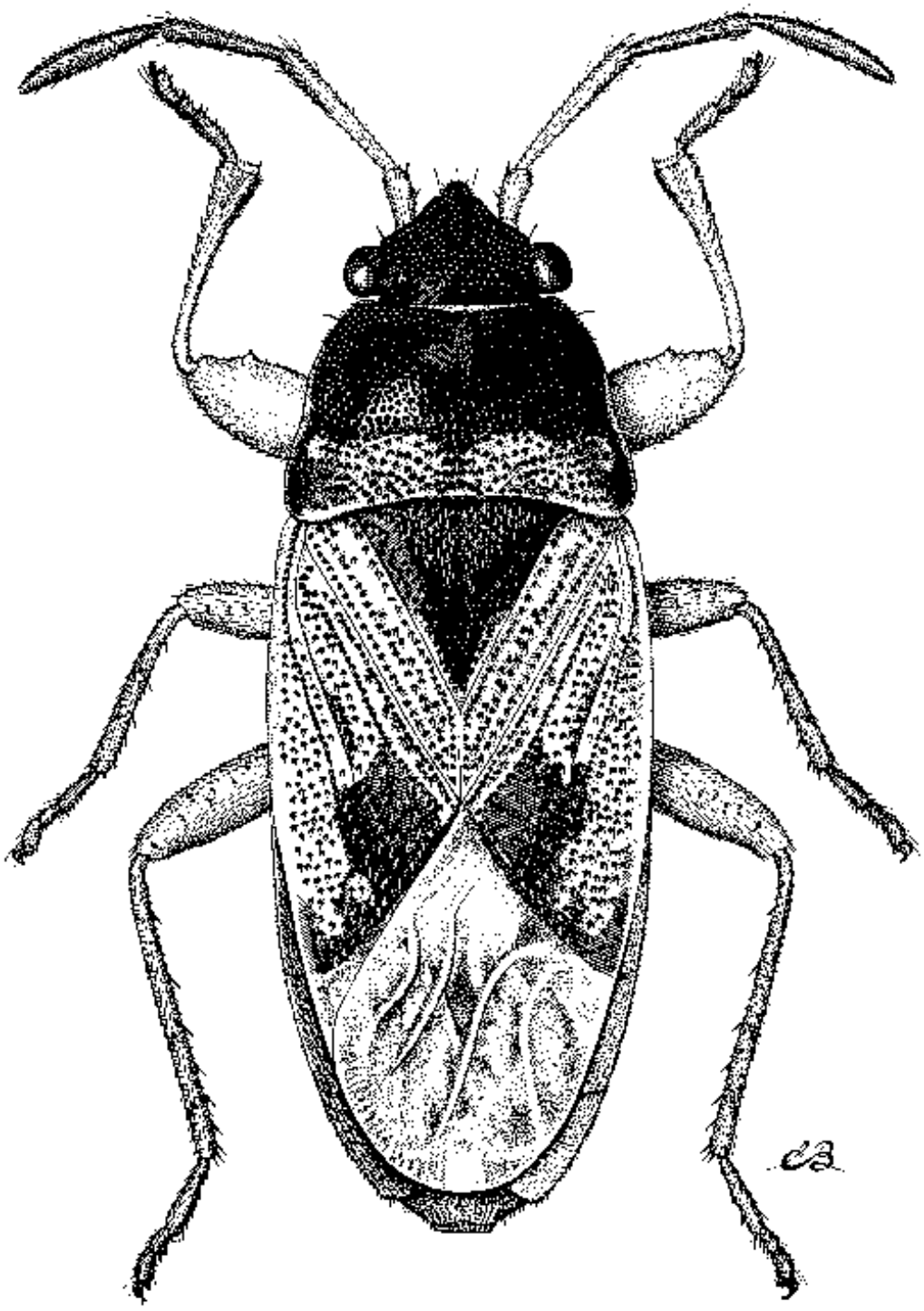

Figure 2. *Cordillonotus stellatus* Scudder (female, dorsal habitus), a very rare species from ungrazed habitat.

Acknowledgements

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Contents of grasslands newsletters 1–5

Web watch: Grasslands National Park (Saskatchewan)

http://parkscanada.pch.gc.ca/parks/saskatchewan/grasslands/grasslands_e.htm

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Grasslands National Park is located in southwest Saskatchewan on the Canada/US border. It was created to protect one of the largest pieces of undisturbed mixed-grass prairie in North America.

The Park is a 'work-in-progress'. It will eventually cover 900 square kilometres (350 square miles) in two blocks of land along the Canada - U.S. border in southwestern Saskatchewan. The federal government purchases the land on a willing-seller/willing buyer basis. There is no expropriation. As of 1996, the national park owned a total of 450 square kilometres (175 sq. mi.) in both the East and West blocks.

The Park is home to a unique blend of prairie-adapted common and endangered species from the pronghorn, sage grouse, burrowing owl, and ferruginous hawk to the prairie rattlesnake and eastern short-horned lizard. It is the only place in Canada where colonies of black-tailed prairie dogs can be found in their native habitat.

Remnant teepee rings, projectile points and other artifacts indicate that the Plains Indians lived here, evolving a lifestyle centred on the great herds of bison. Sitting Bull and his Sioux followers took refuge here from the U.S. Army after the battle of the Little Bighorn in 1876. The North West Mounted Police and European settlement followed.

Badlands and rock formations in Grasslands National Park (A. Cornellier)

Large cattle operations were established in the late 1800s. The Homesteading Act of 1908 closed the open range in favour of farming. Cattle were fenced in and ranching lost some of its freedom forever. The weathered remains of long abandoned homesteads stand testament to those early attempts to adapt to a demanding environment. The ranchers and homesteaders who persevered, combined farming, ranching and country hospitality to create the prairie communities surrounding the park today.

The Entomological Society of Saskatchewan made collections of arthropods in the park from 1987 to 1990 that totaled more than 300 identified species plus additional unidentified material. This collection was turned over to the park in April, 1993 and now resides at the Park Interpretation Centre at Val Marie, Saskatchewan. Collections from the area include 33 species of Acrididae (representing about half of the species known from the province), two species of solpugids, and species of spiders that appear to be indigenous to the Great Plains. More recent collections have been made by V.M. Behan-Pelletier (Agriculture and Agri-Food Canada) and A.T. Finnamore (Provincial Museum of Alberta).

Information on Grasslands National Park is provided by Parks Canada on the Internet at: http://parkscanada.pch.gc.ca/parks/saskatchewan/grasslands/grasslands_e.htm

Some recent publications

Insects of the Yukon

This book contains useful reference to grasslands and their arthropods, notably in the two chapters on leafhoppers and on true bugs, which emphasize the importance of dry grasslands especially on south-facing slopes.

Scudder, G.G.E. 1997. True bugs (Heteroptera) of the Yukon. Pp. 241–336 *in* H.V. Danks and J.A. Downes (Eds.), Insects of the Yukon. Biological Survey of Canada Monograph 2.

Abstract. So far, 216 species or subspecies of Heteroptera, belonging to 19 families, are recorded from the Yukon, about half of these reported here for the first time. This total represents 5.6% of the North American heteropteran fauna, and 17.1% of the Canadian true bug fauna. It is composed of 4 (1.8%) semiaquatic, 12 (5.6%) aquatic, and 200 (92.6%) terrestrial species.

Thirteen different faunistic elements are recognized within the true bugs in the Yukon. Species that occur in both Palaearctic and Nearctic regions are a significant component, with 61 species (28.2%) involving 5 faunistic elements: Circumboreal or near Circumboreal with 44 species (20.4%), Palaearctic-East Beringian with 7 species (3.2%), Palaearctic-Western Nearctic with 7 species (3.2%), Palaearctic-Cordilleran with 2 species (0.9%) and East-West Beringian with just one species (0.5%). The 141 exclusively Nearctic species constitute 65.3% of the fauna. Eight faunistic elements are recognized within this component: Nearctic including Beringian with 68 species (31.5%), Nearctic excluding Beringia with 22 species (10.2%), Western Nearctic including Beringian with 13 species (6.0%), Western Nearctic excluding Beringia with 11 species (5.1%), Cordilleran including Beringian with 12 species (5.6%), Cordilleran excluding Beringia with 11 species (5.1%), Subarctic with 2 species (0.9%) and East Beringian endemic with 2 species (0.9%). Five species, constituting 2.3% of the Yukon fauna, are considered to belong to a Nearctic-Neotropical element, with one species constituting a possible Asian element. Several species still lack exact identification, so their zoogeography remains to be analyzed.

The zoogeographic history of the various faunistic elements is discussed with reference to feeding habitats and the past and present vegetation of the Pacific Northwest. This paper also contains records of 28 species new to Alaska and 6 species new to Canada. Additional records of Heteroptera new to various provinces of Canada are recorded in a tabular format.

The Heteroptera show a distinct attenuation of the fauna as one proceeds northward, with 205 species in the southern Yukon, and only 5 species in the arctic coastal region. Most of the Heteroptera in the Yukon are widely distributed in the territory, with very few localized and closely tied to a specific habitat. However, there is a group of species closely associated with the xeric *Artemisia frigida* - grass community found on south-facing slopes along the Yukon drainage system and scattered localities elsewhere.

Sixty-one Heteroptera are predators, constituting 28.2% of the Yukon bug fauna. Most phytophagous species are polyphagous and associated with herbaceous vegetation. Nevertheless, *Salix*, *Pinus* and *Picea* are the main host genera for the Heteroptera of the Yukon. Wing polymorphism and flightlessness occurs in 33 species (15.3%) of the heteropteran fauna. Ten (4.6%) of the species exhibit myrmecomorphy, and 2 species (0.9%) are aposematic.

Hamilton, K.G.A. 1997. Leafhoppers (Homoptera: Cicadellidae) of the Yukon: dispersal and endemism. Pp. 337–375 *in* H.V. Danks and J.A. Downes (Eds.), Insects of the Yukon. Biological Survey of Canada Monograph 2.

Abstract. The Yukon leafhopper fauna includes 145 species, of which 80 are new records; 21 other species from adjacent areas probably occur there. Most are boreal species of the Nearctic region, with a smaller, mainly Holarctic component that inhabits the trundra. Seventeen are Beringian endemic species, and 8 are northwestern plains species restricted to intermontane valleys; these 25 species probably survived the Pleisto-

cene mainly in 2 areas of the Yukon: 6 species centre on the unglaciated arctic plain, and 18 are found along the Yukon River system, where they may have survived the glacial period on sun-warmed south-facing bluffs. The last of these inhabits the Carcross sand dunes, and has a subspecies around the Great Lakes. Postglacial dispersal has usually been slow; most wide-ranging species have not crosssed the entire continent in either direction, and a third of the arctic/subarctic fauna has not even crossed the Mackenzie River.

Invertebrates of wetlands

Among many useful chapters in the recent treatment of invertebrates in freshwater wetlands of North America is an account of invertebrates of prairie potholes.

Euliss, N.H., Jr., D.M. Mushet, and D.A. Wrubleski. 1999. Wetlands of the Prairie Pothole Region: Invertebrate species composition, ecology, and management. Chap. 21, pp. 471–514 *in* D.P. Batzer, R.B. Rader and S.A. Wissinger (Eds.), Invertebrates in Freshwater Wetlands of North America: Ecology and Management. Wiley, New York.

Abstract. The Prairie Pothole Region (PPR) of the United States and Canada is a unique area where shallow depressions created by the scouring action of Pleistocene glaciation interact with mid-continental climate variations to create and maintain a variety of wetland classes. These wetlands possess unique environmental and biotic characteristics that add to the overall regional diversity and production of aquatic invertebrates and the vertebrate wildlife that depend upon them as food. Climatic extremes in the PPR have a profound and dynamic influence on wetland hydrology, hydroperiod, chemistry, and ultimately the biota. Available knowledge of aquatic invertebrates in the PPR suggests that diversity of invertebrates within each wetland class is low.

Harsh environmental conditions range from frigid winter temperatures that freeze wetlands and their sediments to hot summer temperatures and drought conditions that create steep salinity gradients and seasonally dry habitats. Consequently, the invertebrate community is composed mostly of ecological generalists that possess the necessary adaptations to tolerate environmental extremes. In this review, we describe the highly dynamic nature of prairie pothole wetlands and suggest that invertebrate studies be evaluated within a conceptual framework that considers important hydrologic, chemical, and climatic events.

British Columbia Habitat Atlas

A habitat atlas for wildlife at risk in parts of B.C. provides one means for habitat protection (see p. 1)

MELP (British Columbia Ministry of Environment, Lands and Parks). 1998. “The Habitat Atlas for Wildlife at Risk in the South Okanagan and Lower Similkameen”. B.C. Ministry of Environment, Lands & Parks. ISBN 0-7726-3720-2. [Obtainable at a cost of $20 from B.C. Environment Office, 201-3547 Skaha Lake Road, Penticton, B.C. V2A 7K2]

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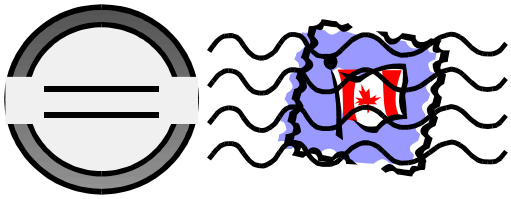

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