NEWSLETTER OF THE
BIOLOGICAL SURVEY OF CANADA
(TERRESTRIAL ARTHROPODS)

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General Information

The Newsletter of the Biological Survey of Canada (Terrestrial Arthropods) appears twice yearly. All material without other accreditation is prepared by the newsletter editor.

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Queries, comments, and contributions to the Newsletter are welcomed by the editor. Deadline for material for the Spring 2010 issue is January 31, 2010.

Editorial Notes

The Biological Survey of Canada is a not-for-profit corporation which develops and coordinates national initiatives in the taxonomy and ecology of the Canadian flora and fauna, with particular reference to the entomological fauna. The newsletter reports on activities relevant to the Biological Survey, and accepts submissions on systematics and faunistics in areas supported by the Survey.

This newsletter is available on the BSC website at:
News and Notes

News from the Biological Survey of Canada / Commission biologique du Canada

The Biological Survey of Canada (BSC) operated for several decades under the umbrella of the Canadian Museum of Nature, in a unique partnership with the Entomological Society of Canada, to promote study on Canadian biodiversity. The terms of that partnership changed dramatically in the past year, when the Museum reported that they could no longer support a full secretariat for the BSC. Currently the BSC is operating as a not-for-profit corporation, with an elected board to oversee operations. The first Board of Directors, established provisionally until the first AGM in October, consisted of members of the previous Scientific Committee of the BSC who agreed to serve in that capacity (Drs. Robert Anderson, Patrice Bouchard, Doug Currie, Donna Giber son, Dave Langor, and Joe Shorthouse). This board has met approximately monthly via conference call, addressing questions of the future and structure of the BSC.

Under the new structure, there have been a number of staffing changes. Dr. Andrew Smith, the interim head of the BSC Secretariat, completed his contract in September, 2009. Since that time, Susan Goods, our long time administrator for the BSC, has been continuing to help organize meetings, look after our website, and generally keep alive the day-to-day operations of the BSC. A Memorandum of Understanding with the Canadian Museum of Nature ensures space and access to some of Susan’s time until April 2010; the Directors are currently negotiating a new MOU to take the BSC into the years to come. At this point, I’d like to acknowledge how much we owe Susan Goods, both for her work on the BSC for many years, and for her help in navigating through this difficult period.

The first Annual General Membership meeting of the new not-for-profit corporation was held in Winnipeg in October following the Joint Annual Meeting of the Entomological Society of Canada and the Entomological Society of Manitoba. Current membership of the BSC consists mainly of the membership of the now defunct “Scientific Committee” of the former BSC structure, but members can include anyone who has an interest in participating in the projects of the BSC, and a willingness to attend the annual meetings. A process for applying for membership is currently being developed by the board, and will be posted on our website.

The Directors are continuing to meet monthly via conference call, addressing the long-term financial stability of the BSC, charitable status for the BSC, and the on-going projects of the BSC. More details of these projects and activities can be found in the report of the AGM, below.

Report on the first Annual General Meeting of the Biological Survey of Canada / Commission biologique du Canada

Fort Garry Hotel, 222 Broadway, Winnipeg, MB, 21 October 2009,

The members of the Biological Survey of Canada (BSC) met following the Joint Annual Meeting of the Entomological Society of Canada and the Entomological Society of Manitoba in Winnipeg.

Election of Directors

A major item of business was to formally elect the Board of Directors for the BSC. A provisional board had been in place since February, but the by-laws require that a formal board be elected at the first AGM. Joe Shorthouse, the President of the provisional Board of Directors called for nominations, and conducted the vote, resulting in the following slate of Directors, all to serve a two-year term:
Dr. Patrice Bouchard,  
Canadian National Collection of Insects  
Dr. Doug Currie,  
Royal Ontario Museum  
Dr. Donna Giberson,  
University of Prince Edward Island  
Dr. Dave Langor,  
Canadian Forest Service, Natural Resources Canada  
Dr. Joe Shorthouse,  
Laurentian University  
Dr. Felix Sperling,  
University of Alberta

The Directors will appoint a slate of officers during their first conference call meeting, scheduled for late November.

Reports

1. Status of the BSC

Joe Shorthouse reported on the activities of the BSC during the past year. He noted that the organization was now mainly a volunteer organization, with members drawn from the entomological community and other organizations wishing to partner with the BSC on various projects. The current MOU (Memorandum of Understanding) with the Canadian Museum of Nature is in effect until March 2010, with a new MOU currently under negotiation. The current agreement includes some logistic support from CMN to support the BSC, so it is hoped that it will continue. In addition, the BSC will continue to be associated with the Entomological Society of Canada. This relationship was formalized during the ESC Governing Board meeting with a Memorandum of Agreement between the two organizations. Among other things, the MOA provides for a permanent seat on the BSC Board of Directors to be filled by an appointee of the ESC. Currently this appointee is Dr. Felix Sperling, a Director at Large of the ESC Governing Board.

The subject of fundraising prompted considerable discussion around the table. Ideally, we would like to secure funding for an executive director position, as well as an administrative assistant. Several options are being explored, including partnerships with different government departments, as well as a process where the BSC may look at obtaining contracts or industry support for some of our BSC projects with an “indirect costs” component to help to fund a secretariat. Another option could be trying to set up an endowment to cover our operating costs. However, for at least the near term, we will continue as a largely volunteer organization with some logistic support from the CMN. Currently, Dave Langor is exploring the option of obtaining charitable status so that we can provide tax receipts for donations. There was also some discussion about preparing a business plan for both individual projects and the broader BSC organization. A major point that came out of the discussions was that we need a subcommittee to take on the role of preparing a business plan and a strategy for fund-raising, but none of our members currently have the time to take this on. The directors were charged with continuing to pursue funding options, and to consult widely about potential fundraising options.

In a related discussion, members asked about the Biological Survey Foundation, and its status under the new BSC structure. The BSF was set up to provide funds to support publications related to the activities of the BSC, and is currently set up as a Charitable Foundation. Members discussed whether it was appropriate to have two charitable foundations that were similar in scope. The discussion focussed on the main objective for these funds, for example, whether they would be solicited for specific projects (like publications or scientific projects) or for operational funding for the BSC. It was generally agreed that a single body would be best, unless the two organizations could be very well differentiated, but it wasn’t clear what the implications would be of combining the two organizations. The members agreed that we should proceed with a separate application for charitable status for the BSC while we work out the implications. The Directors were charged with collecting more information about
the process, and to proceed with the application for charitable status for the BSC.

Several projects of the BSC are continuing, and are reported below, under “Scientific projects”.

Newsletter and other publications

Donna Giberson reported that she and Susan Goods are working on the Fall 2009 issue of the BSC newsletter. There are several articles and updates already in for the newsletter, and it should come out some time in November. Many subscribers currently receive their newsletters electronically, and it is likely that we will move to an electronic version for all members except the institutional subscribers, who will continue to receive paper copies.

Joe Shorthouse pointed out that a new and updated BSC brochure was developed and is available on request.

Scientific projects

The BSC has a rich history of involvement in scientific projects relating to biodiversity studies, generally driven by the interests and research funding of the membership of the Scientific Committee. Under the new structure, the BSC is continuing some of these projects, but also is pursuing some targeted projects for which the BSC can be an active partner in seeking funding. The first project fully under the new structure is the new Northern Biodiversity Program, which is a partnership between a number of entomological researchers, government agencies, industry partners, and the BSC, to resample areas in the arctic originally sampled for the Northern Insect Survey.

Joe reported that the project has received some funding and will be going ahead, with sampling to occur in 12 arctic and subarctic localities over the next 2 years. Meetings are planned with some other potential funders this autumn, to hopefully extend the scope of the project, and also to provide some indirect costs funding to support the BSC.

The current projects, as approved by the membership of the BSC, are summarized below:

2. Publications

Arthropods of Canadian Grasslands

This is a multi-volume review of insect biodiversity, management, and ecology in Canadian Grasslands. The BSC recruited a number of authors to report on the current state of knowledge of insects in grasslands, and the current plan is to produce a work in 3 volumes, each volume dealing with a different aspect of insects in grasslands. Copy editing is complete for Volume One, and most authors have submitted their chapters for review for the second volume. Authors and an editor are still being recruited for the third volume. These volumes will be available in electronic versions, though some hard copies will be available for institutions, and to send out for review by journals.

Canadian Journal of Arthropod Identification

This on-line journal now has a number of high quality, well illustrated keys to regional, national, and international entomofauna, and several other submissions are under review. In addition, the BSC has agreed to take on the “Insects and Arachnids of Canada” series from NRC, and publish these on-line through CJAI. A full report on the Journal can be found on p. 55 of this newsletter.

Other publications

The BSC regularly produces briefs that are intended to provide information on applied topics (such as correct labelling standards for entomological museums, or how to conduct biodiversity surveys) or topics of philosophical interest (such as the importance of research collections, and “How to assess insect biodiversity without wasting your time”). These are available free of charge on the BSC web site. Interest was expressed at this meeting in a new brief that would review the needs and available information relating to mapping distribution records.
3. **Activities**

**BioBlitzes and Curation Blitzes**

Two important annual events of the BSC are the BioBlitzes and Curation Blitzes organized by BSC members in different areas of the country. No formal BSC BioBlitz was held in 2009, largely due to the focus of the Directors on the restructuring of the BSC, but these should continue in subsequent years. BioBlitzes consist of an organized field trip to a part of the country of entomological interest, with participants agreeing to share collecting information with local jurisdictions and/or collections. The Curation Blitzes are relatively new events, and are associated with the Annual Meeting of the Entomological Society of Canada. Systematists are invited to an evening in an insect collection located near the meeting, and spend the evening helping to curate or verify specimens from their area of expertise that reside in the collection. The most recent Curation Blitz was held at the JB Wallis Museum at the University of Manitoba (see p. 35 for a report).

4. **Continuing Scientific Projects:**

There are four continuing projects of the BSC. All of these involve members of the BSC, and progress on each is reported at each AGM.

a) Forest arthropods

b) Northern Biodiversity Program

c) Terrestrial Arthropods of Newfoundland and Labrador (see also p. 37)

d) Invasions/reductions

The next Annual General Meeting of the BSC will be held in conjunction with the Entomological Society of Canada meeting, in Vancouver, Fall 2010.

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The entomological community has lost one of its classic figures. Rob Roughley passed away suddenly at his home on 9 November, 2009 at the age of 59. Rob was an authority on water beetles, especially the Dytiscidae. He completed his B.Sc. (Agr,) in Entomology in the Department of Environmental Biology at the University of Guelph in 1974. He was part of the cadre of young entomologists emerging from Guelph at the time, inspired by Dave Pengelly. Rob became immersed in taxonomy and systematics and stayed on at Guelph to revise the genus *Hydaticus* (Dytiscidae) for his M.Sc., spending some of his time during this period working at the Canadian National Collection in Ottawa. He went to the University of Alberta to revise the genus *Dytiscus* for his Ph.D. under the supervision of George Ball. Even before he defended his Ph.D. thesis, he accepted a faculty position in the Department of Entomology at the University of Manitoba, where he remained until his untimely death. He was an untiring supporter of collections and collection management in Canada, and as Curator of the J.B. Wallis Museum, helped to develop the JBWM to where it stands today. Rob was integral to obtaining CFI funding to expand the rapidly growing museum facilities and to implementing one of the first bar-coded databases for entomological museums in Canada.

Rob had a big voice, a big personality and a big heart. I have met few entomologists more generous with their time and expertise. He was endlessly supportive of students, and always provided the encouragement and enthusiasm for
all things entomological that seemed to inspire so many of them. If you needed assistance, a reference, some specimens, an opinion, or an update on scores in the NHL games the night before, Rob was always there. I knew that if I ever found a specimen that I wanted to share with someone, I could always count on Rob to come to the lab for a look; he was always predictably excited by whatever I had to show him, even if it wasn’t a beetle. He was involved at many levels, from the work he and his students were doing in diversity in prairie grasslands, in the insects of the subarctic environment of Churchill, with the Biological Survey of Canada, the Nature Conservancy of Canada, the Committee on the Status of Endangered Wildlife in Canada, CANPOLIN, the dytiscids of North America and the water beetle fauna of Middle America.

Rob has been an important component of the entomological community in Canada and he will be sorely missed.

Terry D. Galloway, University of Manitoba

Rob Roughley and the Biological Survey of Canada

Rob Roughley was a member of the Biological Survey of Canada Scientific Committee from 1991-1994, and again from 1999 until his passing in 2009. During that time he was an active member, particularly on the Grasslands project. Rob was instrumental in starting up the annual BSC BioBlitzes, though they weren’t called BioBlitzes back then. He co-organized a collecting expedition with Kevin Floate to the grassland at Onefour Alberta, as part of the grasslands project. He also helped with the 2004 event in Aweme, MB and the 2007 one in Riding Mountain National Park. For the latter he travelled directly from the Churchill Arctic Entomology course to the BioBlitz (driving 750 km from Thompson to Wasagaming in the Park) and after a couple of hours’ sleep in his car, joined in the collecting with his usual gusto. Rob also organized the 2005 BSC symposium at the Entomological Society of Canada meeting on Arthropods and Fire, and co-authored the very popular BSC brief on “Terrestrial Arthropod Biodiversity: Planning a Study and Recommended Sampling Techniques”. He was also instrumental in setting up the extremely valuable historic locality database on the BSC website called the Common and Historical Collecting Localities within Canada. Rob was active in the BSC until the end, presenting a paper on his work on beetles of the Churchill Manitoba area in the 2009 BSC symposium and helping to host the 2009 Curation Blitz at the J.B. Wallis Museum.

Rob worked at the University of Manitoba for over 25 years. He is survived by his wife Pearl, his daughters Amy and Kate, son Keegan, and stepsons Ryan and Chad. Donations can be made in his memory in support of the J.B. Wallis Museum of Entomology at the University of Manitoba. Donations can be made online, or one can obtain a pdf form to be mailed in, from the University of Manitoba’s donations webpage at http://umanitoba.ca/admin/dev_adv/donate_now/index.html. In either case, the donation should be directed to “the J.B. Wallis Museum of Entomology in memory of Dr. R.E. Roughley”. This will ensure that the funds are appropriately directed to the future support of the museum to which Rob contributed so much, and that his wife Pearl receives periodic statements listing the donors.

Rob Roughley (second from right) waving the BSC flag at the 2005 Wateron Lakes National Park BioBlitz. Also present Joe Shorthouse, Felix Sperling and Dave Langor. (photograph by Andrea Renelli)
The annual BSC symposium this year was organized by Andrew Smith and Doug Currie, and was held on the morning of Wednesday, Oct. 21st. The symposium was nicely paired with the contributed session on Systematics, Conservation, and Biodiversity which occurred the afternoon before, and both of these sessions were very well attended.

Doug Currie introduced the symposium with a few words about the BSC and its continuing projects. He indicated that the papers to be presented at this symposium represented a broad range of projects on biodiversity assessment across taxonomic groups and regions, but also a wide range of researchers, from established university and government scientists to up and coming students leading a new wave of biodiversity science. The following papers were presented during the session:

Galloway, T.D.
Department of Entomology, University of Manitoba, Winnipeg, MB

Biodiversity of lice on birds and mammals in Manitoba

When Galloway & Danks (1991) reviewed ectoparasites in Canada, there were published records for 36 species of lice in Manitoba. They recommended entomologists collaborate with ornithologists and mammalogists. Since 1994, I have worked with the Manitoba Wildlife Rehabilitation Organization, Manitoba Conservation, Oak Hammock Marsh and Prairie Wildlife Rehabilitation Centre. Animals are salvaged, frozen and washed to collect ectoparasites. Current estimates from >7,000 hosts are 294 species of lice from birds and 32 species from mammals; >500,000 specimens. Salvaging hosts is an effective means to investigate biodiversity and ecology of lice.

Hamilton, K.G.A.
Canadian National Collection of Insects, Agriculture and Agri-Food Canada, Ottawa, ON

Border conflicts - how leafhoppers can help resolve ecoregional viewpoints in Canada and the USA

Ecoregions are defined using different parameters and assumptions in Canada and the USA. The only composite (published in 1999) minimizes the differences but needs to be tested against an impartial data set spanning the borders. Leafhoppers, which are speciose in the northern states and southern Canada, have been extensively collected and analysed for distribution patterns. These patterns tend to follow those of their plant hosts, and therefore reflect ecoregional patterns of lower trophic levels. In general, leafhopper distribution patterns agree with the synthesis but differ in some significant details, especially on the prairies where agriculture has extensively disrupted presettlement ecosystems. (Note: The full paper for this presentation can be found on p.41 of this newsletter.)

Humble, L.M a, b; Laplante, S. c; Terzin, T. d
aNatural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Victoria, BC; bDepartment of Forest Sciences, University of British Columbia, Vancouver, BC; cCanadian National Collection of Insects, Agriculture and Agri-Food Canada, Ottawa, ON; dBiodiversity Institute of Ontario, University of Guelph, Guelph, ON

Developing DNA barcode libraries for Cerambycidae

DNA barcoding uses short, standardized DNA sequences from the mitochondrial gene cytochrome oxidase 1 (COI) for species identification, and can be applied to any arthropod life stage. Barcoding requires libraries of COI sequences for all species in the target taxa, and few sequences are available for bark and wood borers. To develop a barcode library for Cerambycidae, samples from >1500 individuals representing 350 species in Canadian Forest Service reference collections were processed, yielding barcodes >500 bp long for 218 species, and partial barcodes (224–491 bp) for another eight species.
We discuss the technique’s limitations and potential application to regulatory and research surveillance programs for introduced species.

Kowal, V.A. Cartar, R.V.
Department of Biological Sciences, University of Calgary, Calgary, AB

Responses of terrestrial arthropod communities to anthropogenic forest disturbances at local and landscape scales

Anthropogenic impacts are ubiquitous in Canadian forests, which have experienced a mixture of disturbance types with potentially varying effects on biodiversity. The “edge effect” that accompanies direct disturbances has great potential to change or increase the initial disturbance effect. With this project, we use terrestrial arthropod assemblages to compare the edges of three anthropogenic disturbances in a mixed-wood coniferous forest: clearcut logging, forest roads and oil and gas pipelines. We employ multi-scale analysis of environmental factors shaping assemblage structure, from the local to the landscape level, to provide insights into the effects of different forest disturbances.

Parker, D.a; Phillips, I.b
a AquaTax Consulting, Saskatoon; bSaskatchewan Watershed Authority, Saskatoon, SK

Saskatchewan aquatic macroinvertebrate biodiversity surveys and database: past, progress and plans

Saskatchewan aquatic macroinvertebrate research has a rich history spanning more than 70 years. We are assimilating this historical data with our current survey and monitoring results into an online resource for the Saskatchewan fauna. In our presentation we highlight the online database, some of our research successes, obstacles we have encountered and outline some of our future plans.

Roughley, R.E.
Department of Entomology, University of Manitoba, Winnipeg, MB

Beetles of Churchill, Manitoba

Various aspects of the beetle fauna of Churchill, Manitoba are examined. Three main distribution patterns are present: 1. Northern from Alaska east to Manitoba, 2. Transcontinental northern often to Greenland, 3. Churchill plus adjacent Nunavut. The most diverse families of the 500+ spp. are Carabidae (82 species) and Dytiscidae (84 species). The most common life history pattern involves 1+ aquatic life stages. The most common feeding pattern is predation. The majority of new records for the Churchill are found along the Churchill River, suggesting that habitat change rather than climate change is more important for beetles.

Shorthouse, J.D.
Department of Biology, Laurentian University, Sudbury, ON

Factors influencing the distribution of gall-inducing cynipids on wild roses across Canada

Thirteen species of cynipid wasps of the genus Diplolepis induce galls on the wild roses of Canada. Galls of each species are inhabited by parasitoids and inquilines that form gall-specific component communities. Rose galls provide a unique opportunity to study the zoogeography of microhymenoptera because presence of the insects can be determined at various sites throughout the season without observing the adults. Galls sampled across Canada reveal patterns that illustrate the northeastern movement of roses and cynipids following deglaciation and the impact of factors such as northward flowing rivers of the Hudson Bay Lowlands, the Rocky Mountains, freezing winter conditions and wind.

Walter, D.E.
Royal Alberta Museum and University of Alberta, Edmonton, AB

Unexpected diversity in boreal forest and aspen parkland mites (Acari: Oribatida): results from the Alberta Biodiversity Monitoring Institute

When the Alberta Biodiversity Monitoring Institute surveys began in 2007, 132 species of oribatid mites had been reported from Alberta, mostly from the Rocky Mountains. Currently, I have records for ~300 species, including three new to North America, 16 new to Canada and 95 previously unknown in Alberta; 24–35 of these represent new species. To date, most ABMI samples and new records are from boreal forest and aspen parkland, indicating an unexpected richness in these previously poorly sampled biotic regions. Limited samples from the grasslands also indicate numerous new species.
Demise of NRC Research Press Monograph Series

As announced in February 2009, the Monograph Series at NRC Research Press is currently in its last year of operation. The termination date for this publishing entity will be March 31st, 2010. Since 1994, the Monograph Series specialized in publishing specialized monographs on various science and engineering subjects. In the last few years, it published important contributions in the Insects and Arachnids of Canada handbook series as well as other entomology-related monographs outside of the handbook series. More details on the sudden and unexpected demise of the Monograph Series can be found at http://pubs.nrc-cnrc.gc.ca/eng/stforum/st.html.

The long-time Editor of the Monograph Series recently suggested that people interested in reversing this decision can send letters to the Prime Minister (Stephen Harper), the Minister of State for Science and Technology (Gary Goodyear), the leaders of the federal parties, your local Member of Parliament and/or the President of the National Research Council (Pierre Coulombe - see details below).

Dr. Pierre Coulombe
President, NRC
NRC Executive Offices
Room W-307, Building M-58
1200 Montreal Road
Ottawa, ON K1A 0R6

The Insects and Arachnids series will not be terminated when the monograph series at the NRC Press ceases operation. Please see Project Update: The Canadian Journal of Arthropod Identification on p. 55 for details on the new format for this series.

Patrice Bouchard

The Evolution of the BSC Newsletter

Beginning with this issue all subscribers (except for institutions) will receive the newsletter electronically. This decision was made because of the BSC’s limited resources but also because advancements in technology means that there should be no obstacles in receiving the newsletter in this format for the vast majority of subscribers. In addition, having only an electronic version will allow all subscribers to view the newsletter in colour. This will also simplify the preparation of illustrations for contributors and the layout team.

Comments and suggestions on the future format of the newsletter are welcome. Please send them to the editor: bsc@mus-nature.ca.

The Alan and Anne Morgan Collection of Boreal and Northern Coleoptera moves to Guelph

We are pleased to announce that the Morgan Collection of Boreal and Arctic beetles, a major collection of Canadian Coleoptera, has been added to the University of Guelph Insect Collection in the School of Environmental Sciences (formerly Department of Environmental Biology), University of Guelph. The collection consists of some 58,000 specimens housed in 220 Cornell drawers and represents the result of a lifetime of collecting and curation in support of Anne and Alan Morgan’s work on sub-fossil and extant beetles. The Coleoptera are largely from localities in Newfoundland and Labrador, northern Quebec, northern Ontario, northern Manitoba, and Nunavut, then through the Northwest Territories and the Yukon, as well as northern and central Alaska. There are also specimens from many areas in western Canada and in higher altitude regions in the western United States. This is a comprehensive and well-identified collection including many rarely collected taxa, and it complements the existing beetle collections in the University of Guelph Insect Collection, which are mostly from southern Ontario. The collection is currently housed in a small room entirely dedicated to the Morgan Collection, adjacent to the main insect collection. Parts of the collection will be databased and integrated with the main collection as time and resources permit.

Alan and Anne Morgan and Stephen Marshall
Curation Blitz at Wallis Museum, University of Manitoba

On Monday 15 October 2009 during the joint annual meetings of the Entomological Societies of Manitoba and Canada, 18 curious entomologists made their way from the luxurious Fort Garry Hotel to the most important collection of insects in Manitoba, The J.B. Wallis Museum of Entomology (at the University of Manitoba) welcomed visitors to browse the holdings, to identify specimens in their area of expertise and to learn from experienced museum workers. Faculty members Rob Roughley (curator of the Wallis), Terry Galloway, and former graduate student Heather Flynn made the visitors feel welcome and facilitated access to the collections.

Through the evening, people from Ottawa seemed to focus on the back ends (a.k.a. boy-bits) of flies (Syrphidae, Conopidae and Empididea) while those from the north and east (Yukon and Newfoundland) seemed to be entranced by small vials of alcohol and presumably the aquatic insects in them as well. The more experienced museum workers spent most of their time ‘networking’ while neophyte grad students were busily filling in spreadsheets based on label data from lady beetle specimens.

It was a mix of people from experienced systematists to agricultural entomologists looking to learn about a new group they have been asked to work on. We left with a better understanding of the historical value of this collection which has specimens dating back to the late 1800s. A few more specimens were identified and spreadsheets documenting those identifications are filtering back to the curators.

The most startling memory of the evening came late. Terry Galloway, well known for his interest in arthropods that live in and on vertebrates, put a dramatic photo on his computer screen. It attracted the interest of Laurence Packer, the bee man. Where do their interests overlap? The photo was a close up of the nostrils of an eagle from Brazil. The insects in the nares were not lice, but meliponine bees foraging, presumably, for eagle snot. There are always surprises.

We hope many of you will be able to participate next year in Vancouver. It is a great opportunity to learn from experienced systematists, contribute your expertise to other collections and network with enthusiastic entomologists. As I overheard from a participating graduate student, “…entomologists are so normal and friendly”.

Dave McCorquodale

[Photos of people working and studying insects at the Wallis Museum]
International Year of Biological Diversity 2010

The International Year of Biodiversity (IYB) has been proclaimed by the United Nations General Assembly and will take place in 2010. The slogan “Biodiversity is life. Biodiversity is our life” and logo for the year, were unveiled in Montreal on 2 October 2009. People are encouraged to use the IYB logo posted at http://www.cbd.int/2010/logo/

During 2010, stakeholders from around the world will work together to raise awareness on the accelerating biodiversity loss; help make biodiversity a top of mind concern; generate public pressure for action by decision makers, and mobilize society for the post-2010 period.

The 10th Meeting of the Conference of the Parties (COP 10) to the Convention on Biological Diversity (CBD) will be held in Aichi-Nagoya, Japan, October 2010. That is also the deadline for the 2010 Biodiversity Target adopted at COP 6 (held in The Hague, Netherlands) in 2002, which called for contracting parties to “significantly reduce the rate of loss of biological diversity by 2010.” COP 10 will mark an important milestone for the CBD.

In Canada, the year will be celebrated by a variety of events organized by governments, non governmental organizations and a range of community agencies and individuals. The ultimate objective is to obtain a commitment by communities to reinforce implementation of the CBD.

The IYB National Committee sees an opportunity to showcase Canada’s natural beauty and encourage Canadians to get outdoors and experience nature in their communities, workplaces, schools, and their backyards. BioKits which include a series of outdoor activities and tips have been developed by The Biosphère of Environment Canada for that purpose. Some sample initiatives are given below:

The Green Wave, a tree planting initiative supported by the Secretariat of the CBD, will be an important element of outreach to school children and youth. http://greenwave.cbd.int/en/about-greenwave

The new 2010 IYB section on the Environment Canada web site provides a virtual meeting place where Canadians can share their stories about how they are celebrating this very special year. http://www.cbin.ec.gc.ca/2010/default.cfm?lang=eng

22 May 2010, International Day for Biodiversity, marks the grand reopening of the Canadian Museum of Nature (CMN) Victoria Memorial Museum Building. One of the highlights will be the inauguration of the new Water Gallery. http://nature.ca. The Alliance of Natural History Museums of Canada, whose members are fully engaged in IYB, will take an active part in the celebrations.

The Canadian Museum of Nature is also planning a symposium on Arctic Biodiversity, 18-19 November 2010. The CMN has a long tradition of work in the Arctic dating back to the Canadian Arctic Expedition of 1913-1916. The symposium will target the research and scientific community, environmental professionals, biodiversity stakeholders, and policy makers with interest in the Arctic.

International Year of Biodiversity will be a key turning point. “There is little time to wait. We need to work together in our own lives, but also as communities, national and global citizens to halt this loss of biodiversity. The good news is that we don’t have to start from scratch. . . .” (Secretariat of the Convention on Biological Diversity)

Anne Breau,
Canadian Museum of Nature
Almost 250 years have passed since Joseph Banks made the first known entomological collections from Newfoundland and Labrador (NL) in 1766. Since then, a great number of scientists and collectors have visited the shores of this ruggedly beautiful province to sample its fauna. Entomophilic visitors include the likes of Philip Henry Gosse, Carl Lindroth, Ernst Palmen, members of the British Schools Exploring Society and most of the professional taxonomists who have worked in Canada over the last 60 years. These collecting efforts, ranging in length from a few days to several months, have resulted in the amassment of specimens that reside in collections mainly in Canada, the USA and Europe. Sites that were part of the Northern Insect Survey in the mid 20th century (St. John’s, Gander, Harmon Field/Stephenville and St. Anthony on the island, and Cartwright, Goose Bay, Hope-dale, Nutak and Hebron in Labrador) received a large amount of survey attention. Furthermore, the extensive collecting efforts of long-time resident entomologists David Larson and Ray Morris, and the Forest Insect and Disease Survey of the Canadian Forest Service have resulted in large and comprehensive collections at Memorial University of Newfoundland (MUN), Agriculture and Agri-Foods Canada (AAFC, St. John’s) and the Canadian Forest Service (CFS, Corner Brook). Over the last 10 years, systematic survey efforts coordinated by the Newfoundland Department of Environment and Conservation and the Biological Survey of Canada have continued to fill in gaps in our knowledge of the fauna of this province, and this survey work will continue into the foreseeable future.

Since its inception in 1977, the Biological Survey of Canada (BSC) has been interested in the terrestrial arthropod fauna of NL. In November 2003, the ‘Terrestrial Arthropods of Newfoundland and Labrador’ was instituted as a project of the BSC. The goal of the project is to document and describe the diversity of terrestrial arthropods in the province and distribute this information. Specific objectives are to:

1) database specimens from NL residing in collections in Canada and elsewhere;

2) extract information on species occurrences from the published literature;

3) conduct targeted surveys (locations, habitats, taxa) to fill in gaps in knowledge;

4) collate biodiversity information from all sources and distribution the information in the form of species lists, distribution maps and identification keys;

5) analyze and synthesize biodiversity information to aid in General Status and Trends Assessments and provide assessment of faunal change through time.

Herein, we provide a brief update on progress to date.

Databasing

Hitherto, databasing activities have been focused on Lepidoptera and a few families of Coleoptera (Carabidae, Staphylinidae, Coc-
cinellidae). Once label data have been captured, localities are geo-referenced to facilitate production of distribution maps. Databasing activities have been focused on the Canadian National Collection of Insects (CNCI, Ottawa), the MUN collection (currently on long-term loan to the CFS in Edmonton), the AAFC collection (St. John’s), The CFS collection (Corner Brook) and the Zoological Museum at the University of Helsinki (Finland). Databased specimens are assigned an accession label.

Literature surveys

There are thousands of records of NL terrestrial arthropods that occur in the primary and secondary (gray) scientific literature. Such literature includes: faunistic works that focus on the NL fauna; taxonomic notes, revisions and monographs; population and community ecology studies; and surveys of pest insects and forest conditions. This information is gathered via computerized searches of literature catalogues and manual scanning of journals, books and government reports. This is a very laborious process that is less than 50% complete, but has resulted in a large number of interesting records. To date the database of NL entomological literature includes about 900 references (available upon request to David Langor).

Targeted surveys

Labrador has had far less arthropod survey activity than insular Newfoundland, largely because Labrador is a bit more expensive to reach and travel in, and the road network is greatly limited. The NL Dept. of Environment and Conservation (NDEC) and BSC have initiated a multi-year project to survey the terrestrial arthropods in selected parts of Labrador. Survey crews were active in 2008 (mainly in the vicinity of Goose Bay and 2009 (southern Labrador and Goose Bay). Plans are under way to commence work in northern Labrador. Gros Morne National Park, which has many rare ecosites, was the site of the 2005 BSC Bio-Blitz and there has been follow-up work. This park will continue to receive target inventory work in the future. As well, sand dune habitats and coastal limestone barren habitats have received focused survey attention by NDEC personnel.

Information collation and distribution

Species lists are available for most orders of NL terrestrial arthropods (Table 1). While keys are available for most insect families, none are available for other arthropod orders (Table 1). Several recent publications have documented the diversity of NL insects and spiders (see attached reference list). It is expected that
Table 1. No. of known species for each order of terrestrial arthropods in Newfoundland and Labrador, and availability of keys to species.

<table>
<thead>
<tr>
<th>Class/Order</th>
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<th>Keys</th>
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over the next 5-10 years a series of monographs will be published on the provincial fauna, including keys, distribution, biological notes, illustrations and references.

**Analyses and syntheses**

Recent work has focused on assessing the Status and Trends for the 196 species of Carabidae in NL, as part of a national initiative. Similar assessments are planned for other beetle families in the near future, including Curculionidae and Staphylinidae. Additional recent work includes an assessment of the non-native terrestrial arthropod fauna of NL. To date 456 non-native species are recorded from the province, including 44 spp. From Labrador. This represents about 8% of the known terrestrial arthropod fauna of NL, and suggests that the island of Newfoundland (with at least 9% of its terrestrial arthropod fauna of exotic origin) is one of the most intensively invaded jurisdictions in Canada.

**Future needs**

The number of participants in the Project have been few to date and include David Langor and David Larson (Project Leaders); Barry Hicks, Jan Klimasewski and Chris Majka (Coleoptera); Greg Pohl and Doug Macaulay (Lepidoptera); Geoff Scudder (Heteroptera); José Fernandez Triana (Hymenoptera-Braconidae); and Roger Pickavance (spiders). The Project could benefit from the involvement of other faunal specialists insofar as to build on current checklists and to test and improve existing keys. If you are interested in participating please contact David Langor (dlangor@nrcan.gc.ca). Participation could involve participation in collecting trips in the province, identification of specimens, or taking leadership with pulling together a checklist and/or key for a particular taxon.

While collections in NL, the CNCI and the Zoological Museum of the University of Helsinki contain the vast major of known NL specimens, undoubtedly other specimens reside in other collections in North America and abroad. We would be very interested to hear of substantive NL arthropod material in other collections. Please contact David Langor with any pertinent information.

**References**


A rare arctic *Xestia wockei* moth spotted by Doug Macaulay in Labrador (photograph by Doug Macaulay)
Border Conflicts: How Leafhoppers Can Help Resolve Ecoregional Viewpoints in Canada and the USA

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Abstract
Ecoregions are defined using different parameters and assumptions in Canada and the USA. The only ecoregion composite (published in 1999) minimizes the differences but needs to be tested against an impartial data set spanning the borders. Leafhoppers, which are speciose in the northern states and southern Canada, have been extensively collected and analysed for distribution patterns. These patterns tend to follow those of their plant hosts, and therefore reflect ecoregional patterns of lower trophic levels. In general, leafhopper distribution patterns agree with the 1999 synthesis but differ in some significant details, especially on the prairies where agriculture has extensively disrupted presettlement ecosystems.

Introduction
Biologists from the days of Darwin have been fascinated by biogeographic patterns of biota. Early classifications of North American floras and faunas (summarized in Scudder 1979) emphasized climate and dominant vegetation as ruling factors in such regional patterns. Biotic maps in Canada are usually based on 12 forest regions (e.g., Hosie 1969) while in the U.S.A. the dominant vegetational types were designated as 106 regions of “potential natural vegetation” (Küchler 1964). Other classifications stressing endemism are little used in Canada since postulated glacial refugia are considered significant only for arctic and alpine insects, having been too close to glaciers to account for most of Canada’s endemic species found in more temperate areas (Scudder 1979, fig. 3.44). Instead, substrate has been used as a measurable test for the extent of 15 large

Fig. 1. Southern Canadian Ecozones (Smith et al. 1996) compared to biomes in adjacent U.S.A.
biotic areas in Canada (Fig. 1). These areas are called Ecozones, and their subdivisions are Ecoprovinces, Ecoregions and Ecodistricts (Smith et al. 1996). A subsequent analysis combined these various criteria into a single map of North American terrestrial Ecoregions (Fig. 2) based equally on regional distinctions and endemism (Ricketts et al. 1999). The compilers did not provide lists of biota upon which it was based, but seem to have emphasized botanical and vertebrate distributions with other data from some beetles and macrolepidoptera. It is evidently a compromise classification using a mixture of criteria with many of the Canadian “Ecoprovinces” converted into equivalents of “Ecoregions” further south.

This study examines a rich fauna of insects not previously utilized in defining regional biotas. Records are based mainly on specimens of leafhoppers and their relatives, or “short-horned” bugs (Fig. 3) in the Canadian National Collection (CNC), Ottawa. Arctic and subarctic areas were sampled in 1947-1961 during the Northern Insect Survey at 64 arctic and subarctic localities (Cody et al. 1986). Boreal and far north sites represented in the CNC were mapped by Hackett (1965, figs. 1-7) and representation of southern localities typical of “short-horned” bugs are summarized by Hamilton (1982, map 1). Since 1963, 45 years of sampling leafhoppers (Hemiptera: Cicadellidae) and related insects at more than 1000 sites across Canada and the northern U.S.A. has increased CNC holdings to approximately 300,000 identified specimens.

Analyses have been published of “short-horned” bug faunas for the islands of Newfoundland and Cape Breton in Nova Scotia (Hamilton and Langor 1987), for the Yukon (Hamilton 1997a), and for the Prairie Ecozone (Hamilton 2004a, b) while unpublished synopses have been prepared for each of the other southern ecozones. These studies find considerable cross-border disjunctions in the present Ecoregional classification. Evidently, new data is needed to bring cohesion to the ecoregions of southern Canada and the northern U.S.A.

Understanding biogeographic patterns

Ecoregions are based on two kinds of data that correlate well with both biotic and abiotic ecological conditions: overall biodiversity and regional endemism. In this study, large-scale patterns of overall biodiversity emerge (Maw et al. 2000) and high levels of endemism and some curiously disjunct populations are noted in specific areas of Canada (Bouchard et al. 2002; Paiero et al. 2003; Hamilton 1995, 2002a, b, 2004a).

Regional faunas vary with ecological conditions in various distinct ways that may be interpreted through the relative proportions of endemics to total biodiversity. Simple cline distributions (e.g., from wet to dry areas) will support both the highest biodiversity and highest endemism in places of optimal condi-
Fig. 3. Examples of families of short-horned bugs in Canada. Cicadidae: *Okanagana ornata* Van Duzee, found in California, Oregon and at D’Arcy, B.C.; Cicadellidae: *Zygina flammigera* (Fourcroy), a wind-dispersed microleafhopper imported from Europe to coastal B.C.; Cercopidae: *Clastoptera atrapicata* Hamilton, a B.C. endemic; Membracidae: *Ceresa alta* Walker, a North American pest; 5, Derbidae: *Otiocerus degeerii* Kirby, restricted to southern localities; Achilidae: *Synecdoche constellata* (Ball), a Pacific coast species also known from two inland sites; Delphacidae: *Toya propinquha* (Fieber), a migratory introduced species; Cixiidae: *Oliarus coconinus* Ball, a disjunct in the Okanagan Valley; Fulgoridae: *Scolops abnormis* Ball, an endemic of the Okanagan Valley; Caliscelidae: *Bruchomorpha beameri* Doering, a prairie species also widespread in the intermontane valleys of B.C.

Photographs courtesy of Gernot Kunz, Tom Murray, Charles Schurch Lewallen and Werner Eigelsreiter.
tions, usually those far removed from extremes (Fig. 4, cline). Such distributions are common within ecoregions. If, however, the biodiversity and endemism are both highest near both ends of the ecological cline, as happens across the boreal forest zone with maximum numbers of species and endemics in Newfoundland (Hamilton and Langor 1987) and in Beringia (Hamilton 1997) then at least two separate ecoregions are represented along the gradient. Where biodiversity is high on either side of an anomalous area, and endemism is highest in that anomaly (Fig. 4, relict), this represents a site where a former ecoregional fauna persists embedded in an unfavorable ecological area, such as a sandhill surrounded by land overgrown with forest. If the fauna of two biomes overlap at an ecotone or “tension zone,” biodiversity will be higher there than in either adjacent area (Odum 1971), but endemism should be lower (Fig. 4, ecotone). This study reports a rare additional case: where climate cycles over a multi-year periodicity, as does rainfall on the Canadian steppe (Sauchyn et al. 2004), endemic species characteristic of adjacent areas cannot establish populations adapted to either extremes, and an hiatus of low biodiversity and also low endemism occurs (Fig. 4, hiatus).

“Well-developed ecotonal communities” differ from most ecotones in containing endemics adapted to an admixture of conditions (Odum 1971) such as prairie grasses growing in partial shade, or animals foraging in open areas but retreating to forested patches for nesting. Well developed communities of endemics in ecotonal conditions indicate that these conditions have lasted for much longer periods than the present interglacial and are therefore equivalent to ecoregions. It is notable that “aspen parkland” (ecotonal between prairie and boreal forest) has one of the richest faunas of endemic short-horned bugs in Canada. A second such ecotone rich in endemics is the belt of sand plain, alvar and oak savannah extending from Lake Huron to the interlake district of Manitoba. This area contrasts with that found in the prairie-forest transition zone extending from southern Ontario to Texas, the habitat of the massasauga rattlesnake Sistrurus catenatus (Ref.), but few other endemics. Two other and much less biodiverse well-developed...
ecotonal communities (with several endemic species each) exist. One of these is along the upper Fraser River and its tributary the Thompson in central British Columbia, where aspen parkland species from the Great Plains coexist with inland forest species and a very few Great Basin endemics. The other is the island of Newfoundland where both boreal and temperate-zone species have adapted to a hemiboreal environment. All four of these ecotonal communities are equivalent to ecoregions and are more clearly demarcated in their short-horned bug fauna than are other communities around them.

Faunal description

“Short horned” bugs are traditionally called Homoptera Auchenorrhyncha (more recently, Hemiptera suborders Archaeorrhyncha and Clypeorrhyncha). They are readily identified by their small, bristle like antennae and tubular, hypognathous mouthparts. Cicadas (Cicadidae) are the largest “short horned” bugs. They are notable for their loud mating calls or “songs” and their subterranean nymphs (Hamilton 2009). Leafhoppers (Cicadellidae) are by far the most common and diverse of these insects and include most of the Hemiptera introduced into Canada, principally from Europe (Hamilton 1983). Other families are spittlebugs (Cercopidae and Clastopteridae), treehoppers (Membracidae) and planthoppers (Fulgoroidea). Probably over 1,500 species of “short horned” bugs inhabit Canada (Maw et al., 2000). This is less than 3% of the total estimated insect fauna of Canada (Danks 1979). Other bugs are estimated to have more than 2,500 species in Canada, but half of these are aphids (Aphidoidea) and plant bugs (Miridae) with perhaps only about 50% of the species known. Fully 93% of the “short horned” bug fauna in adjacent states of the U.S.A. has been recorded from Canada, indicating a well-studied Canadian fauna suitable for regional faunal evaluation.

Most “short horned” bugs feed on plant sap as adults. Nymphs of two small fulgoroid families (Derbidae, Achilidae) feed on fungi under bark. All these suctorial insects together form a sizeable portion of the Canadian insect biomass. They probably supply a large part of the diet of insect and arachnid predators and parasites. They are thus important in nutrient cycling. Leafhoppers, and planthoppers of the family Delphacidae, are particularly important in wetlands and shorelines as they include numerous grass and sedge-feeding species. “Piglet bugs” (Fulgoroidea: Caliscelidae) are almost exclusively grass and sedge-feeding insects that may be found commonly throughout southern Canada although their species are much fewer than those of other Fulgoroidea.

Leafhoppers and their relatives are jumping insects with powerful hind legs. They disperse largely by running and jumping, but they also disperse by flight even when most of the population are short-winged (“brachypterous”) and flightless. They have been recorded to migrate over thousands of kilometres (Medler 1962; Cheng et al. 1979; Ghauri 1983) when aided by strong winds. Yet many species have very restricted distributions: over 90 species of leafhoppers plus 35 planthoppers, 8 treehoppers, 7 spittlebugs and 4 cicadas are known from only very small areas of Canada (Hamilton 1999a). This seeming contradiction apparently reflects the diversity of life styles found in these insects and the necessity for differentiating endemic species from widespread ones in any faunal analysis.

A great number of species of leafhoppers fly, but only few individuals of most species are found in flight intercept traps. The main exception to this rule is the genus Xestocephalus which appear to be ant-guest insects; apparently adults fly actively near ground level in search of ant nests. Traps more than 1 metre above the ground collect few leafhoppers, mainly long-winged species of Macrostelus (Waloff 1973), at least some of which are known to be migratory (Chyikowski and Chapman 1965). Tree inhabiting species, especially “micro leafhoppers” (Typhlocybinae) probably are dispersed by wind much more than ground inhabiting species. Other tree canopy species are more commonly collected in traps than species from low
vegetation, as the usual flight path of leafhoppers is obliquely downwards. The rapidly dispersing exception seems to be sexually immature individuals (Waloff 1973); possibly these actively disperse over short distances to prevent inbreeding. By the time females become gravid they usually lose the power of flight.

Most migratory bugs are light-bodied insects not more than 4 mm long that are easily carried by air currents. They usually show modifications for flight: their wings are usually more than 4 times as long as wide, and (in Delphacid planthoppers) their eyes are very large compared to the width of the head. Wind-carried insects apparently include most microleafhoppers plus Balclutha spp. Only these and the migrant “aster leafhopper” Macrosteleus quadri-lineatus (Forbes) are excluded from the following biogeographic discussion.

Many tropical species of planthoppers are also migratory. Only a few of these are known from Canada, but one, Sogatella kolophon (Kirkaldy), which overwinters in the southern U.S.A. has been found as far north as Cape Breton Island.

The rate at which non-migratory leafhopper populations spread is best observed in species imported by human activity. These “exotics” expand their ranges at rates between 10 and 100 km/year (Hamilton 1983). Perhaps these figures may be upward extremes for leafhopper vagility, as imported species are often the ones most able to encroach on occupied areas. These insects disperse readily by following introduced floras along transportation corridors.

Native species or ones which inhabit fragmented habitats appear to spread at much slower rates. For example, only one arctic species out of 24 has been able to invade islands across major water channels and a third of the arctic Alaskan-Yukon leafhoppers have not crossed the Mackenzie River valley in the 12,000 years since deglaciation (Hamilton 1997a). Some native species have been spread unnaturally quickly by human activities; thus, for example, the Canadian clover leafhopper Ceratagal-lia humilis (Oman) is a pest in eastern Canada although its native range is in the south-central plains of the U.S.A. (Hamilton 1998, Map 13).

**Faunal composition**

Southern Canada has seven Ecozones (Fig. 1). The Boreal Shield is the most extensive ecozone, but the forest classification of Canada (Hosie 1969) divides the Boreal Shield roughly at latitude 48°N, with the lower part assigned to the Great Lakes-St. Lawrence zone. The latter classification is preferred here because most faunas of short-horned bugs (excepting only Achilidae and Delphacidae) decrease dramatically across the boreal forest divide, which corresponds to the 2500 degree-day isotherm for the growing season (National Atlas of Canada, 4th ed., 1974, p. 50). A similar disjunction occurs between insular Newfoundland (except for the Long Range Mountains) and Labrador (Maw et al. 2000) at 50°N. This dramatic decrease in the phytophagous fauna probably corresponds to the open understory of coniferous forests that has a very limited diversity of herbaceous plants. This study therefore focuses on the six parts of Canada that lie below latitude 48°N: insular Newfoundland, hemiboreal parts of the Boreal Shield, Atlantic Maritime Ecozone (AME), Mixedwoods Plains Ecozone (MPE), Prairies Ecozone (PRE), Montane Cordillera Ecozone (MCE) and Pacific Maritime Ecozone (PME).

Insular Newfoundland has a boreal aspect but coastal areas to the south and west have a strong admixture of 23 hemiboreal leafhoppers and 21 temperate-zone species (44 species in all) compared to 42 boreal species (Hamilton and Langor. 1987) for an overall hemiboreal aspect. There are also six species endemic to Newfoundland and adjacent land to the south-west, in contrast to only four exclusive to Cape Breton Island and two found around the Gulf of St. Lawrence. The presence of emergent land on the adjacent Grand Banks during Pleistocene minimum sea levels (Fig. 5) must have served as a glacial-age refugium for the distinctive Newfoundland fauna.

The Maritimes or AME is divided into three “ecoprovinces” which in turn are subdivided
into 14 “ecoregions.” The AME fauna of native “short-horned” bugs reflects to some degree the broader geographical patterns expressed in this classification, but not the finer subdivisions (Hamilton and MacQuarrie 2000, and Hamilton in press). At least 285 species out of 425 have limited dispersal opportunities and are truly year-round residents in the AME. These most clearly support the designation of distinctive “Ecoprovinces” within the AME. These “Ecoprovince” faunas are, indeed, more discrete than that of the AME itself. In this connection it is noteworthy that the North America-wide biodiversity classification system (Ricketts et al. 1999) recognizes three separate “Ecoregions” but not the AME. They segregate the Northumberland Lowlands ecoprovince as a separate Ecoregion, and map the tip of Cape Breton Island in the same Ecoregion as most of Newfoundland, the north shore of the St. Lawrence, and the highlands of Gaspé and New Brunswick. The data from “short-horned” bugs support the separation of the lowlands, but do not support such a “lumping” of widely separated highland areas. The highlands of Cape Breton are quite dissimilar from the other hemiboreal areas in having a number of lowland disjuncts plus the majority of endemics in Nova Scotia. The fauna of Îles-de-la-Madeleine, QC is also distinctive. Technically, these remote islands in the middle of the Gulf of St. Lawrence belong to the Northumberland Lowlands Ecoprovince, but they have a distinctive leafhopper and spittlebug fauna (Hamilton 2002a). Their fauna of 35 native and 7 introduced “short-horned” bugs is tiny compared even to the depauperate fauna of Prince Edward Island, which has 123 native species and 19 European species. Still, it is surprisingly rich considering the distance from the mainland and differs significantly from the Prince Edward Island fauna in consisting primarily of species typical of the Gaspé. It also includes one strongly disjunct leafhopper, Rosenus acutus (Beamer), which is not otherwise known south or east of northern Manitoba. The biota includes a number of endemic forms and even a few endemic species. None of these was probably able to weather the last glacial

Fig. 5. Pleistocene minimum sea levels 12,500 years before the present (BP) exposed many of the offshore banks near Nova Scotia (NS), New Brunswick (NB) and Maine (ME). Lower sea levels probably made a land connection to the Îles de la Madaleine and formed offshore refugia for hemiboreal insects and plants. Embayed shallow waters in the Gulf of Maine permitted mild temperatures and associated vegetation to invade New Brunswick until 5000 years BP.
period on these islands. Instead, they probably came to the islands from the mainland at a time when glaciers had retreated enough to allow a boreal forest to flourish (Fig. 5), yet before melting ice caps raised sea levels closer to their present height, increasing the distance between the islands and the mainland.

The Mixedwoods Plains Ecozone in southern Ontario and the St. Lawrence Valley of Québec was mostly dense forest in presettlement days, except where wetlands and sedge marsh broke the canopy. The dominant bug fauna of the MPE is therefore one that feeds on trees, understory plants and sedges, with a smaller component that feed on grasses associated with rocky outcrops and 14 boreal species found in scattered bogs. It is surprising therefore that 12% of the 563 native species is similar to that of the prairies of western Canada and grasslands in the western or southern U.S.A. (Hamilton 1997b). Most of these 66 grassland species are host-specific, showing that they evolved in an area where grasses, alkaline-adapted sedges and other arid-adapted plants formed a dominant or subdominant part of the ecosystem. Peripheral zonation of this fauna partly reflects milder climate near the Great Lakes and partly the presence of sand or limestone that maintains aridity throughout much of the growing season. Fully 47 grassland species are found in such coastal situations, 15 being widespread, seven found only on the eastern side of Lake Huron from the Bruce Peninsula to Ipperwash Beach and 12 are found only from Grand Bend to Ipperwash. Many others are found near the southern tip of Ontario, or on limestone plains (“alvars”) from Manitoulin Island in Lake Huron south to the Bruce Peninsula and east to Ottawa (Bouchard et al. 2002, Paiero et al. 2003). Similar faunas are found in northwestern and northeastern parts of southern Michigan and in oak savannah from northeastern Illinois and southern Wisconsin diagonally through Minnesota to eastern Manitoba including the Tolstoi “tall-grass” prairie (Hamilton 1995) at the southern tip of the Boreal Plains Ecozone.

The Great Plains of Canada experienced less detailed surveys than in the U.S.A. in the 19th century when the native vegetation of the presettlement prairies was still extensive. Now, only fragments of the eastern half of this area still retains a semblance of its native grasses and the original extent and character of the eastern “prairies” is almost entirely conjectural. Ecoprovinces of the Prairie Ecozone are therefore based on soil types rather than vegetation, a measure more of the degree of aridity than of presettlement vegetation. Fortunately, leafhoppers, “piglet bugs” and delphacid plant-hoppers are abundant, diverse and frequently host-specific on native prairie plants. Three cicadas, one spittlebug, seven treehoppers, 47 planthoppers and 168 leafhoppers make up a fauna consisting of 55 species widespread on the Great Plains, 39 species characteristic of eastern plains (six species are found only in tall-grass prairie and seven on oak savannah), and 132 species found on the drier western “steppe” (Hamilton 2004a,b). The northward extension of tall-grass prairie into southern Manitoba in the vicinity of Morden, the warmest part of the Canadian prairies, continues into eastern Saskatchewan (Hamilton 2005). Of the western fauna, 34 are widespread, 40 are restricted to aspen parkland and 58 are found only on “short-grass” prairie. These distributions do not match the concentric patterns of the Ecoprovinces of the Prairie Ecozone (nor of the Ecoregions that are based on these Eco-provinces) but instead follow an anomalous pattern (Fig. 6). An oak savannah fauna occupies most of the Red River Valley and vicinity around southern Lake Manitoba northwest to Winnipegosis; a western fauna extends along the southern edge of the Ecozone as far as the sandhills of western Manitoba, but this fauna drops off rapidly to the north. However, there is a major biodiversity “hot spot” of 92 prairie species at Elbow, Saskatchewan where the Qu’Appelle Valley headwaters nearly meet the South Saskatchewan. Apparently the transverse valley system represented by these two rivers (a relict of a glacial-age meltwater spillway) is a conduit between the arid western fauna, which inhabits its sun-parched south-facing
slopes, and the eastern fauna which inhabits the moister valley bottom. All around this area is tableland subject to wide and periodic changes from exceptionally dry to exceptionally moist years. This highly volatile climate is suitable only for highly vagile, widespread plant feeding insects like leafhopper “tramps.”

The distinctive “aspen parkland” fauna from the northern fringe of the prairies also extends into the Montane Cordillera Ecozone where it forms a disjunct fauna along the upper reaches of the Fraser River and extends as far south as Princeton, B.C. (Hamilton 2002b). This grassland fauna is quite distinct from that of the Pacific Northwest fauna that extends into the southern Okanagan Valley. Elsewhere, the Montane Cordillera Ecozone consists largely of temperate forest valley bottoms embedded in boreal forest-clad mountains (Hamilton 1999b). A total of 465 species of Homoptera-Auchenorrhyncha are reported from the Ecozone. Of these, 157 are confined to valleys (138 of these occur in the Okanagan Valley); 28 are confined to mountains; and 148 are widespread species of the boreal and hemiboreal zones. The fauna is consistent with the recognition of three ecoregions: a widespread boreal forest fauna extending across Canada, a northern grassland extension of the prairies that occupies the lowest valleys, and semiarid shrub-steppe in the south, with Ponderosa pine woods as ecotone among all three and therefore commensurate with an extension of the interior forest ecoregion in the Pacific Northwest states. Ecodistricts 1002 and 1005 together (lower Fraser valley) are unique in the ME as their endemic fauna of four species probably came from the coastal intermontane valleys of Oregon and Washington states by way of the Pacific Maritime Ecozone.

The short-horned bug fauna of the northern end of the Pacific Maritime Ecozone shares with the adjacent parts of the MCE a large part of its boreal and wide-ranging fauna. There is a small component of coastal endemics, principally around the Queen Charlotte Islands. Further south the Pacific coast has more species ranging northward from Oregon and California, particularly on the southern tip of Vancouver Island. A few species in this temperate-zone mixed hardwood forest are species shared with the Palouse grassland of Washington state and the Okanagan Valley that must have crossed the Coastal Range by way of the Columbia River in postglacial times.

Discussion

Short-horned bugs provide clear evidence of regional faunas in two aspects of southern
Canadian biogeography where data is sadly lacking: the exact southern boundary of boreal forest and the extent and nature of presettlement grasslands.

Boundaries of ecoregions of ecotonal origin are usually ragged rather than continuous (Newfoundland is the exception) but can be mapped fairly easily as large-scale regions encompassing the particular sites with highest biodiversity. Boundaries of a hiatus are much more problematic because biodiversity though such regions is very low and therefore difficult to characterize. In the case of the boundary between aspen parkland and arid plains in Saskatchewan there is conflicting evidence between the prevalence of aspen and that of dominant and subdominant grasses such as mat muhly, Muhlenbergia richardsonis (Trin.) Rydb. The insects, on the other hand, show a sharp boundary across the area of least biodiversity where the South Saskatchewan and Qu’Appelle Rivers transect the area and bring these two faunal zones into direct contact with maximum diversity, a very narrow east-west ecotone.

Of all the ecoregions in Canada, the shrub steppe of the Okanagan is by far the most clearly defined by its extraordinarily high biodiversity and endemism in a geographically constricted area. Yet this faunal region cannot be demarcated by its biota (83 endemic species in the north and 73 in the south, with 37 species in common). This is an exemplar of an ecoregional situation with a clinal distribution. Such ecoregions commonly have indefinite boundaries. In such cases the boundaries of the ecoregion must be set by factors other than biota, such as soil types, which permit precision.

Conclusions

Ecozone classification of landscapes offers three advantages: (1) a nested set of regional landscapes at differing scales which simplifies interpretation and offers a broader choice of descriptive options; (2) precise boundaries suitable for conservation decisions and ecological management; (3) the “lumping” of altitudinal zones in such mapping simplifies the data and works well in glaciated landscapes where altitudinal endemism is unlikely and fauna are scattered vertically by summer updrafts. On the other hand, reliance on surrogates such as soil types divorces such analyses from direct faunal and floral comparisons provided by ecological studies such as “potential natural vegetation.” Ecoregional landscape patterns based on patterns of biodiversity and endemism but with precise boundaries governed by geological factors is a happy compromise between these two systems. But ecoregional patterns are very complex to analyse and only as good as the data base on which they are founded. Inclusion of the rich and geographically limited faunas of short-horned bugs is essential for a well-founded biogeographical assessment that transcends national boundaries and offers a return to nested sets of landscape scales.

Twenty-five ecoregions in Canada lie south of Canadian Shield forest (Ricketts et al. 1999). Of these, five (7, 8, 27–29) lie partially or almost entirely within boreal forest as defined by the 2500 degree-day isotherm. The three western ecoregions (27–29) enclose deep valleys that support temperate-zone species and are therefore included in this analysis. The two eastern ecoregions (7, 8) lack such strong topographic features and their insect biodiversity strongly supports their subdivision according to existing forestry maps (Hosie 1969). The faunal analysis according to endemism supports the following 15 redefined ecoregions that cross the Canada-USA border representing four biomes. The rest of Canada’s ecoregions fit into the Arctic, Taiga (subarctic, mostly above the 1500 degree-day isotherm) and Boreal biomes.

Hemiboreal and deciduous forest biome

(Fig. 7: 1-7)

(eastern Canada)

1. Hemiboreal zone or forest/boreal transition (southern half of ecoregion 7-8) is consistent on both sides of Lake Superior, with a few endemics centrally located, mostly on the Upper Peninsula of Michigan and adjacent Wisconsin. Its faunistics are quite distinct from those of aspen parkland
(ecoregion 55) which forms a similar transition but with numerous grassland endemics scattered around the rim of the Great Plains from western Manitoba to central Colorado.

2. **Newfoundland** forms a distinctive hemiboreal ecoregion with a strong admixture of both boreal and temperate-zone insects along with four endemic leafhoppers (Hamilton and Langor 1987).

3. **Northern oak savannah** (ecoregion 9 in Minnesota and Michigan) is consistent with the eastern half of ecoregion 59 (“northern tall grasslands”) in Manitoba, the southern half of ecoregion 59 in Wisconsin (based on early survey records) and the Manitoulin-Bruce Peninsula limestone outcrops and beach ridges around Lake Huron in Ontario. Most of its endemics are around Lake Michigan and its northwest extent (7 endemics) forms an ecotone with aspen parkland. The “boreal” fauna of the boggy strip of land south of Lake Winnipeg is included here because it is interspersed by sandy areas that have a quite different, more southerly aspect that supports a hemiboreal fauna of leafhoppers and includes a relict oak savanna around Tolstoi.

4. **Southern Great Lakes forest** (ecoregion 10) has the greatest biodiversity of any ecoregion in Canada, but has only one endemic species, the very rare cicada *Okanagana noveboracensis* Emmons in the vicinity of Niagara Falls. The fauna is richest at the tip of southern Ontario and adjacent Michigan.

5. **Great Lakes lowland forest** (ecoregion 11) is consistent with the southern half of ecoregion 9, with a few endemic insects and prairie disjuncts found mostly in the vicinity of the Great Lakes.

6. **Acadian forest** (ecoregion 12) is an isolated extension of hemiboreal forest on the eastern side of the St. Lawrence lowlands. It has six endemics mostly at its eastern tip closest to the presumed glacial refugium of the Grand Banks of Newfoundland, and a distinctive coastal fauna of 12 species that attenuates northward from the New England states. Its fauna is similar to that of the Adirondack Mountains in New York state (part of ecoregion 8) from which it is separated only by the narrow Hudson Valley, but distinct from the more southerly hemiboreal forest in Pennsylvania (ecoregion 15).

7. **Gulf of St. Lawrence lowlands** (ecoregion 13) represents an isolated extension of broadleaf forests found in coastal Maine (northern part of ecoregion 14) with mainly coastal endemics, some of which are widely disjunct from the New England fauna, most notably the cicada *Tibicen lyricen* (DeGeer) that has been photographed on July 31, 2007 at Richibuctou, NB.

**Montane forests biome (Fig. 7: 8-11) and Intermontane arid lands biome (Fig. 7: 12)**

(western Canada)

8. **Pacific coastal forests** (ecoregions 23, 24, 33, 34) have a fauna associated mainly with pine, sedge and alder. Three endemics are found on the unglaciated Queen Charlotte Islands and adjacent mainland.

9. **Interior forests** (ecoregions 25-30) appear to be a northern extension of interior forests of Oregon and western Washington (ecoregions 37, 38) that became isolated as interior shrub steppe spread during post-glacial warming. Its few endemics and disjuncts in Canada are associated with ice front conditions during the last ice age (e.g., *Psamnotettix beirnei* Greene in the vicinity of Mt. Revelstoke is a sister-species of *P. alexanderi* Greene in the vicinity of Mt. Washington in New Hampshire).

10. **Leeward forests** (ecoregions 31, 32) encompass arid valleys which represent an ecotone of aspen parkland and shrub steppe, with 27 prairie disjuncts plus a few endemic insects confined to the upper Fraser Valley.
11. Puget Sound forests (ecoregion 35) are probably a northern extension of Willamette Valley forests (ecoregion 6) with a postglacial influx of shrub steppe fauna which constitutes most of the endemic insects.

12. Palouse grasslands (ecoregion 53) is a westward extension of montane grasslands in ecoregion 43 (South Central Rockies) that differs sharply in its short-horned bug fauna from that of the adjacent Great Plains, although the dominant grasses across the passes are identical. This tiny area has an enormous number of grassland endemic short-horned bugs (275) and probably represents a postglacial fusion of numerous isolated grassland refugia (Hamilton 2002b). The southern Okanagan Valley is enriched by 22 arid-adapted species from the shrub steppes (ecoregion 75) which invade sun-parched eastern slopes in the vicinity of Okanagan Falls south to Osoyoos and another 24 extend their ranges into arid areas north and east from there.

Great Plains grasslands (Fig. 7: 13-15)

13. Aspen parkland (ecoregions 55-57 with southern boundary extending to the South Saskatchewan and Qu-Appelle Rivers) represents a periglacial grassland that became disjunct from grasslands of the Colorado mountains (ecoregion 45) when postglacial aridity eliminated much of the fauna from the intervening Wyoming basin (ecoregion 77). There are 40 endemics plus undescribed Delphacidae scattered throughout the region.

14. Steppe or “mixed grasslands” (ecoregions 56 and 58 south of aspen parkland) has most of its 58 endemic bug species in southeastern Alberta and adjacent Saskatchewan, but there are isolated populations of western species as far east as western Manitoba, and there are 34 prairie-endemic species in common with aspen parkland. The leafhopper fauna tapers off southwards, leaving some species in southern Canada widely disjunct from populations in Kansas (particularly significant are the flightless Attenuipyga halli Oman, and Pectinapyga

Fig. 7. Fifteen ecoregions south of the boreal zone supported by faunas of short-horned bugs.
15. **Prairie** or northern tall grasslands (western half of ecoregion 59 and eastern part of ecoregion 55) probably existed only in the southern Red River Valley of Manitoba where the degree-days of the growing season exceed 3000, but a northwestern extension into Saskatchewan (Hamilton 2005) has many of the same six endemic species (especially those on little bluestem, *Andropogon scoparius*). This northern prairie has an admixture of 26 more widespread northeastern prairie species and appears to be an ecotone with aspen parkland.

**References**


The Canadian Journal of Arthropod Identification (CJAI) is heading into its fourth year and has now established a solid reputation for the publication of cutting-edge, thoroughly illustrated taxonomic reviews with user-friendly keys. The most recent issue to appear (Tabanidae of Canada, east of the Rocky Mountains 1: a photographic key to the species of Chrysopinae and Pangoniinae) came out this summer, two other papers are currently out for review, two are back from review but not yet ready for posting, and about a dozen are in advance stages of preparation.

Many of the contributions in preparation are major reviews in the tradition of the highly regarded “Insects and Arachnids of Canada” series that was until recently published by NRC Research Press. That arrangement ended with the demise of the NRC Research Press monographs series and CJAI is now positioned to fill the void by accepting submissions of work originally drafted for the “Insects and Arachnids of Canada” series. We have encouraged all prospective authors to that series, and especially those who were left with manuscripts already completed or partly completed for NRC press, to publish with CJAI. Most authors are enthusiastic about the CJAI alternative, and we are looking forward to some major contributions that would otherwise have been paper publications put out by NRC press. CJAI is the perfect venue for this kind of work because of the potential for fully utilizing large numbers of high-quality color photographs, the desirability of making keys digital and interactive, and because of the wide readership ensured by open access.

Another possible partnership for CJAI is under discussion with the Encyclopedia of Life (EOL) project. EOL is interested in developing a system for routine “harvesting” of species pages from CJAI. Since most CJAI publications are keys that lead to taxon pages (genus pages, species pages) for each terminal taxon, this seems like an attractive idea from the EOL perspective. The taxon pages provided by our authors are authoritative, reviewed, and usually accompanied by high-quality images, so access to CJAI pages will be a great boon to EOL. This will mean asking our authors to indicate whether they are willing to grant (or not grant) permission to EOL to harvest their pages and post them (with full attribution) on the EOL site. That will put the onus on our authors to ensure that all images used in their pages are available on a Creative Commons license (making them freely available for use by anyone) if they want their pages posted to EOL. This differs from our current policy which explicitly leaves image copyright with the photographers, so harvesting of their species pages by EOL (as opposed to linking, which is already routine and encouraged) may not be acceptable to all authors. Even if authors choose not to make their content available through a Creative Commons agreement, they will be encouraged to standardize their taxon pages so they are more in line with EOL species pages while at the same time enhancing the “common look and feel” of CJAI papers.
Although we are striving for a “common look and feel” for CJAI we are also continuing to encourage a variety of formats including both dichotomous and non-hierarchical keys. Non-hierarchical keys (like LUCID) are relatively difficult to review and edit, and thus put an extra strain on our reviewers and section editors. Reviewers have so far generously supported CJAI with their time and expertise, and we hope that continues even at a time when many journals are struggling with “reviewer fatigue”. A new PowerPoint template developed by the journal has made it easier for authors who are not familiar with digital keys to produce high quality interactive keys with less demand on the journal for setting up pages. See http://www.biology.ualberta.ca/bsc/ejournal/tm_08/tm_08.html for an example of a recent key developed on that template.

We need more high-quality submissions to CJAI. As with any other journal, papers must be original and must serve a purpose. It is not the objective of CJAI to publish digital versions of material readily available in recent paper publications or other forms, but we welcome reviews that use new data, new images and new approaches to make identifications and related information newly available to a broad user community.

The CJAI is a product of the Biological Survey of Canada, and receives financial support from the Biological Survey Foundation.

CJAI 08: Tabanidae of Canada, east of the Rocky Mountains 1: a photographic key to the species of Chrysopsinae and Pangoniinae (Diptera: Tabanidae)

Anthony W. Thomas and Stephen A. Marshall
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Abstract. The family Tabanidae is characterized and interactive photographic keys are provided to the 3 subfamilies of Tabanidae in Canada east of the Rocky Mountains. Keys are also provided for the genera and species of the subfamily Chrysopsinae of this region (including 40 species of Chrysops Meigen [deer flies] and one species of Merycomyia Hine) and the genera and species of the subfamily Pangoniinae (one species of Goniops Aldrich and two species of Stonemyia Brennan) occurring in eastern and central Canada. Distribution maps for all species are provided, incorporating significant additional records since the most recently published maps (Teskey, 1990).
**Introduction**

*Arctic Corner* provides a forum for news and updates on research involving arctic arthropods. Contributions to *Arctic Corner* are welcomed by the Editor (see inside front cover).

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**The Birth of the University of Alaska Museum Insect Collection**

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I was honoured to accept a position on the Scientific Board of the Biological Survey of Canada as the first international member. I had long been aware of the BSC through its publications and newsletters and have always been impressed by the high quality of the organization and its products. This article is a summary of projects and growth at the University of Alaska Museum Insect Collection, which might be of interest to those studying the northern insect fauna.

Having spent three years working at the University of Calgary before taking the position as Curator of Insects at the University of Alaska Museum in 2006, I’ve learned a lot over the last six years about both the northern insect fauna and the entomologists who study it. Alaska was included in the Northern Insect Survey of 1947–1958 (Buddle et al. 2008) and has long been of interest to northern entomologists for good reason – it represents a key component important to unscrambling the biogeographic history of many northern insect lineages.

Alaska and the adjacent regions of Canada and northeastern Russia are a distinct biotic province, often referred to as Beringia. During the Tertiary, easternmost Asia and northwestern North America were fully connected and essentially identical biotically. Successive glacializations and sea level changes caused the repeated appearance and disappearance of the Bering Land Bridge throughout the Quaternary, creating conditions for a diverse biota to develop. The periodic flooding and the emergence of the Bering Land Bridge acted variously as a barrier, as a filter, or as a dispersal route. This complex biogeographic history has created a biota of vicariant taxa and intercontinental biogeographic disjunctions. Much of interior Alaska was not glaciated and acted as a refugium for taxa eliminated from glaciated regions.

In addition to this complex biogeographic history, the northernmost latitudes are warming more rapidly than any other region on Earth (Serreze et al. 2000) and alarming ecological and physical changes are being seen in Alaska (Chapin et al. 2006). The boreal forest which dominates much of this northern landscape
is the coldest forested biome on Earth and is filled with organisms adapted to low temperatures. Alaska has warmed about 4°F since the 1950s and 7°F in the interior during the winter. The growing season has lengthened by about two weeks, shrubs are invading the tundra and permafrost and glaciers are melting (Stone et al. 2002, Lawrence & Slater 2005, Sturm et al. 2005, McGuire et al. 2009).

The climate of Alaska is rapidly changing and we are ill prepared to understand the ecological community-level changes that are bound to result because we do not know the majority of the “players” involved. Our knowledge of the arthropod fauna is at least half a century, or more, behind that of the vascular plants which were monographed by Hultén (1968). We expect to see disruptions, losses, and gains to the Alaskan insect fauna as ranges shrink and expand. Documenting these changes requires solid baseline knowledge and extensive sampling.

Into this arena I arrived in 2006 to build the University of Alaska Museum’s insect collection into a valuable state, national, and international resource. The insect collection is our museum’s youngest and is in the greatest need of major curatorial attention. It was started with National Science Foundation support in the year 2000 under direction of interim Curator Dr. James Kruse and built from three large accessions of Alaskan specimens: ~50,000 specimens of Alaskan aquatic insects (Ephemeroptera, Diptera, Plecoptera, Trichoptera, etc.) stored in glass vials and preserved in ethanol, ~30,000 biting fly specimens (mostly Culicidae and Simuliidae) on pins and in vials of alcohol collected by K.M. Sommerman during the Northern Biting Fly survey of 1947-1958, and ~75,000 pinned terrestrial insect specimens collected between 1940 and the mid 1970s for a US Department of Agriculture collection in Palmer, Alaska. This last collection has the greatest taxonomic breadth of the three, with specimens from almost all orders found in Alaska, including some rarities (e.g. Archeognatha). Specimens of this collection were determined by world authorities of the time, (e.g. Sabrosky, Lindroth, Townes, Franclemont, Muesebeck, Stone, and Krombein), many at the USNM. These accessions remain in deteriorating cabinets dating to the age of the specimens themselves although new cabinets are on the way! (See NSF grant below)

Smaller subcollections were also present before I arrived, including 24 boxes of primarily bee voucher specimens collected by John Bishop. Newer collections generated post 2000 included 149 specimens collected by J. Kruse from the Koyukuk-Nowitna National Wildlife Refuge / Nogahabara Dunes. A fairly large collection (993 specimens) from the Arctic National Wildlife Refuge produced in the late 1990s was also donated.

The majority of Alaskan insect taxa are currently missing from the collection. A species-level inventory of the collection has so far yielded 1,245 identified species while estimates for the state total of non-marine arthropods are above 7,000 species.

Maintaining, enhancing, and enlarging the collection.

As can be seen in Figure 1 the collection, as measured by catalogued specimens, has grown enormously over the last three years. However, many tens of thousands of uncatalogued specimens remain in our backlog of historical material and newly accessioned unprocessed material so although we have over 46,000 specimens catalogued, the collection probably contains over 200,000 specimens altogether. I am pleased we now at least have an inventory of all the identified species in the collection so although we currently lack a complete catalogue of our specimens, we at least know what species are present. We are aggressively databasing specimens and given the relatively small size of our collection, hope to complete this task within the next few years.

Although the majority of specimens catalogued into the UAM Insect collection were
collected by collaborators, volunteers, donors, and independent researchers, (many well before I arrived at UAF), I have personally collected or managed the collection of over 9,800 now processed and catalogued specimens from 170 Alaskan collection sites. Major expeditions are listed below:

2007 – Alaska Peninsula: In June, I visited the Peninsula National Wildlife Refuge in King Salmon and trained their field technicians on collecting methods (pitfall and hand collecting) as part of a USFWS contract with the University of Alaska Museum. This contract resulted in 1,907 catalogued specimens.

2007 – Interior: In August, I took part in a Bureau of Land Management sponsored float trip on Beaver Creek in the White Mountains for 4 days. Specimens collected on this trip included the first interior Alaskan records of the arachnid order Pseudoscorpiones and first state record of the family Membracidae.

2008 – Arctic: In June and July, I traveled the Dalton Highway to Toolik Lake Field station on the North Slope, collecting along the way and establishing a latitudinal transect of collection stations using Flight Intercept Traps and pitfall traps. Leaf litter arthropods were also sampled using Berlese funnels. Important baseline data were recorded for comparison with future samples. Coleoptera and Hymenoptera from this effort have been catalogued (1,887 specimens).

2008 – Aleutians: In June, as part of contract work with the USFWS Maritime National Wildlife Refuge, I traveled aboard the USFWS research vessel Tiglax to visit and document the terrestrial arthropods of various Aleutian Islands. In addition to the discovery of two salpingid beetle species apparently new to science (collaborative project with V. Gusarov), I was fortunate to visit the island Kasatochi, which two months later erupted violently, virtually sterilizing the island. I am now part of a large team of scientists working together to document the island’s regrowth. This inventory work also involved training USFWS technicians to run pitfall and Malaise traps which have since yielded 4,608 catalogued specimens from a very poorly documented part of the world.

2008 – Southeast Alaska: In September I was invited to give a talk at the University of Alaska Southeast in Sitka. I used the opportunity to make my first collections of southeast Alaskan arthropods which belong to ecosystems (temperate coastal rainforests) that are dramatically different from interior Alaska. This produced a series of specimens for many species previously absent from the UAM collection including the first Alaskan diplopods for the collection.

2009 – Aleutians: In July and August I made two expeditions to the Aleutians. The first was a general inventory of arthropods from various islands. On this trip I was joined by three Canadian entomologists, Henri Goulet, Anaïs Renaud, and Caroline Boudreaux. This trip established collaborations which will benefit all our institutions.

The second trip was to return to Kasatochi one year after it had erupted. I expected there to be no surviving arthropods but was surprised...
to find at least 13 species (only a few of which seemed to be breeding). Research on this volcano has led to considerable press coverage including an international radio interview for PRI / BBC’s ‘The World’.

**Loans and exchanges.** Table 1 shows the number of loans in-state, out of state, and internationally since the start of the collection. Exchanges of specimens have happened at a small scale but most collections improvement results from donations and expeditions.

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We have also been fortunate to have a number of entomologists visit the state within the last three years to collect who have improved our collections with new specimens and identifications. Among these include Charles Triplehorn, Charlie and Lois O’Brien, David Maddison, Robert Davidson, Robert Acciavatti, Drew Hildebrandt, Terry Whitworth, James Woolley, Chris Dietrich, and Henri Goulet. Given our remote location, with only two PhD level systematic entomologists in the state, and currently still small and partially unorganized collection, we are very appreciative for the help! Once we’ve completed our reorganization funded by NSF we’d love to host a BSC Curation-Blitz.

**UAM Database – Arctos.** Online documentation of the UAM collections is among the most sophisticated and publicly accessible anywhere. Arctos is a multi-institutional, permanently (and only) online database designed with industrial strength features akin to the systems used by banks and airline companies.

Mammals were the first UAM collection in the Museum database. Arctos (http://arctos.database.museum), is a system based on the data model developed by Berkeley’s Museum of Vertebrate Zoology (the “MVZ Model”), an extension to a modeling exercise (the “ASC Model”) by the Association of Systematic Collections (now NSCA) in 1993. Arctos was the first complete implementation of that entire model. It is a suite of applications written in ColdFusion-7 running over Oracle-10g so that the working database and the public online database are one and the same (there is no “off-line” version). Strong security and account systems control who can edit records. Arctos is on two Linux servers hosted by a wholly owned subsidiary of the Golden Valley Electric Company known as AlasConnect. This solution affords great stability and safety to the database.

UAM has generalized the MVZ Model to include invertebrates and plants, and there are now 176,477 northern plant records in Arctos. The system maps collecting localities to a GIS viewer (BerkeleyMapper) and includes detailed relationships of specimens to publications. It also relates loans and accessions to projects, and thereby relates projects to each other through loans and accessions. We are aggressively georeferencing specimens following GBIF’s “Guide to Best Practices for Georeferencing” (Chapman & Wieczorek, 2006) so their data are available for dynamic mapping and GIS analyses.

Both the Harvard Museum of Comparative Zoology (MCZ) and the Museum of Vertebrate Zoology at Berkeley are each running clones of Arctos and each has approximately two full-time programmers collaborating on continuing development. Records from the University of New Mexico’s Museum of Southwestern Biology comprise almost half the records in our Fairbanks server.

Arctos is evolving steadily, and its usage has been increasing. In the first six months of 2009, Arctos served 384,198 pages to 18,226 unique visitors who made 32,259 visits to the database website (55% of these were new visitors). 2,085 users have created personal log-ins
allowing them to customize the interface for more advanced searches on Arctos.

Arctos runs a DiGIR provider, and thus provides its records to the Global Biodiversity Information Facility (GBIF) and similar portals. UAM’s Arctos was the first database to establish reciprocal links between museum catalogue records and GenBank’s DNA sequence accessions. In addition to searching UAM’s database for data or specimens, users are now coming directly to specific records from the DiGIR portals and GenBank’s “LinkOuts.” Almost half of Arctos users go directly through the Arctos interface (40%), while 24% of users are referred from Google, and 14% from GenBank.

Images have been included in Arctos as “virtual specimen parts” (a category which will soon include digitized audio and video as well), but as part of the present NSF BRC funding to the UAM Herbarium, we have developed protocols to store specimen-based images at the Texas Advanced Computing Center with reciprocal linkages to and from Arctos, analogous to the arrangement with GenBank. For the Herbarium project, TACC has agreed to archive 200,000 17-megapixel images. These images are being accessed by users online at a rate of over 1,000 per month.

Not surprisingly, given the young age of the UAM Insect Collection, there are not many insect records in Arctos yet (10,892) and we have yet to fully transfer our cataloguing system to Arctos. This will be a task our soon-to-be-hired Collection Manager will help accomplish.

Arthropods of Alaska Checklist. The arthropod fauna of Alaska is one of the most poorly known of any US state. With the exception of a few well studied groups, there are no checklists and entomologists continue to find new state and continental records of higher taxa, in addition to undescribed species. Commonly encountered species in the Fairbanks area have yet to be published as members of the Alaskan fauna. This lack of historic faunistic knowledge makes it difficult to identify changes, but it is never too late to establish baselines.

In 2008 with funding from NSF-EPSCoR (Experimental Program to Stimulate Competitive Research) we consolidated information on this fauna from three sources: 1) published literature, 2) the UAM Insect collection and the Canadian National Collection (CNCI), and 3) a sampling transect running north from Fairbanks (65°N) to an arctic field site (Toolik LTER, 68.6°N), to provide a solid base of information for future research. This effort builds on the Alaska Insect Survey Project initiated by J. Kruse and described briefly in BSC Newsletter vol. 21(1) (Kruse 2002) and includes many cooperators in Alaska, including checklist efforts by the USDA.

Literature records for Alaskan arthropods were consolidated from 227 publications representing 6,149 species. Prior to this award, our list stood at 1,831 species. Records from the UAM and CNC insect collections, combined with recently collected specimens (2,094 from the transect described above), have added another 772 species, all unreported from Alaska in the literature and are thus new state records, for a total of 6,921 species. Many of these records require additional vetting so these
numbers are not final. In addition, 512 species are tentatively flagged as potential Alaskan endemics – known so far from no other region on Earth. We are eager to join with those interested in collaborating in these efforts and, of course, happy to loan specimens!

**National Science Foundation – Biological Research Collections.** In early 2009 a proposal submitted to NSF was funded. This award enables us to replace the insect collection’s aging compactor units and unsound cabinets with new compactors from SpaceSaver and Delta Design cabinets, providing a substantial increase in available collection space. This upgrade will virtually eliminate dangers to specimens from pests, relieve overcrowding, enable a consistent taxonomic organization of the entire collection, make specimens safely accessible, facilitate specimen databasing and digital photography efforts, and provide significant room for future growth. Two graduate students, Jozef Slowik and Brandi Fleschman, (both working on Alaskan spiders), and two undergraduate students have been hired and are being trained in collections-based entomology and public outreach. To date, we’ve transferred the alcohol collection from cardboard boxes previously stacked on top of the pinned specimens cabinets, to vial unit trays on open metal shelving in our new wet storage room. A search to hire a Collections Manager is almost complete.

The UAM Insect Collection is becoming a valuable state resource for agencies such as the United States Fish and Wildlife and the United States Department of Agriculture. We’ve recently accessioned most of Dominique’s Collet’s private research collection (over 8,000 specimens from the Kenai Peninsula, including the first Strepsipteran for the state) and anticipate accessioning the bulk of Kenelm Philip’s private collection of Alaskan butterflies. The Alaska Entomological Society is now three years old and although it’s challenging to manage a society across such vast distances as Juneau to Fairbanks, the society has helped entomologists stay informed about each other’s work. In short, the last three years have been an exciting phase of rapid growth, hiring, and exploration of Alaska’s entomofauna and we look forward to a bright future.

**References**


*Editor’s note: see p. 34 for news of another northern collection donation to the U of Guelph museum.*
Bylot Island and the Northern Biodiversity Program: Ongoing Studies about Arctic Entomology and Arachnology

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Research in Canada’s north is increasing in popularity, and for good reason. It is well known that Arctic ecosystems are fragile, and under significant threat due to factors such as climate change and increased industrial activity. From a political standpoint, issues about northern sovereignty are frequently in the public eye, and our politicians seem to be making quite regular trips to the North. The Canadian entomological community has a long history of excellence in the North, and I am pleased to report on two exciting, ongoing studies that reflect some of the current research in Arctic Canada.

Bylot Island

Many decades ago, wildlife biologists documented the importance of Bylot Island to migratory birds, notably Snow Geese. Bylot Island is part of Sirmilik National Park, and is located at the northern tip of Baffin Island, relatively close to Pond Inlet. The Centre d’études nordiques and its associated scientists, universities, and governmental institutions, have established permanent research camps on Bylot, with the overarching objective to better understand the entire ecosystem, from permafrost to insects to wildlife. I was fortunate enough to visit Bylot in June 2009, and can report that it is a breathtaking place, for its beauty as well as its arthropod fauna.

There are important entomological and arachnological connections to the bird fauna of Bylot Island, and it is recognized by the wildlife biologists that the fitness of many of the breeding birds is related in important ways to arthropods. Several years ago, Professor Joël Bêty (Université du Québec à Rimouski) began working more formally on this research theme, and he and I currently co-supervise a Master’s student (Elise Bolduc) on a project about the phenology of insect and spiders in Arctic Canada, with the goal of relating peaks in activity with the timing of when insectivorous birds breed and produce their clutches in tundra habitats. The work actually expands beyond Bylot Island, as the larger team associated with the International Polar Year’s ArcticWOLVES project has sampled arthropods in several localities.
including, among others, Southampton Island and Herschel Island.

**Northern Biodiversity Program**

The second initiative is about the revival of the Northern Insect Survey (NIS). Fifty to sixty years ago, Canadian entomologists made impressive collection forays into dozens of boreal, subarctic and arctic sites as part of the well known Northern Biting Fly Program and the NIS. Several years ago, a group of scientists (primarily associated with the Biological Survey of Canada Scientific Committee) believed the time was right to initiate a large-scale research program to revisit and resample some of the NIS sites. This was a unique use of the BSC’s expertise, and points to how the BSC is moving towards a new research agenda in addition to its other initiatives. Members of the BSC are partnering, under the broader BSC umbrella, to seek funding for specific projects. The new project is broadly titled the Northern Biodiversity Program, and reflects our goal of increasing the taxonomic scope beyond the boundaries of Entomology. We look forward to working with many other scientists and collaborating organizations as the project develops over time.

The first phase of the Northern Biodiversity Program is underway: Doug Currie (Royal Ontario Museum, and University of Toronto), Donna Giberson (University of Prince Edward Island), Terry Wheeler (McGill University) and I have initiated a project titled “Ecological Structure of Northern Arthropods: Adaptation to a Changing Environment”. Together with a host of collaborators (notably the BSC, the Canadian National Collection of Insects (CNCI), the Canadian Museum of Nature, the Canadian Centre for DNA Barcoding, Natural Resources Canada, and many northern partners), this three year project will focus on sampling 12 of the original NIS sites (Fig. 1), and will catalog historical specimen data from the CNCI to look retrospectively at how the fauna

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**Fig. 1.** Twelve sites, across four Canadian provinces, three territories, and three ecoclimatic zones, selected for phase 1 of the Northern Biodiversity Assessment. Square brackets indicate the old place name if a change in locality name occurred since the original Northern Insect Survey of 1947-1962.
has changed in the past 50-60 years. Our project will involve training many graduate students and a post-doc, and includes funding related to entomological training and education in the communities of Kugluktuk (Nunavut) and Norman Wells (Northwest Territory). This is an exciting project, but it is only one step towards the larger goal of a more complete assessment of biodiversity in Canada’s North. We are in the process of seeking partners and other collaborations to make this happen.

In summary, research related to entomology and arachnology in Northern Canada is alive and well. The time is right for entomologists in Canada to return to a strong northern focus and show how we can use our ecological and taxonomic skills to better understand northern Canada’s biological wealth.

**Web Links:**

Bylot Island:  
http://www.cen.ulaval.ca/bylot/

Photographic journey of Bylot Island:  
http://www.blurb.com/bookstore/detail/771535

Centre d’études nordiques (CEN):  
http://www.cen.ulaval.ca/

ArcticWOLVES:  
http://www.cen.ulaval.ca/arcticwolves/en_intro.htm

Biological Survey of Canada’s Vision Statement for Northern Biodiversity Assessment:  
COSEWIC Insect Assessments – Processes, Achievements and Advantages

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Background

“While there is life there is hope” was the way we began a regular university lecture on the protection of biodiversity in the 1990s. Among the multitude of errors made by humans during our stewardship of planet earth, there are occasional actions that provide hope. One of these, for which Canadians can be proud, occurred in 1992 when Canada became the first industrialized nation to sign the international Convention on Biological Diversity (CBD). Most other countries followed. The proclamation of the Species at Risk Act (SARA) in 2003 fulfilled a key obligation under the Convention. Of course protecting species requires an assessment of which species are at risk. This is the job of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Due to their variety and numbers, insects are hugely important. Their decline has significance for the entire ecosystem because so many other species depend upon them. In Canada 30,000 different species of insects are known (named and described) and an estimated additional 25,000 others are unknown (known but undescribed or expected). Because humans are relatively large animals, biological research (including conservation biology) is strongly biased toward the larger but least functionally significant groups, the vertebrates (Samways 1993). Canada has less than a hundred entomologists studying basic ecology and systematics of insects and arachnids (for past figures see Danks and Goods 1997). Clearly we cannot study the status of all Canadian insects all at once, nor do we need to, since species within a few groups can act as useful indicators. Analyzing the conservation status of individual insects provides accurate information that becomes part of an understanding of environmental changes. Official assessments of conservation status by COSEWIC lead to programs and research of both a general and specific nature that at the same time provides a basis for specific conservation actions and improves our general understanding of the state of the environment.

About COSEWIC

COSEWIC can be traced back to a time prior to the first meeting of the CBD. It began with a national symposium organized by the Canadian Nature Federation and the World Wildlife Fund in May 1976 http://www.cosewic.gc.ca/eng/sct6/sct6_3_e.cfm#his Shank 1999, Hutchings and Fiesta-Bianchet 2009). This symposium entitled “Canada’s threatened species and habitats” recommended the establishment of a committee consisting of representatives of the Federal and Provincial governments as well as appropriate conservation and scientific organizations for the purpose of establishing the status of endangered and threatened species and habitats in Canada. The Com-
The committee on the Status of Endangered Wildlife in Canada (COSEWIC) was established in 1977 by the Federal-Provincial-Territorial Wildlife Directors (FPTWD) and the first status designations were made in April 1978. Although the committee continues to improve its operating procedures (now covered by an extensive and detailed manual of 308 pages), the basic composition and objectives of have not changed. COSEWIC has now provided 32 years of science-based assessment of the status of wildlife species at risk in Canada and has assessed 585 species, 33 of which are insects.

**COSEWIC membership**

COSEWIC has 31 voting members. The voting includes (1) a member from each of the 13 provincial and territorial government wildlife agencies, (2) 4 federal agencies (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), (3) 3 non-government science members, (4) 10 co-chair votes (shared by pairs of co-chairs of the 10 Species Specialist Subcommittees (SSCs) including marine mammals, terrestrial mammals, birds, reptiles and amphibians, freshwa-
ter fishes, marine fishes, arthropods, molluscs, vascular plants, and mosses and lichens, and (5) 1 Co-chair from the Aboriginal Traditional Knowledge (ATK) Subcommittee.

Co-chairs are elected by COSEWIC following a competition and serve a 4-year term. SSC members are elected by the SSC also for a 4-year term. The co-chairs of taxonomic groups are responsible for reading and voting on status reports for groups other than the groups they represent as experts. Co-chairs also participate in many other aspects of the committee (renewal, policies, processes). SSC members serve as advisors regarding a specific group. They review status reports, gather information on candidate species and threats, prioritize the candidates and recommend status.

In so far as possible, SSC members are selected so that expertise is available for all of Canada and for all taxon subgroups that are covered by the SSC. The SSC membership varies in number depending on the taxonomic group. The Arthropod SSC currently has 17 members: Gary G. Anweiler, Robb Bennett, Robert A. Cannings, Paul M. Catling (co-chair), Sydney G. Cannings, Heather Flynn, Henri Goulet, Ronald Hooper, Donna Hurlburt, Dan L. Johnson, Colin Jones, Ross Layberry, David McCorquodale, James Miskelly, Lawrence Packer (co-chair), Gregory R. Pohl, and Rob Roughley (until his passing on 9 November 2009).

COSEWIC is supported by a Secretariat which is part of Environment Canada and includes 13 permanent staff. Each pair of co-chairs and the SSC is supported by a scientific project officer who assists the co-chairs and completes all business relating to contracts for status reports and maintains records and schedules. Monique Goit is the scientific project officer for the Arthropod co-chairs and SSC.

Co-chairs and members of SSCs are dedicated to the protection of biodiversity. Co-chairs who are working outside government receive a small amount of compensation for their time. Co-chairs with government jobs, who have been given permission to work on COSEWIC-related work during business hours, work for free although their travel and accommodation expenses to meetings are paid. SSC members receive no compensation, although their travel and accommodation expenses to meetings are also paid. With such a high level of expert volunteer support based on dedication of Canadian biologists to the natural environment, COSEWIC is a model of government cost efficiency. For more information on the composition of COSEWIC see http://www.cosewic.gc.ca/eng/sct6/sct6_4_e.cfm

COSEWIC process

The COSEWIC assessment process involves 4 steps:

1) development of a candidate list within an SSC,
2) ranking of candidates suggested by all SSCs,
3) commissioning and writing of a status report,
4) a series of reviews followed by an evaluation by COSEWIC at species assessment meetings in April or November.

The SSC develops a list of candidate wildlife species (taxa) that are believed to be at risk and likely to meet risk assessment criteria. This is done by systematically reviewing the status of all species in a group and/or by communicating with experts on particular groups. The candidates are then prioritized by the SSC at their annual meeting and the highest priority species are submitted to COSEWIC for status report production. See also “Recommending candidate species …” below and Appendix Table 1 for an example of the information needed to assess species.

The highest priority species from all 10 SSCs are then reviewed and ranked by COSEWIC in descending order of priority. As time and resources allow, COSEWIC will commission status reports for these highest priority species so that an assessment can be undertaken.
Status reports for selected candidate species and for species already assessed by COSEWIC that require a reassessment are commissioned by COSEWIC though a Call for Bids from prospective report writers. These are evaluated by a subset of the SSC, comprising members whose geographic and taxonomic knowledge most closely fits the taxon being bid upon, while also taking into consideration the need for approximately equitable workloads among members.

Selected report writers are provided with a standard COSEWIC status report formatting template. The first version of the status report produced by the report writer is called the “draft status report” and is reviewed over a 3 month period by relevant federal, provincial and territorial jurisdictions, SSC members and members of the ATK (Aboriginal Traditional Knowledge) Subcommittee. It may also be reviewed by chairs of recovery teams, wildlife management boards (WMBs) and external experts (inside or outside government agencies). Following the review period, reviewer comments are incorporated by the report writer in consultation with the responsible co-chair. This leads to a “provisional status report” at which point the involvement of the report writer is concluded. Once the provisional report has been reviewed and accepted by the responsible co-chair, it is sent to the same list of reviewers for a second 3-month review as an “interim report” which must be sent at least six months before a COSEWIC Wildlife Species Assessment Meeting. Following the second review period, comments are incorporated into the status report by the responsible co-chair. At this point a “final interim report” which includes the recommendation of status from the SSC is distributed to all members of COSEWIC for discussion at the upcoming Wildlife Species Assessment Meeting. The final interim reports must be sent to COSEWIC members at least two months before the meeting.

At the COSEWIC Wildlife Species Assessment Meeting, the responsible co-chair presents the species to COSEWIC members who will have reviewed the status report beforehand and submitted a straw ballot that states whether they agree with the SSC’s designation and, if not, what status they consider to be more appropriate. The committee considers 3 aspects before accepting a status report:

1) Is there sufficient information presented in the report to determine wildlife species eligibility?

2) Given sufficient information, is the wildlife species eligible for assessment?

3) Is the status report adequate and acceptable for assessment purposes?

Once the status report has been accepted, the Committee proceeds to discuss the appropriate status designation. As a first step in this deliberation, information in the status report is used to assess the species according to the quantitative COSEWIC criteria. These are extensive but can be summarized under 5 considerations:

A. Decline in Total Number of Mature Individuals;

B. Small Distribution Range and Decline or Fluctuation in Numbers;

C. Small and Declining Number of Mature Individuals;

D. Very Small or Restricted Total Population; and

E. Quantitative Analysis.

These criteria are based on the revised International Union for Conservation (IUCN) Red List categories (IUCN 2001, Mace et al. 2008). As a final step in the assessment process, the Committee considers all the information, analysis, and discussion presented at the meeting, and evaluates whether the status category suggested by the application of the criteria and guidelines is consistent with the definition of the status category used by COSEWIC. The status categories are:

**Extinct (X)** – A wildlife species that no longer exists.
Exirpated (XT) – A wildlife species that no longer exists in the wild in Canada, but exists elsewhere.

Endangered (E) – A wildlife species facing imminent extirpation or extinction.

Threatened (T) – A wildlife species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction.

Special Concern (SC) – A wildlife species that may become threatened or endangered because of a combination of biological characteristics and identified threats.

Data Deficient (DD) – A category that applies when the available information is insufficient (a) to resolve a wildlife species’ eligibility for assessment or (b) to permit an assessment of the wildlife species’ risk of extinction.

Not At Risk (NAR) – A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.

The result of these considerations is a recommended status and an alpha-numeric code which refers to specific details about the assessment. This recommendation is voted upon by COSEWIC members (e.g. a status of ENDANGERED, B1ab(iii), B2ab(iii) refers to a species that has a Canadian range of less than 5,000 km², an index of area of occupancy of less than 500 km², severely fragmented populations and continuing decline in extent or quality of habitat). Next the results are reported to the Canadian government and the public. Following the Minister of the Environment’s official response to the assessment results, wildlife species that have been designated by COSEWIC may then qualify for legal protection and recovery under the Species at Risk Act (SARA).

The preceding is a rather extreme simplification of a comprehensive process that is governed by an extensive and detailed operations and procedures manual. For more information on all aspects of COSEWIC, including a document detailing COSEWIC’s assessment process and criteria, see http://www.cosewic.gc.ca/eng/sct6/index_e.cfm. The rigor of the procedure can be readily perceived through the fact that each report is reviewed on at least 4 occasions and by a total of over 50 individuals.

Relationships

(1) General Status

The National General Status Working Group (NGSWG) was established in 1998 by the Canadian Wildlife Directors to meet commitments of monitoring and reporting on the status of wildlife (http://www.wildspecies.ca/home.cfm?lang=e, Twolan and Nadeau 2004) as required under the Accord for the Protection of Species at Risk (Environment Canada 1996). While COSEWIC is aimed at providing detailed information on species at risk to support SARA and protect endangered species, NGSWG is intended to reveal general trends in the status of species within a broad range of taxonomic groups over time. NGSWG status ranks are determined by the group (representatives of each Canadian province and territory as well as representatives of three federal agencies) working with teams of experts. The categories used in general status assessments include “at risk”, “may be at risk” and “sensitive”. These categories are useful to COSEWIC in determining candidates. COSEWIC assessments are especially useful to NGSWG in assigning species to the “at risk” category (as are the legal lists of provincially endangered species).

(2) SARA

COSEWIC assessments are the basis for legal listing of species at risk. In June 2003, the Species at Risk Act (SARA, Government of Canada 2002, www.sararegistry.gc.ca) established COSEWIC as an advisory body, thus ensuring the continuation of assessments using the best available information. SARA is intended to prevent wildlife from becoming extinct and to secure the necessary actions for their recovery. It provides for the legal protection of wildlife species and the conservation of their biological diversity.
There is often misunderstanding about what SARA applies to and especially how it affects private landowners. This results in landowners denying access to biologists studying important populations. Prohibitions under SARA do not apply to insects on private land. For more information on what is covered by SARA see [http://www.sararegistry.gc.ca/involved/you/privland_e.cfm](http://www.sararegistry.gc.ca/involved/you/privland_e.cfm).

(3) Recovery

The assessments of COSEWIC are science-based, independent, transparent and not concerned with consequences. This contributes to a reliable assessment. The consequences are mostly, if not entirely, beneficial. One of the purposes of SARA is to provide for the recovery of extirpated, endangered and threatened species, and to manage species of special concern to prevent them from becoming endangered or threatened. SARA therefore requires recovery strategies for all endangered species (see [http://www.sararegistry.gc.ca/sar/recov/ryn/background_e.cfm](http://www.sararegistry.gc.ca/sar/recov/ryn/background_e.cfm)). Recovery strategies are posted as final or proposed on the Species at Risk Public Registry ([https://www.registrelepsararegistry.gc.ca](https://www.registrelepsararegistry.gc.ca)).

Assessing Insects

The first assessments in the early days were for birds and mammals, later for fish, vascular plants and reptiles. In 1994, COSEWIC’s mandate was expanded to include arthropods. The first insect was assessed in 1997 when Karner Blue (*Lycaeides melissa samuelis*) was determined to be extirpated. It had not been seen despite extensive search since 1991. The assessment provided a basis of programs and research for its re-introduction through the work of the Ontario Karner Blue Recovery Team (established in 1991). Re-introduction had been successful in Ohio (Chan & Packer 2006). This first insect assessment also served to raise the profile of efforts to protect diminishing oak savannah habitat in Ontario (Packer 1991).

The first chair heading the Lepidoptera species specialist committee was Dr. Theresa Fowler of Environment Canada. This group of specialists systematically evaluated the risk status of all Canadian butterflies and also considered moths where information was sufficient. In 2003, COSEWIC received approval from the wildlife directors to begin assessing the status of arthropods other than butterflies and moths as an Arthropod Advisory Committee with two co-chairs. Dr. Paul Catling was elected as the 2nd co-chair, and took responsibility for other groups of Canadian insects. The next step was a systematic review of the status of Canadian dragonflies and crayfishes (Catling 2007) and a general survey of other insects. After 12 years of outstanding service Dr. Fowler stepped down in 2006 and Dr. Laurence Packer took over as
Representatives of three groups of arthropods not previously assessed by COSEWIC have status reports near completion. These are Canadian Philaronia (Philaronia canadensis – Heteroptera), the Georgia Basin Bog Spider (Gnaphosa snohomish - Araneae) and the Dune Tachinid (Germaria angustata – Diptera).

Some authors have suggested that the estimated number of insects at risk is low by at least an order of magnitude (Redak 2000). Currently 33 species of insects have been assessed and for 37 others, status reports are in preparation or the species have been defined as high priority candidate species for commissioning of a status report (Table 1). Of course it is likely that there are hundreds of insects at risk in Canada and the assessments do not indicate the total. They do however, provide some extremely useful information and they have led to actions that have protected many other species of conservation concern.

Just as we do not know exactly how many insects are at risk in Canada, we do not know how many we have lost. Not all of the likely extirpated species have been assessed by COSEWIC. Some like the Regal Fritillary (Lepidoptera: Speyeria idalia) in southern Ontario, may have been established or the few records that exist may have been because...
they were vagrants. All we know is that they are likely gone now. We believe that the Rocky Mountain Locust (Orthoptera: Melanoplus spretus) was extirpated before 1900, perhaps as a result of loss of riparian grassland in the west (Lockwood and DeBrey 1990) to grazing and tilling. The North American Burying Beetle (Coleoptera: Nicrophorus americana, Fig. 7) may also be gone. Its status in Canada is presently under review through a COSEWIC status report. The Giant Lacewing, Polystoechotes punctatus (Neuroptera: Polystoechotidae, Figure 8), historically known from BC, Alberta, Ontario and Québec, has evidently become very rare over extensive regions and may be gone from eastern Canada. How many other species have declined for the same unclear reasons as this conspicuous (large size and attracted to lights) indicator is anyone’s guess.

For information on other Canadian species at risk, see the publication entitled: “Canadian Wildlife Species at Risk” available on the COSEWIC website under Species Assessment: http://www.cosewic.gc.ca/eng/sct0/index_e.cfm. Results of recent assessments are available at the same location.

Table 1. Canadian insect species assessed by COSEWIC (shaded), those in process of having status reports completed, and top priority candidate species for status reports. Within each of these three groups, species are arranged by year of assessment, then alphabetically by scientific name. The table shows scientific name, common name, order, current status, date last assessed, province where the species occurs and ecozone (where number corresponds to those in Table 3).

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Order</th>
<th>Current Status</th>
<th>Date last Assessed</th>
<th>Province / Territory</th>
<th>Ecoreg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lycaenides melissa samuelis</td>
<td>Karner Blue</td>
<td>Lepidoptera</td>
<td>Extirpated</td>
<td>1997-04 ON</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Callophrys (Incisalia) irus</td>
<td>Frosted Elfin</td>
<td>Lepidoptera</td>
<td>Extirpated</td>
<td>1999-04 ON</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Euchloe auronides</td>
<td>Island Marble</td>
<td>Lepidoptera</td>
<td>Extirpated</td>
<td>1999-04 BC</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Euphydryas editha taylori</td>
<td>Taylor’s Checkerspot</td>
<td>Lepidoptera</td>
<td>Endangered</td>
<td>2000-11 BC</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Euphyes vestris vestris</td>
<td>Dun Skipper (western population)</td>
<td>Lepidoptera</td>
<td>Threatened</td>
<td>2000-11 BC</td>
<td>10</td>
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<tr>
<td>Limenitis weidemeyerii</td>
<td>Weidemeyer’s Admiral</td>
<td>Lepidoptera</td>
<td>Special Concern</td>
<td>2000-11 AB</td>
<td>12</td>
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<tr>
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<td>Island Blue</td>
<td>Lepidoptera</td>
<td>Endangered</td>
<td>2000-11 BC</td>
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<tr>
<td>Satyrium behrii columbia</td>
<td>Behr’s (Columbia) Hairstreak</td>
<td>Lepidoptera</td>
<td>Threatened</td>
<td>2000-11 BC</td>
<td>11</td>
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<tr>
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<td>Lepidoptera</td>
<td>Endangered</td>
<td>2002-05 AB</td>
<td>12</td>
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</tr>
<tr>
<td>Apodemia mormo</td>
<td>Mormon Metalmark (southern mountain population)</td>
<td>Lepidoptera</td>
<td>Endangered</td>
<td>2003-05 BC</td>
<td>11</td>
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<tr>
<td>Apodemia mormo</td>
<td>Mormon Metalmark (prairie population)</td>
<td>Lepidoptera</td>
<td>Threatened</td>
<td>2003-05 SK</td>
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<td>Copablepharon fuscum</td>
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<td>Lepidoptera</td>
<td>Endangered</td>
<td>2003-11 BC</td>
<td>10</td>
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<tr>
<td>Hesperia dakotae</td>
<td>Dakota Skipper</td>
<td>Lepidoptera</td>
<td>Threatened</td>
<td>2003-11 MB, SK</td>
<td>12</td>
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<tr>
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<td>Poweshiek Skippering</td>
<td>Lepidoptera</td>
<td>Threatened</td>
<td>2003-11 MB</td>
<td>12</td>
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<tr>
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<td>Ottoc Skipper</td>
<td>Lepidoptera</td>
<td>Endangered</td>
<td>2005-05 MB, SK</td>
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<td></td>
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<tr>
<td>Melaporphyria immortua</td>
<td>Dark-banded Flower Gem</td>
<td>Lepidoptera</td>
<td>Data deficient</td>
<td>2005-05 AB, MB, SK</td>
<td>12</td>
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<td>Province / Territory</td>
<td>Ecoreg</td>
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<tr>
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<tr>
<td>Schinia bimatris</td>
<td>White Flower Moth</td>
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<td>2005-05</td>
<td>MB</td>
<td>12</td>
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<td>Schinia verna</td>
<td>Verna’s Flower Moth</td>
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<td>TH - returned</td>
<td>2005-05</td>
<td>AB, MB, SK</td>
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<tr>
<td>Erynnis persius persius</td>
<td>Eastern Persius Duskywing</td>
<td>Lepidoptera</td>
<td>Endangered</td>
<td>2006-04</td>
<td>ON</td>
<td>14</td>
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<tr>
<td>Papatépema aweme</td>
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<td>Lepidoptera</td>
<td>Endangered</td>
<td>2006-04</td>
<td>MB, ON</td>
<td>12, 14</td>
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<td>Polites sonora siris</td>
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<td>Lepidoptera</td>
<td>Special Concern</td>
<td>2006-04</td>
<td>BC</td>
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<td>2006-04</td>
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<td>AB, BC</td>
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<td>Lepidoptera</td>
<td>Endangered</td>
<td>2006-04</td>
<td>AB, SK, MB</td>
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<td>Lepidoptera</td>
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<td>2006-04</td>
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<td>Pale yellow dune moth</td>
<td>Lepidoptera</td>
<td>Special concern</td>
<td>2007-11</td>
<td>AB, SK, MB</td>
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<td>Lepidoptera</td>
<td>Endangered</td>
<td>2007-11</td>
<td>AB, SK, MB</td>
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<td>Gonophus quadricolor</td>
<td>Rapids Clubtail</td>
<td>Odonata</td>
<td>Endangered</td>
<td>2008-04</td>
<td>ON</td>
<td>14</td>
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<td>Cobblestone Tiger Beetle</td>
<td>Coleoptera</td>
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<td>2008-11</td>
<td>NB</td>
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<td>Odonata</td>
<td>Special Concern</td>
<td>2008-11</td>
<td>NB, ON</td>
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<td>Maritime Ringlet</td>
<td>Lepidoptera</td>
<td>Endangered</td>
<td>2009-04</td>
<td>QC, NB</td>
<td>15</td>
</tr>
<tr>
<td>Anarta edwardsii</td>
<td>Edward’s Beach Moth</td>
<td>Lepidoptera</td>
<td>Endangered</td>
<td>2009-04</td>
<td>BC</td>
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<td>Lepidoptera</td>
<td>Special Concern</td>
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<td>New report</td>
<td>ON, QC, NB</td>
<td>14</td>
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<td>Hungerford’s Crawling Water Beetle</td>
<td>Coleoptera</td>
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<td>New report</td>
<td>ON</td>
<td>14</td>
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<td>Cicindela parowana wallisi</td>
<td>Wallis’ Dark Saltflat Tiger Beetle</td>
<td>Coleoptera</td>
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<td>New report</td>
<td>BC</td>
<td>11</td>
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<td>Northern Barrens Tiger Beetle</td>
<td>Coleoptera</td>
<td>NA</td>
<td>New report</td>
<td>ON, QC</td>
<td>14</td>
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<td>Cuckoo Bee</td>
<td>Hymenoptera</td>
<td>NA</td>
<td>New report</td>
<td>SK, MB, ON, NS</td>
<td>9, 12, 14, 15</td>
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<td>Mottled Duskywing</td>
<td>Lepidoptera</td>
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<td>New report</td>
<td>MB, ON, QC</td>
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<tr>
<td>Scientific Name</td>
<td>Common Name</td>
<td>Order</td>
<td>Current Status</td>
<td>Date last Assessed</td>
<td>Province / Territory</td>
<td>Ecoreg</td>
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<td>Germaria angustata</td>
<td>Dune Tachinid Fly</td>
<td>Diptera</td>
<td>NA</td>
<td>New report</td>
<td>YT</td>
<td>7</td>
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<tr>
<td>Gnaphosa snohomish</td>
<td>Georgia Basin Bog Spider</td>
<td>Araneae</td>
<td>NA</td>
<td>New report</td>
<td>BC</td>
<td>10</td>
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<td>Gomphus ventricosus</td>
<td>Skillet Clubtail</td>
<td>Odonata</td>
<td>NA</td>
<td>New report</td>
<td>ON, QC, NB, NS</td>
<td>14, 15</td>
</tr>
<tr>
<td>Hemileuca sp.</td>
<td>Bogbean Buckmoth</td>
<td>Lepidoptera</td>
<td>NA</td>
<td>New report</td>
<td>ON</td>
<td>14</td>
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<td>North American Burying Beetle</td>
<td>Coleoptera</td>
<td>NA</td>
<td>New report</td>
<td>MB, ON, QC, NS</td>
<td>14</td>
</tr>
<tr>
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<td>Heteroptera</td>
<td>NA</td>
<td>New report</td>
<td>ON</td>
<td>14</td>
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<tr>
<td>Prays atomocella</td>
<td>Hop-tree Borer</td>
<td>Lepidoptera</td>
<td>NA</td>
<td>New report</td>
<td>ON</td>
<td>14</td>
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<tr>
<td>Sanfilippodytes bertae</td>
<td>Bert’s Predaceous Diving Beetle</td>
<td>Coleoptera</td>
<td>NA</td>
<td>New report</td>
<td>AB</td>
<td>12</td>
</tr>
<tr>
<td>Somatochlora hineana</td>
<td>Hine’s Emerald</td>
<td>Odonata</td>
<td>NA</td>
<td>New report</td>
<td>ON</td>
<td>14</td>
</tr>
<tr>
<td>Stylurus laurae</td>
<td>Laura’s Clubtail</td>
<td>Odonata</td>
<td>NA</td>
<td>New report</td>
<td>ON</td>
<td>14</td>
</tr>
<tr>
<td>Stylurus olivaceus</td>
<td>Olive Clubtail</td>
<td>Odonata</td>
<td>NA</td>
<td>New report</td>
<td>BC</td>
<td>11</td>
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<tr>
<td>Copablepharon absidum</td>
<td>Columbia Dune Moth</td>
<td>Lepidoptera</td>
<td>NA</td>
<td>withdrawn 2009-04</td>
<td>BC</td>
<td>11</td>
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<tr>
<td>Argia vivida</td>
<td>Vivid Dancer</td>
<td>Odonata</td>
<td>NA</td>
<td>Candidate</td>
<td>AB, BC</td>
<td>11</td>
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<tr>
<td>Bembidion lachnophoroides</td>
<td>A Carabid Beetle</td>
<td>Coleoptera</td>
<td>NA</td>
<td>Candidate</td>
<td>AB, SK</td>
<td>12</td>
</tr>
<tr>
<td>Bombus ashtoni</td>
<td>Ashton’s Bumble Bee</td>
<td>Hymenoptera</td>
<td>NA</td>
<td>Candidate</td>
<td>AB, BC, MB, NB, NL, NS, NT, ON, PE, QC, SK, YU, NU</td>
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<td>Cicindela formosa gibsoni</td>
<td>Gibson’s Big Sand Tiger Beetle</td>
<td>Coleoptera</td>
<td>NA</td>
<td>Candidate</td>
<td>SK</td>
<td>12</td>
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<tr>
<td>Coccinella novemnotata</td>
<td>Nine-spotted Lady Beetle</td>
<td>Coleoptera</td>
<td>NA</td>
<td>Candidate</td>
<td>AB, BC, MN, NB, NS, ON, PE, QC, SK</td>
<td>10, 11, 12, 14, 15</td>
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<tr>
<td>Efferia sp.</td>
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<td>Diptera</td>
<td>NA</td>
<td>Candidate</td>
<td>BC</td>
<td>11</td>
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<td>Lepidoptera</td>
<td>NA</td>
<td>Candidate</td>
<td>BC</td>
<td>10</td>
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<tr>
<td>Hesperia colorado oregonia</td>
<td>Western Branded Skipper</td>
<td>Lepidoptera</td>
<td>NA</td>
<td>Candidate</td>
<td>BC</td>
<td>10</td>
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<tr>
<td>Hydroporus carri</td>
<td>Carr’s diving beetle</td>
<td>Coleoptera</td>
<td>NA</td>
<td>Candidate</td>
<td>AB</td>
<td>12</td>
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<tr>
<td>Hypochlora alba</td>
<td>Greenish-white Grasshopper</td>
<td>Orthoptera</td>
<td>NA</td>
<td>Candidate</td>
<td>AB, SK, MB</td>
<td>12</td>
</tr>
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</table>
There have been some useful regional considerations of threats noted in assessments (e.g. Guppy et al. 1994, Pohl 2008) and a consideration of the message regarding the conservation status of Canadian butterflies based largely on COSEWIC assessments was recently produced by Hall (2009). We are now in a position to consider trends nationwide. There are assessments for 33 insect species, but in addition there are 18 species for which status reports are underway and 19 candidates that have been carefully selected (Table 1). For all of these 70 species that are of high conservation concern, we have information on occurrence and threats. Although this sample is minute compared to the number of Canadian insects, it is nevertheless representative to a degree since it has involved a consideration of well known nationwide insect groups including all Canadian butterflies, all Canadian dragonflies and all Canadian Tiger Beetles. These groups occur across Canada and they include both predacious and non-predacious species and species of both aquatic and terrestrial habitats. The inclusion of miscellaneous species from other groups improves the sample. Consequently the coverage may be considered relatively reliable for drawing some preliminary conclusions. Although a detailed analysis is beyond the scope of this review (but is planned for a future...
issue of the *Journal of Insect Conservation*), there are some preliminary results regarding geography and threats that will be of interest to Canadian entomologists.

**Where are the problems?**

A number of analyses have shown that for all Canadian terrestrial species at risk, the largest number of species occur in Ontario and British Columbia and that the Mixedwood Plains, Prairies, and Pacific Maritime ecozones are major areas of concentration. The same is true for 70 insects listed in Table 1. The high number in the montane cordillera is largely due to the rapidly declining habitats in the Okanagan and southern Similkameen Valleys (Lea 2008).

Table 2. Canadian provinces showing the number of insects of conservation concern in each ecoregion based on COSEWIC assessment criteria (from Table 1).

<table>
<thead>
<tr>
<th>Province</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alberta</td>
<td>17</td>
</tr>
<tr>
<td>British Columbia</td>
<td>26</td>
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<tr>
<td>Manitoba</td>
<td>18</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>8</td>
</tr>
<tr>
<td>Newfoundland-Labrador</td>
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<tr>
<td>Nova Scotia</td>
<td>7</td>
</tr>
<tr>
<td>Northwest Territories</td>
<td>2</td>
</tr>
<tr>
<td>Ontario</td>
<td>24</td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>3</td>
</tr>
<tr>
<td>Quebec</td>
<td>10</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>13</td>
</tr>
<tr>
<td>Yukon</td>
<td>2</td>
</tr>
<tr>
<td>Nunavut</td>
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</table>

**What are the threats?**

Threats to Canadian species at risk have been reviewed by Ventor et al. (2006) and more recently by Hutchings and Fiesta-Bianchet (2009). These and most studies worldwide have identified habitat loss followed by invasive alien species as the major threats to terrestrial (non-marine) species (Vento et al. 2006). In the last analysis of Canadian insects, including 19 species of Lepidoptera, habitat loss was the major threat and losses due to agriculture and urban development were equally important (Ventor et al. 2006). However preliminary analysis of the information for 70 insects in Table 1 suggests that 30 are being impacted by urban expansion and 9 by agricultural expansion. Both of these threats exist across Canada, ranging from commercial cranberry production replacing habitat of the Georgia Basin Bog Spider, *Gnaphosa snohomish* (Araneae: Gnaphosidae, Bennett et al. 2006) near Vancouver to urban expansion reducing habitat and increasing vehicle impact mortality for migrating monarchs (*Lepidoptera: Danausplexippus*) in the east.

Table 3. Canadian Ecoregions showing the number of insects (far right column) of conservation concern in each ecoregion based on COSEWIC assessment criteria (from Table 1). *(Editor’s note: please see Fig. 1 on p. 41 to see a map of these ecozones)*

<table>
<thead>
<tr>
<th>Ecoregion</th>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>1 Arctic cordillera</td>
<td>0</td>
</tr>
<tr>
<td>2 Northern Arctic</td>
<td>0</td>
</tr>
<tr>
<td>3 Southern Arctic</td>
<td>1</td>
</tr>
<tr>
<td>4 Taiga Cordillera</td>
<td>1</td>
</tr>
<tr>
<td>5 Taiga Plains</td>
<td>2</td>
</tr>
<tr>
<td>6 Taiga Shield</td>
<td>3</td>
</tr>
<tr>
<td>7 Boreal Cordillera</td>
<td>3</td>
</tr>
<tr>
<td>8 Boreal Plains</td>
<td>3</td>
</tr>
<tr>
<td>9 Boreal Shield</td>
<td>3</td>
</tr>
<tr>
<td>10 Pacific Maritime</td>
<td>16</td>
</tr>
<tr>
<td>11 Montane Cordillera</td>
<td>16</td>
</tr>
<tr>
<td>12 Prairies</td>
<td>25</td>
</tr>
<tr>
<td>13 Hudson Plains</td>
<td>2</td>
</tr>
<tr>
<td>14 Mixedwood Plains</td>
<td>24</td>
</tr>
<tr>
<td>15 Atlantic Maritime</td>
<td>7</td>
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</tbody>
</table>
larly in south-central British Columbia, south coastal British Columbia and southern Ontario. These hotspots for insects and other animals and plants at risk are seriously lacking in protected areas (Kerr and Cihlar 2004, Warman et al. 2004, Deguise and Kerr 2006). Well-planned land securement and integration of conservation strategies with agricultural and urban land-use plans outside formally protected areas are key strategies (Samways 1993).

The other reported threats to insects identified to be of conservation concern in Canada cover a diverse range. Invasive terrestrial plants are the second most important threat, affecting 11 of the 70 species, and pollution affects 10 species. Interestingly tree or grass planting in natural habitats (and sometimes associated subsequent use of pesticides to protect the plantings) has threatened 9 species. Nine species are also threatened by succession and dune stabilization. Lack of fire threatens 9 species but fire is also a threat to some of these. The inconsistency in fire effects is to some extent a problem of scale since populations and habitats in extensive areas were never completely burned and recolonization was possible from unburned areas. Because some specialized habitats only remain as isolated fragments today, an entire population can be destroyed without hope of recolonization. A change in the nature of fires may be negatively impacting some fire-dependent species, for example in the Okanagan region of British Columbia, where fires may be less frequent but burn hotter due to accumulated fuel, especially that from invasive plants. Trampling and ATV use affected 9 species and overgrazing and trampling by cattle affected 6 species. Insect enthusiasts may take some comfort in the fact that collecting was identified as a threat to only 1 species.

The Monarch Butterfly (*Danaus plexippus*) is the only insect for which a genetically modified organism has been considered as a threat (Losey et al. 1999). In this case, an increasingly popular commercial corn has been genetically engineered to produce a bacterial toxin. Corn pollen is transported by the wind and accumulation of toxic pollen on milkweed leaves may kill butterfly larvae. The significance of this risk may be less than initially suspected (e.g. Sears et al. 2001).

Climate change has been listed as a threat for only one species. This is likely misleading, since in some cases the effects of climate change are difficult to evaluate because we often do not have comparable sampling data over sufficient lengths of time. It has likely already played a bigger role than we think in changes in the occurrences of insects in Canada (Kerr and Kharouba 2007). This is suggested by recently expanded distributions here and elsewhere (Parmesan et al. 1999, Kerr and Kharouba 2007). Disjunction and 1-3 % loss of current distributions of butterflies in Canada has been predicted (Peterson et al. 2004). Within fragmented natural landscapes many insects may be unable to spread into new areas and may also have a limited ability to keep track of suitable climates. In parts of Europe insects have been successfully introduced into northern areas beyond their northern range limits as southern populations declined (Willis et al. 2009).

**How much don’t we know?**

It is growing increasingly difficult to determine specific threats to species of conservation concern. In the past species were assessed...
for threats that were either clear, or we could formulate reasonable explanations for decline often involving a variety of factors, as for the North American Burying Beetle (*Nicrophorus americanus*, see Sikes and Raithel, 2002). Now we are assessing species that are showing huge declines, for example in some species of Bumble Bees (Colla and Packer 2008), the potential causes of which are less well understood.

The decline of many insect-eating birds is also somewhat of a mystery. Could it be the result of the decline of insects? At least some insect eating birds appear to have declined less in remote areas where insects have been affected less by pesticides, loss of natural ecological processes and numerous other threats.

The impacts of endangerment of insects on ecosystems is also poorly understood. Some insects at risk may always have had relatively little obvious impact on their environment. Others may have a disproportionately large effect and may act as keystone species. There are many examples of the decline of a single species affecting many others (Catling et al. 1998). A new development in Canada is the endangerment of keystone insects, for example, some of the pollinating Bumble Bees that were abundant and widespread a little more than a decade ago (Colla and Packer 2008). Many plants rely to a greater or lesser extent on these bees for pollination allowing reproduction and Bumble Bees are the only or primary pollinators of many plants including some that are already endangered like the Miccoosukee Gooseberry (*Ribes echinellum*, see Catling et al. 1998) Other plants relying on Bumble Bees provide fruit for mammals (including man) and birds, so loss of such insects could have serious results. The reasons for bee declines are poorly understood at the present time, although pathogen spillover from commercial bee populations introduced to pollinate greenhouse crops is likely a contributing factor (Colla et al. 2006).

It is probably best not think about the fact that 25,000 Canadian insects are unnamed and undescribed—basically completely unknown. We have undoubtedly lost some that we never knew. For science this is the loss of key elements of a jigsaw puzzle.

Fig. 6. Cobblestone Tiger (*Cicindela marginipennis*) is known in Canada only from New Brunswick. The first beetle to be assessed by COSEWIC, it has a very specific cobblestone shore habitat that is threatened and was assessed as ENDANGERED in November 2008. Photo by Dwayne Sabine, New Brunswick, 26 August 2004 (used with permission).

**Impact of COSEWIC assessments**

COSEWIC assessments do far more than simply contribute to a listing under SARA that in turn contributes to protection of a particular species. Some of the benefits that come immediately to mind are listed below:

1) increasing the profile for cooperative conservation actions and funding programs including recovery for individual species, groups of species and critical habitats.

2) providing criteria for securement and management of natural areas. Conservation areas selected on the basis of presence of a species at risk represent other taxa in need of protection significantly better than random choices (Warman et al. 2004).

3) providing information and education that contributes to an understanding of the state of Canada’s environment.

4) providing or aiding in securing funding support for the collection and analysis of data

5) sustainability of Canada’s natural resources

Number 4 should be of particular interest to Canadian entomologists. Currently, 18 status reports are underway, each gathering and syn-
thesizing entomological data, initiating hypotheses and leading to further work. These 18 reports are collectively valued at $135,000.00 paid to report writers. Listing a species under COSEWIC also often generates provincial funding for biological study or recovery programs. Two COSEWIC contracts have also recently been let to review some larger groups of arthropods. One contract valued at $20,000.00 is underway with the objective of gathering data from museum collections and analyzing it to determine whether native lady beetles (Coleoptera: Coccinellidae: Coccinellinae) are declining, to provide a basis for future candidate selections and assessments. The Arthropod SSC is also responsible for another contract valued at $20,000.00 aimed at evaluating the status of Canadian arthropods other than insects and arachnids. This will result in a valuable synthesis of scientific information and will provide the basis for a COSEWIC strategy for dealing with other arthropod groups.

The Arthropod Species Specialist Committee is one of the largest groups of directly co-operating entomologists representing all of Canada. Training workshops and presentations are a regular feature of annual meetings and are attended by as many guests as committee members.

**Recommending candidate species to the Arthropod SSC**

Several categories of information are required by the SSC in order to determine the level of importance of a particular candidate. The information can be brief and can be recorded easily by filling out categories on one or two pages (See Appendix 1). The one or two-page document used by the SSC is essentially the same as that used by COSEWIC to rank all candidates so as to decide on those for which status reports will be commissioned.

One of the most important pieces of information needed to rank species for COSEWIC is information on the decline of a species. This is a particular difficulty for insects. It is less of a problem with birds with so much census data and fishes with catch data. There is reliable information on the decline of a few groups such as certain lady beetles (Coleoptera: Coccinellidae - Cormier et al. 2000) and long-horned wood boring beetles (Coleoptera: Cerambycidae - McCrorquodale et al. 2007), and for a few species such as *Ceropales bipunctata* (Hymenoptera: Pomilidae – Godsoe 2003), *Tachysphex pechumani* (Hymenoptera: Sphecidae – Kurczewski 1998, 2000), *Polystoechotes punctatus* (Neuroptera: Polystoechotidae - Marshall 1996, 2006) and *Gomphus fraternus* (Odonata: Gomphidae – Catling 2001) in Lake Erie.

We have anecdotal information on decline of hundreds of species but real data is required to reliably indicate declines and suggest causes. Even some documented declines, such as that...
of *Hexagenia limbata* (Ephemeroptera: Ephemeroidea – e.g. Manny 1991) and other species of *Hexagenia* has reversed in many areas indicating the importance of current data. Entomologists can play an important role here in gathering the needed information. The lack of details on decline does not mean that the species can’t be assessed by COSEWIC, however. Decline of habitat can be used as a surrogate to population decline and this can often be quantified in some way.

Another important piece of information for species assessment is an assessment of potential threats. These are sometimes easily evaluated, such as dam construction threatening an aquatic insect requiring fast water and riffles, or a declining foodplant. For example, does flowering dogwood (*Cornus florida*) in southern Ontario have host specific insects that are declining as a result of the decline in dogwood due to the Dogwood anthracnose (also called dogwood leaf blotch, a disease caused by the fungus *Discula destructive*)?

Finally, information on range and distribution of many insects can be obtained from taxonomic monographs and museum collections. It is often desirable to visit a few old localities to confirm presence if there are no recent records.

The SSC welcomes suggestions for candidates. Simply call or email a co-chair and provide some of the information shown in Appendix 1. For taking the time recently to provide information on candidates, we thank Canadian entomologists who are not on the SSC including Syd Cannings, Andy Hamilton, Don Lafontaine, Dwayne Lepitzki and Monty Wood.

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**References**


Appendix Table 1. Candidate documentation of the kind used by the Arthropod Species Specialist Group to determine priority candidates and by COSEWIC to select priority candidates for status reports.

**Gibson’s Big Sand Tiger Beetle, *Cicindelea formosa gibsoni***, Author: PMC

**Canadian range:** Saskatchewan

Order Coleoptera Linnaeus

Family Carabidae Latreille

Species *Cicindela formosa* Say, 1817 – Big Sand Tiger Beetle

Subspecies *Cicindela formosa gibsoni* Brown, 1940 – Big Sand Tiger Beetle (Gibson’s)

*Cicindelea formosa gibsoni* is a distinctive subspecies of Canada’s largest Tiger Beetle. It is known only from two small areas that are disjunct by approximately 1000 km: the Great Sand Hills of Saskatchewan and a similar dune field in Colorado. It inhabits areas of open sand (estimated at 0.2 % of the Great Sand Hills area of approximately 1000 km\(^2\)). In the interior of Canada areas of open active dunes have recently declined by 40% per decade as a result of stabilization by vegetation and these declines are well documented for the Great Sand Hills (e.g. Hugenholtz and Wolfe 1999). Although increasing aridity (due to global warming) may expand active sand in the future, there may be much more stabilization before this happens (Wolfe, pers. comm.), and other pressures such as seeding to improve and protect pasture from anticipated effects of global climate change could reduce the habitat further. This subspecies is tracked by the Colorado Natural Heritage Program and listed there as S1 (critically imperiled) and globally T1 (critically imperiled infraspecific taxon). Acorn (2004) notes that this species does not readily colonize new open sand habitat.

i. **Taxonomic level** – subspecies *moderate*

ii. **Proportion of global range in Canada** - < 50% *moderate*

iii. **Existing global conservation status** – T1 *high*

iv. **Canadian population size and trends** – inferred decline due to decline in habitat in Great Sand Hills *high*

v. **Threats** – decline in area of open sand appears to be continuing. *moderate*

vi. **Small extent of occurrence or area of occupancy** – EO = Approx. 1000 km\(^2\), AO probably less than 100 km\(^2\) – *high*

vii. **Limiting biological factors** – this species has apparently not been able to colonize new sandy habitats. *moderate*

References:


Natureserve ranks: [www.natureserve.org/explorer/speciesIndex/Genus_Cicindela_103839_1.htm](http://www.natureserve.org/explorer/speciesIndex/Genus_Cicindela_103839_1.htm)
The list of specimens and information sought is intended to facilitate cooperation among entomologists through the exchange of specimens. If you have a request for material that might be obtained in Canada please submit your request using the form below or the on-line form available at the URL noted above.

Biological Survey of Canada
P.O. Box 3443, Station "D"
Ottawa, ON K1P 6P4; fax 613-364-4022

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**Material requested (specify taxon, region, habitat, or other details, as appropriate):**

**Collecting and preserving methods and other information requested for above:**

**Cooperation offered - if there is anything specific you might be able to exchange for material requested above (e.g. identifications, material) please indicate it here:**

**Residual specimens available for loan, exchange, or to give away. Please specify as much detail as possible, e.g. collecting localities, collecting method, taxon (if known), amount of material, and how the samples are preserved.**

How long would you like the above posted on the BSC web site?