Spring 1999 Vol. 18, No. 1

NEWSLETTER OF THE BIOLOGICAL SURVEY OF CANADA (TERRESTRIAL ARTHROPODS)

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Canadian Museum of Nature / Musée canadien de la NATURE

General Information

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

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Queries, comments, and contributions to the Newsletter are welcomed by the editor. Deadline for material for the Fall 1999 issue is July 16, 1999.

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Editorial Notes

The Biological Survey of Canada (Terrestrial Arthropods) develops and coordinates national initiatives in taxonomic and ecological entomology on behalf of the Canadian Museum of Nature (formerly the National Museum of Natural Sciences) and the Entomological Society of Canada. This Newsletter communicates information about systematic and faunistic entomology that may be of interest in Canada, and reports especially on activities relevant to the Biological Survey.

News and Notes

Activities at the Entomological Societies' meeting

The 1998 joint annual meeting of the Entomological Society of Canada and the Société d'entomologie du Québec took place in Québec City, 31 October to 4 November 1998. The meeting was attended by more than 300 people, including a large number of student members, many of whom presented papers. The meeting had the theme of "Today's basic research: Tomorrow's Integrated Pest Management", and all of the three symposia and four workshops pertained to this theme. Items in the program or associated with it included:

Symposia on "Applying the basics of chemical ecology in IPM", "Evolutionary ecology: a conceptual framework for the development of IPM", and "Physiology and molecular biology: towards the development of biorational insectides".

Workshops on "Just what is biocontrol anyway?", "What is the role for research in IPM implementation?", "Host resistance against the white pine weevil", and "Insect management with physical control methods".

Submitted papers grouped by the themes of Biodiversity, taxonomy and systematics; Ecology and biological control; Physiology and molecular biology; Ecology and evolution; Ecophysiology; and Insect-flower relations.

A student paper competition, coordinating presentations for the Melville-Duporte prize of the Société d'entomologie du Québec and the President's Prize of the Entomological Society of Canada.

The ESC Heritage Lecture, given by Dr. Jean-Marie Perron, about the birth of entomology in Quebec in the 19th century.

The ESC Gold Medal address, entitled "A national aquatic ecosystem health program program for Canada: we should go against the flow", given by Dr. David Rosenberg.

Governing Board and Annual General Meetings also took place, the Gold Medal and other honours were awarded, and there were many opportunities for informal exchange of information, including an opening reception and a banquet. Exhibits included entomological books and equipment.

Papers on systematics and related themes

The following titles include some of the papers of faunal interest that were presented in various scientific sessions, including posters, in addition to the symposia and workshops. (Interesting treatments on a range of other subjects also were presented in the various submitted paper sessions).

The larvae of *Hydrotrupes* Sharp and *Agabinus* Crotch (Coleoptera: Dytiscidae) with implications for the phylogeny of the Colymbetinae. **Y. Alarie**

Geographic affinities of Diptera in relict grasslands of the Yukon. **S. Boucher**

Systematics of the subfamily Dolichopodinae (Diptera: Dolichopodidae). **S.E. Brooks**

Biogeography of the genus *Liosphex* Townes (Rhopalosomatidae, Hymenoptera): examining disjunct distribution. **S. Guidotti**

A World Wide Web information system on the Tachinidae (Diptera) of bertha armyworm (*Mamestra configurata*, Noctuidae). **J.E. O'Hara**

Staphylinid beetle diversity in mature and regenerating coniferous forests in Alberta. **G.R. Pohl**

Ground beetles (Coleoptera: Carabidae) of tallgrass prairie in southern Manitoba: effects of controlled burning and implications for conservation. **D.A. Pollock and R.E. Roughley**

A method to determine carabid density from pitfall data. **D.A. Raworth and M.-Y. Choi**

Diversity of arthropods associated with nests of passerine birds. **C. Riley**

Phylogeny and zoogeography of *Cetema* Hendel (Diptera: Chloropidae). **J. Savage and T.A. Wheeler**

Chloropidae (Diptera) of the Yukon: unknown diversity and unresolved patterns. **T.A. Wheeler**

1998: The quest for lepidopteran diversity. **L. Morneau, J.R. Spence and W.J.A. Volney**

The evolution of aquatic behaviour in Hymenoptera. **A.M.R. Bennett**

Landscape as a filter for density-dependent parasitoids. **J. Roland**

The effects of landscape structure on population genetic structure of the alpine butterfly, *Parnassius smintheus*. **N. Keyghobadi, J. Roland and C. Strobeck**

Master builders of mobile homes: larvae of Coleophora (Lepidoptera: Coleophoridae). **J.-F. Landry**

Cylindrosella n.sp. (Ptiliidae: Nanosellinae), one of the smallest beetles in North America and its potential as an old-growth forest specialist. **P. Paquin, N. Dupéré and P.-P. Harper**

Regional adaptation in forest tent caterpillar populations. **D. Parry, R.A. Goyer and G.J. Lenhard**

Spatio-temporal patterns of floral utilization by indigenous bees within the new Brunswick lowbush blueberry agro-ecosystem. **S.K. Javorek and K.E. MacKenzie**

Annual variation in native bee populations foraging on lowbush blueberry. **K.E. MacKenzie and S.K. Javorek**

Stand vigour influences the abundance and diversity of eastern hemlock looper natural enemies. **S.A. Pardy**

The ecology of the forked fungus beetle, *Bolitotherus cornutus* (Panzer). **S. Teichert and S. Bondrup-Nielsen**

A spatial analysis of spruce budworm outbreak patterns in Quebec. **D. Gray**

Insect viruses, biodiversity and equibibrium. **J. Drolet, I. Gerke, and H. Rasamimanana**

Sympatry in the European earwig. **S. Guillet, J. Deunff, A. Guiller and M. Vancassel**

Ants: key food in amphibian assemblages. **M.I. Bellocq, K. Kloosterman and S.M. Smith**

Pestiferous and predatory arthropods on an abandoned cranberry farm in British Columbia. **J. Troubridge and S. Fitzpatrick**

Carabidae fauna dynamics within an Integrated Fruit Production apple orchard in Nova Scotia, Canada. **R.F. Smith, C. O'Flaherty, S. Rigby and H. Goulet**

Insects of the Galapagos Islands, Ecuador. **S.B. Peck**

Summary of the Scientific Committee Meeting for the Biological Survey of Canada (Terrestrial Arthropods), October 1998

The Scientific Committee met in Ottawa on 22-23 October 1998.

Scientific projects

The various scientific projects of the Survey were discussed, including the following progress.

1. Arthropods of Canadian grasslands

Dr. Bert Finnamore reminded the Committee that the final year of a three-year project is in progress at Grasslands National Park, and he reviewed the study design. The only zone that has not yet been studied in Grasslands National Park is the riparian zone. A number of trap residues from other zones are now available and distribution and coordination of identifications is in progress.

Following his work on arthropods at CFB Suffield, Dr. Finnamore is scheduled to make a major presentation to the military and others concerning biodiversity analysis. The arthropod data are being used to put forward the case for maintaining the National Wildlife Area on the Suffield base. The arthropod data suggest, for example, that grazing be restricted during climatic extremes (a reversal of the present policy). Elk have been reintroduced as a dominant grazer. Elk do not congregate in large herds (unlike the horses that were removed earlier from the base) and so do not destroy sensitive dune systems. Dr. Finnamore expects to continue his involvement in Suffield because a dam has been proposed, giving potential to study the riparian zone along the South Saskatchewan river that flows through Suffield.

2. Seasonal adaptations

Dr. Hugh Danks provided updates about this project. A paper with Dr. Richard Ring about the particular roles and properties of

trehalose was accepted for publication. The European Workshop on Invertebrate Ecophysiology (in Birmingham, England in September), where many aspects of particular relevance to the project were addressed, was excellent. A paper on "Life cycles in polar arthropods - flexible or programmed?", has been submitted for publication. Work is proceeding on papers on life cycles that were planned a few years ago but deferred in order to finish the Yukon book.

As a result of a contact made in Birmingham, Dr. Danks will be presenting an invited lecture and participating on a discussion panel at an International Japanese-Czech New Year Seminar in Entomology on Seasonal Adaptation in Insects and Mites. This meeting will be attended among others by the many Japanese scientists who work on diapause and related key themes for the seasonal adaptations project. After the conference, lectures and discussions on similar themes will be held at Kochi University.

Plans for cooperative work between Dr. Danks, Dr. Olga Kukal and Dr. David Levin (University of Victoria) on certain aspects of cold-hardiness continue to develop.

3. Potential projects

Two potential scientific projects were discussed, with further details expected at the next meeting of the Scientific Committee. Dr. Doug Currie had determined that August would be the best month from logistical and collecting points of view for a field party to a large river in northern Keewatin. He requested feedback on the level of interest to ensure that the party will have enough participants to make it viable financially.

Dr. David Larson outlined preliminary work towards a potential project on the insects of Newfoundland. He provided updated information about topics such as record-keeping, available lists and databases, keys, and other background materials.

4. Other projects

The Committee also discussed ongoing projects on keys to the families of arthropods in Canada, arctic invertebrate biology and boreal arthropods.

Other scientific priorities

1. Arthropods of soils

Dr. Behan-Pelletier provided updated information on several topics. A report on Soil Biodiversity in Canadian Agricultural Soils is being prepared through Agriculture and Agri-Food Canada for SBSTTA (Convention on Biodiversity) by Dr. Cathy Fox of the London Research Station.

Dr. Behan-Pelletier is involved in research funded by NSF on Soil Biodiversity and Ecosystem function in tall-grass prairie. The grant is held by Diana Wall (previously Freckman) at Colorado State University. The groups studied will be mites, Collembola and nematodes, and the site is the Konza LTER - the largest remaining tract of tall-grass prairie in North America. This NSF project is being matched by a NERC supported project on upland grassland at Sourhope, Scotland.

Students from the University of Victoria and the University of Calgary, along with 13 other students, took a course on oribatid mites at the Ohio State University in summer 1998, taught by Dr. Roy Norton. Ms. Guldborg Søvik, a student in Oslo, is joining a research ship which will go through the high arctic for 6 months to 1 year and she will be collecting soil mites. Dr. Danks noted that an article by Ms. Søvik on this voyage will appear in the 1998 issue of *Arctic Insect News*.

The Database of Ecological Research Projects (DERP), reported on at previous BSC meetings, will be released in the fall of 1998. Dr. Behan-Pelletier had expected the database to be released in the summer, but hopes that the delays will have ensured a better product.

The 7th biennial meeting of the Soil Ecology Society will be held at the Field Museum of Natural History Chicago, May 23-26, 1999. Dr. Dac Crossley retired in October 1998. A conference on: "Invertebrates as Webmasters in Ecosystems" was held to celebrate his retire-

ment. Dr. Crossley has had an enormous influence on soil ecology in the United States. The joint meeting of the Entomological Society of America and the American Phytopathological Society in Las Vegas in November 1998 will have a symposium on Soil Health including an invited talk by Dr. Behan-Pelletier and Dr. Finnamore on "assessing soil arthropods - implications for soil health".

2. Old-growth forests

Dr. Scudder reminded the Committee that at the last meeting discussion centred around the possibility of organizing a symposium and written synthesis to bring together the work that has been done pertaining to old-growth forests. It was decided that plans for such a symposium were premature as one or two years of work remain, especially in B.C., before generalities will be evident. However, a meeting in Victoria in February 1999 will summarize old-growth forest work on Vancouver Island, and the results will be published in *Northwest Science*.

Dr. Ring reported on work in old-growth forests in B.C., and on a proposal for a Wilderness Park, in the mountains north of Vancouver, being promoted by the Western Canada Wilderness Committee. Dr. Scudder reviewed other studies in B.C. old-growth forests, pertaining chiefly to the effects of clear cuts or selective logging and access roads on carabid beetles.

Dr. Ring reported that at Rocky Point the canopy access system and specialized microclimatic station are being taken over by the University of Victoria. This area of old-growth Douglas fir is close to the University, and will be a great asset to studies. The canopy access systems in the Carmanah old-growth forest (now a park) have been dismantled for safety reasons. There has been a great deal of media attention recently from Canada and elsewhere on the work in old-growth forests in B.C.

3. Invasions and reductions

Dr. Marshall reminded the Committee that the Survey had decided to go ahead with the organization of a symposium, possibly at the 2000 EMAN National Meeting if support can be obtained, or as part of the ESC/SEQ/ESAmerica meeting in 2000. This issue continues to become more topical because of increasing concern about new, economically important invaders like the Asian Longhorn beetle, and because of public interest in issues related to endangered species. A draft list of potential speakers has been compiled, but a final selection of topics in sections dealing with changes from taxon, regional and national perspectives has yet to be made. Dr. Marshall noted that the fact that all changes have impacts, and potentially relate issues such as climatic change and introduced species, promotes the importance of baseline data and expertise in allowing impacts to be assessed. In response to questions, he explained that the publicity resulting from the CNF lady beetle survey has been beneficial, but he has serious concerns about the accuracy of the data being published. Unfortunately, misidentification on a massive scale will ultimately damage the overall goals of the project.

4. Endangered species

Dr. Anderson reported that he recently attended a COSEWIC symposium. It was decided to adopt the IUCN categories but retain the COSEWIC definitions.

New terms of reference for COSEWIC had earlier been adopted by the Wildlife Ministers. COSEWIC will report directly to a newly created Canadian Endangered Species Conservation Council (CESCC), including Canadian Wildlife Ministers, and hence will be an official body for considering legislation. The independent scientific process by which species are listed by COSEWIC will continue. However, the new structure also means that the subcommittee chairs, independent scientists who previously voted directly on species status, will no longer have voting status. Only delegates (political appointees) will make the final decisions on species status. This change has caused great concern. Dr. Scudder reported that many senior scientists had requested a meeting with the Minister because of this concern. To date there has been no response, so that the issue may have

to be taken to the media. The new endangered species legislation is expected to be reintroduced to Parliament before the end of the year, and unofficial reports indicate that it will be similar to the original bill, which died on the order paper when the government was dissolved. Members of the Committee added that it would be better to have no legislation than poor legislation, because passing any Endangered Species Act would lead the public to think that the problem has been solved.

5. Funding for biodiversity projects

Dr. Wheeler had compiled a list of sources of funding for biodiversity and systematics projects, divided into several categories such as scholarships, support for fieldwork, and non-traditional sources. He suggested that the best way to disseminate this information would be by posting a brief description and contact information on the web. The web site should also contain some brief considerations of how to apply, the necessity for applications of good quality, and so on, because many students are not aware of the process of applying for grants. The idea of a workshop at an ESC meeting on how to write grant proposals, find funding sources, etc. would also be suggested. Dr. Wheeler agreed to complete his summary and seek feedback from Committee members.

6. Error rates in identifications

Dr. Marshall had tried to find a way to quantify the recognized problem of the high error rates of identifications especially among non-specialists, but without success because of statistical difficulties. The Committee agreed that even in the absence of quantification, it is worth preparing an anecdotal article for the Survey newsletter to expose some of these issues, such as misidentifications in the public lady beetle survey, and other examples noted by Committee members. The article would be both a "wake-up call" for managers of biodiversity studies who feel that identifications are easily purchased, and a justification for the development and maintenance of reference collections.

7. Geographic data

Mr. Antony Downes pointed out that making summary records of distribution by province is quite outdated. Most provinces have a wide range of conditions, so that a more biologically realistic framework should be adopted. He pointed to the National Ecological Framework for Canada as a basis for summarizing distributions. The Committee discussed the possibility of making some review as to whether the current zones are useful from an entomological point of view. Given the work already being carried out by EMAN, however, the Committee decided to wait and see what initiatives EMAN takes regarding ecozones before addressing this broad question.

Dr. Wheeler suggested that the key issue might be the need to adopt data standards on labels, such as the Geographic Positioning System coordinates emphasized by some members. He offered to consider the matter further in order to make a recommendation at the spring meeting of the Committee.

8. Scientific representation on international biodiversity forums

The Committee heard concerns that Canada sends a group of low-profile civil service bureaucrats to biodiversity discussions whereas the U.S. and Europe tend to send scientific experts. Therefore there is poor representation of real activities and expertise in Canada. Part of the concern reflects the fact that many scientists may not have the time or resources to get involved, but much of it reflects the way the Canadian system works. A way to ensure greater scientific input and more expertise in these forums is required.

Members of the Committee cited observations that suggest that it is government policy not to send scientists to these forums because they are not trusted to follow the government's position. Thus, at the Biodiversity Forum meetings documents are prepared for the Conference of the Parties (COP) for example through the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA), and they are written by government personnel.

Non-government individuals have sometimes objected to the content on the grounds that the information is not scientifically correct but to no avail. Some scientists have even advised the Biodiversity Convention Office that they will no longer endorse such documents. Canada has an advisory committee but it is comprised of experts in technology and molecular science. The Canadian Committee and the American President's scientific technology advisory committee recently met to discuss common issues. The Americans wanted to talk about biodiversity but the Canadian committee did not have a member with appropriate background. Submissions have been made to the Prime Minister's Office to add biologists to that advisory committee but no response or even acknowledgement has been received.

It was noted that the Biological Survey Committee in effect is an NGO but, along with other NGO's, it is never invited to these types of meetings. One possibility of good scientific input into the COP, bypassing SBSTTA and the Biodiversity Forum, comes from DIVERSITAS. DIVERSITAS is sponsored by a variety of international groups, although not Canada. However, DIVERSITAS prepared documentation for the last COP meeting which was clearly superior to the material prepared by SBSTAA. Initiatives pertaining to DIVERSITAS, and other interested bodies, will be pursued further.

9. Dissemination of biodiversity information

The committee agreed that Dr. Danks and Dr. Neville Winchester should draft a brief to show how valuable results are being generated by properly conceived work on biodiversity, following the prescriptions made in earlier briefs by the Survey.

Dr. Behan-Pelletier had proposed that the Survey address what sort of products (that give information in the area of biodiversity and that might enhance the Survey's profile) should be put on the Survey's web site. Such faunal and biodiversity information available from the Survey and its cooperators would be much more detailed than the general information currently on the site and also much more detailed than the species lists on the ITIS site, for example. A subcommittee chaired by Dr. Anderson agreed to look at this issue broadly, in order to develop a longer-term plan, including what should be posted, technical issues, funding, and so on.

Dr. Huber and Dr. Anderson reported for the Survey's project on faunal analysis and gaps in expertise that commitments have been received from a number of people to work on specific groups. Posting the information on a web site as it is received may help to encourage contributors because they will see that a product is being developed. Dr. Anderson and Dr. Huber agreed to investigate some of the technical aspects of posting the information on the web, in the context of the wider web site investigations.

10. Monitoring of continuing priorities for work on Canadian faunas

Recent developments related to earlier or currently less active survey projects were considered, including especially information about continuing studies of the Yukon fauna, and also work or plans in peatlands, wetlands, springs, special habitats, mountains, agroecosystems, and the Queen Charlotte Islands.

Liaison and exchange of information

1. Canadian Museum of Nature

Ms. Joanne DiCosimo, President, Canadian Museum of Nature, reminded the Committee about the national consultation process that the Museum had undertaken last year, the results of which were integrated into a five-year plan for the Museum. A number of initiatives fall under the objective of increasing national service. Ms. DiCosimo reported that with the help of a number of environmental interests, an environmental stewardship plan has been produced for the Aylmer site of the Museum, including compilation of baseline data on the flora and fauna. The next step will be the acquisition of an adjacent 56 hectares, to be kept in

perpetuity and preserved appropriately. A compensatory site of 8 hectares of natural wetland will also be preserved. There are plans for an interpretive program on natural wetlands, possibly using the site.

In response to the country-wide opinion that Canadians want to see their national natural science collections, an exhibit is being developed under the working title "Just another millennium". Several travelling exhibits will draw on the breadth of the natural science collections and allow more national access to Canadians.

Dr. Mark Graham, Director, Research Services, Canadian Museum of Nature, reported that a partnership program through NSERC to support graduate students studying systematic research is now in place. The program will promote graduate research in systematics in Canada and provide practical work experience in natural history collections within a professional setting. Seven organizations have agreed so far to supplement the NSERC funding.

Dr. Graham also reported that the CMN is in a position to offer visiting fellowships next year. With members of the Committee, he also reviewed some other initiatives pertaining to biodiversity, Museums and database work.

The Standing Committee of Environment and Sustainable Development, chaired by the Honourable Charles Caccia, has convened a hearing on issues pertaining to systematics research in Canada and bioinformatics. The CMN, Agriculture and Agri-Food Canada, Fisheries and Oceans, Environment Canada and the Canadian Forest Service were invited to make presentations, and the Auditor General will also report on how Canada is addressing its biodiversity commitments. Dr. Graham hopes that this forum will heighten the awareness of systematics research, the level of expertise in Canada and what needs to be done to improve the situation. Dr. Graham and Dr. Smith hoped that the hearing might lead to some formalization of the activities of the Federal Biosystematics Partnership in such a way that it would be able to report on progress being made towards the secure future of biodiversity research in Canada. Dr. Scudder and other members of the Committee hoped that there would be a clear submission about the fate of that area of expertise in the country as a whole. For example, the University of British Columbia has recently recommended that it get rid of all UBC collections because they can no longer be curated properly, one example of a serious national problem.

Ms. DiCosimo noted that the CMN is able to bring the results of a national consultation, which also provides examples in this arena. Dr. Roberts-Pichette added her opinion that the hearing is an excellent opportunity to make key information more widely known.

2. Biological Resources Program, ECORC

Dr. Jim McKenzie, Program Manager, ECORC, reported that as of July 1 ECORC has a new Director - Dr. Jean-Marc Deschênes. He was formerly the Director at the Lennoxville research station and has a background in weed ecology.

Dr. McKenzie reported that on June 16-18 a meeting was held about the Integrated Taxonomic Information System (ITIS). A number of taxonomists and information technology specialists discussed participation in this major international initiative. It was agreed that ECORC would work towards a partnership with ITIS, to support the development of a credible authoritative North American source of information (see http://www.itis.usda.gov/itis/whatsnew.html).

On July 9-10 ECORC hosted a Canadian Biodiversity Information Initiative (CANBII) meeting which was attended by 30 individuals representing collection-based organizations in Canada and the U.S. Plans were developed for the first module of a collaborative long-term on-line project on the biota of Canada. The prototype module will be the butterflies of Canada, intended to demonstrate the utility of collections and observational data as sources of information to support decisions affecting conservation and the sustainable use of biological resources.

In response to enquiries, Dr. McKenzie explained that an agreement is now signed for

ECORC to become a Canadian representative for ITIS, but other Canadian taxonomists would become involved. ITIS is currently on the web but the quality control is very uneven and participants from ECORC have been working with the Americans to bring the system into a more user-friendly environment, and to ensure that the information is trustworthy.

Dr. Danks pointed out that there seems to be much more profile and saleability these days for databasing (such as ITIS and CANBII), which in most cases involves the processing of existing information. The key need, however, is to do the systematics research that provides validated information for the databases, and to ensure that the infrastructures that support this research, such as expertise, training, and collections, are in place. Dr. Finnamore and others pointed out that construction of the database enables funding to be secured. Dr. Danks explained his fear that the product currently being sold to science managers involves the handling of existing information only and that when the existing information dries up the managers may feel that they have been short changed, because resources will have to increase greatly to make any more of the product available. It is important to keep the long-term infrastructure needs firmly in mind.

Dr. Smith provided a brief update on CANBII, including its objectives to deal with the biota of Canada, metadata standards and the integration of biodiversity information into Geographic Information System frameworks.

3. Entomological Society of Canada

Dr. Hugh Danks, President of the Entomological Society of Canada, reported that the ESC Gold Medal for this year is being awarded to Dr. David Rosenberg of the Freshwater Institute in Winnipeg, a very active former member of the Scientific Committee with wide interests in aquatic insects and the environmental impacts of artificial changes.

Dr. Danks reminded the Committee that at the last meeting, he reported on a number of significant changes the Society underwent as a result of decisions following a major Strategic Review. For example, the memoir series was discontinued and the avenue for producing *The Canadian Entomologist* was changed. All of the main elements of the Society's restructuring have been completed during the year, for example additional detailed revisions to the documents that govern operations of the Society (the Standing Rules and Committee Guidelines), changes in ESC staff and resulting personnel negotiations, and plans for a continuing long-term contract with the NRC Research Press for production of *The Canadian Entomologist*. The Society is now well placed to continue for the future. The Society continues to be proud of its various efforts in publication and support of entomology. Nevertheless, even as progress is made, new and potentially worrying issues emerge to prevent the Society from becoming complacent. For example, some loss of subscriptions has taken place, partly due to the economic crisis in Asia.

Dr. Danks added that the annual scientific meeting of the Society, as well as meetings of the Governing Board, take place Oct. 31 – Nov. 4 in Quebec City, so results of those deliberations cannot yet be reported.

4. Canadian Forest Service

Dr. John Huber, Canadian Forest Service, reported that within the next 5 years there will be a 40% turnover of CFS staff, largely due to retirements. He hopes that some of the replacements in the next five years will be taxonomists, for example research positions in the regional laboratories. Dr. Jan Klimaszewski, a staphylinid expert, is now on staff at the Laurentian Forestry Centre in Ste.-Foy.

5. Parks Canada

Mr. Don Rivard, Ecosystem Management Manager, Parks Canada, presented the State of the Parks 1997 Report which is available on the Parks Canada web site at http://parkscanada.pch.gc.ca/library/DownloadDocuments/Documentse.htm

Mr. Rivard pointed out that the chapter on National Parks addresses the maintenance of the ecological integrity of National Parks. The

groups of species looked at are vertebrates and vascular plants. These groups were chosen because of the availability of data. In that regard he mentioned that, as Dr. Danks had commented earlier, the sources of new taxonomic information are drying up.

Mr. Rivard noted the report's conclusions about maintaining ecological integrity. The majority of species recorded this century are still in the Parks, but there are several classes of change. For example, extirpated species are especially large birds and mammals that were hunted. Parks should not be studied as islands but rather in terms of land use: for example road density inside and outside the Parks is closely correlated. There are exotic species and North American incidentals so that the situation is a dynamic one.

Dr. Smith noted that Agriculture received a request from a contractor who had a contract with Parks for biodiversity assessment, but was not involved from the planning stages and so could not justify putting resources into the identifications requested. The only other option would be to charge the usual contractor rate. Such an incident underlines the lack of connections within the federal government, hindering integrated studies of biodiversity. Dr. Scudder added that he too has received requests from contractors, for example for complete lists of species in the Rocky Mountain parks. Such requests demonstrate a lack of understanding by many of the people who are getting involved in biodiversity studies.

Mr. Rivard pointed out that Parks Canada is very decentralized, which hinders the coordination of information. In response to questions, he noted that there is a policy commitment to inventory the species in Canada's national parks but this does not necessarily translate into funding. Parks has been hit with several budget cuts and downsized considerably, and is moving to special agency status. On the other hand, one of Parks' initiatives is to try to change the focus on to more specific aspects of biodiversity. Mr. Rivard thought that the likelihood of funding would increase if the value of such inventories can be made clear to the people who make the decisions. For example, results from some past surveys of invertebrates were never used explicitly. Dr. Graham commented that National Parks are widely distributed across the country and managed in such a way that it should be possible to devise and articulate a scientific approach that relates to management requirements.

Dr. Anderson reminded the Committee that in the U.S. the Great Smoky Mountains National Park is undertaking an all taxon biodiversity inventory (ATBI). Their web site [www.discoverlife.org] includes a complete rationale and background for inventories.

Mr. Cannings reported on a small success story with respect to a dragonfly survey in B.C. National Parks, promoted because someone at the park was keen and willing to help support the study. Dr. Smith concurred, saying that a contact who greatly aided Agriculture's survey in the past was transferred and the replacement was not as interested. This demonstrates the need for continuity but also confirms the problem of lack of connections among federal agencies and the lack of a national strategic overview to address biodiversity issues.

6. Ecological Monitoring and Assessment Network

Dr. Patricia Roberts-Pichette, Executive Secretary, Canada/MAB commented that EMAN is involved in a number of the projects already mentioned. The new Director of EMAN, Dr. Hague Vaughan, has been working with Parks, Forestry and Agriculture on Memoranda of Understanding (MOU) with respect to aspects of biological diversity. Biodiversity work within the 4 natural resources departments is also being discussed. Dr. Roberts-Pichette hopes that these initiatives will result in a better information flow and a more coordinated federal effort.

The Biodiversity Science Board met in June. Dr. Finnamore resigned as its chair but Dr. Scudder agreed to serve out the remaining term as interim chair. A report is being prepared by the Board about Canada's biodiversity actions.

Dr. Smith explained that the Ecological Monitoring Coordinating Office (EMCO) would like a group of interested biologists to come up with recommendations on what should be measured at EMAN sites, to encourage consistent assessment of biodiversity across the country. Arriving at these recommendations would require a workshop or series of discussions with various points of view (taxonomists, ecologists or other appropriate experts) on what kinds of things can be measured relatively easily and cost effectively in a coordinated and standardized way. Dr. Smith, supported by others present, proposed that the Biological Survey Scientific Committee consider taking the lead in putting together the necessary consultations or workshop(s) and ensuring that appropriate interested parties are represented. Drs. Smith, Scudder and Shorthouse agreed to form a subcommittee to explore the possibility of the Survey's involvement and they subsequently arranged a workshop for February 1999.

Dr. Roberts-Pichette provided information about the International Biological Observation year in 2001, a field course this summer with high school students at Long Point Biosphere Reserve which tested the earthworm protocol, and the opening of the Eastern Ontario Biodiversity Museum which received a large part of the natural history collection from Carleton University. The museum will be used as a centre for training local amateurs for biological observation. The Committee discussed the history of this collection and its welfare.

The Mixedwood Plains assessment of species diversity has been on the web for some time. The Montane Cordillera report is in its final stages and is expected to be available on the web before the end of the year. The Prairie assessment is now underway and hopefully will be completed within a year.

Information about the EMAN national meeting in Victoria, January 19-23, 1999, is also on the web:
http://www.cciw.ca/eman-temp/events/national99/intro.html.

7. Parasitology module, Canadian Society of Zoologists

Dr. David Marcogliese, Parasitology module, Canadian Society of Zoologists, reminded the Committee that the major activity of the parasitology module has been to develop EMAN protocols for monitoring parasites. The protocols are being posted on the web. The final version of the protocol for parasites of freshwater fish will be complete by the end of March, and protocols for parasites for other groups are in progress.

The Directory of Parasitologists is on the web and changes can be submitted electronically. The perch project is proceeding slowly although new data continue to accumulate. The national stickleback parasite survey started last year and the first datasets have been contributed from Nova Scotia, New Brunswick, Quebec, and B.C.

Dr. Marcogliese noted that over the past year he has noticed that the remaining employed systematists have less and less time to take on students or conduct personal-interest projects, because resources have decreased while administrative or managerial responsibilities have increased. Dr. Marcogliese reported that the parasitology component of the ATBI of the Great Smoky Mountains Park has ended. Apparently the coordinators for the parasitology Taxonomic Working Group have resigned, perceiving the project set up as flawed.

Dr. Marcogliese reviewed other projects and involvements of Canadian parasitologists. Dr. Brian Emmett had appeared before the Standing Committee of Environment and Sustainable Development in May to answer questions about climate change, environmental assessment, biodiversity, sustainable development and policy. A number of items are behind schedule and there is no audit of provincial involvement and plans. Dr. Marcogliese reported that the Institute for International Parasitology, a unit of CABI in St. Albans, U.K., has been closed and the important collections split up. He reviewed meetings, publications and other topics of interest.

Other items

1. Regional developments

Information of interest to the Survey from different regions of the country was provided, including the following topics.

In British Columbia, Dr. Ring reported on the gypsy moth problem in British Columbia. Recently the United States Department of Agriculture has hinted that B.C. might be quarantined unless sufficient measures are taken against the gypsy moth. Dr. Ring reported that the Entomological Society of British Columbia is alive and well with a good contingent of students and is in a sound financial position. There were a number of excellent speakers at the annual meeting, and several ESBC members were honoured there with life memberships. Mr. Cannings gave more details about the dragonfly inventory project mentioned previously, a regional project of the Royal BC Museum in the Kootenays. The goal of this multi-disciplinary project is to produce both useful scientific products such as keys and distribution maps as well as information for students and people who might like to monitor the local dragonfly population. Dr. Scudder reviewed the projects of students at UBC working on biodiversity and allied projects. He continues his long-term study on the ecology reserve in the South Okanagan. New funding has been received from the Habitat Conservation Trust Foundation for a long-term study on ecosystem renewal and ecosystem recovery from grazing. In addition, funding has been received to launch a major assessment of the possibilities for conservation and development in the South Okanagan, one of the most threatened habitats in Canada, in collaboration with the Canadian Wildlife Service. The ultimate goal is to have complete plans for the whole of the South Okanagan, one with the emphasis on conservation, another with the emphasis on development, and various intermediate plans that both conservationists and developers might accept. This is the biggest and most detailed project of this sort ever undertaken in Canada.

In Alberta, Dr. Finnamore reported that he had received notification in July that negotiations between Shell and the Peruvian government had collapsed and that the major project there was given 24 hours to remove its crews from the field. Dr. Finnamore estimated that 14 million specimens had been collected. The material is now in Lima and the Smithsonian Institution is currently negotiating the fate of the specimens. The Provincial Museum of Alberta is undergoing some changes. Database development and digital information management have been identified as one of the priorities for the museum, notably distributed database systems, whereby any database can be put on the web as a searchable database. A 100-million-dollar expansion proposal for the museum has been put forward, and Dr. Finnamore proposed a substantial expansion of the invertebrate program, which has gone forward for a final decision. Dr. Finnamore also reported that most of the western Parks have some level of programs to study arthropods. Dr. Finnamore attributes the success of these initiatives to younger managers who are receptive to arthropod studies. Dr. Floate added that the $30 million building expansion for the Lethbridge research centre continues and is scheduled to be completed in 2001. He has received funding for a biodiversity survey with a colleague at the University of Lethbridge to look at the effects of grassland fire. A positive report about Dr. George Ball's work on carabid beetles, as professor emeritus at the University of Alberta, had appeared in the University of Alberta Alumni Magazine.

In Ontario, Dr. Marshall reported that Dr. David Gaskin, Department of Zoology, University of Guelph, died recently. A new entomologist has been hired in the Department of Environmental Sciences, Dr. Rebecca Hallett. Dr. Marshall circulated two products from a small publisher from Guelph who is keen on producing a series of naturalists guides to living things in Ontario. The items can be produced quickly and cheaply and several entomological guides are in process now. Dr. Smith announced that plans have been submitted to retrofit the Neatby Building in Ottawa. Dr. Ball

had characterized the recently published revision of the tribe Noctuini, family Noctuidae, by Dr. Don Lafontaine as a taxonomic tour de force, covering 169 species in 31 genera, which reflects very favorably on BRP - ECORC. Dr. Anderson mentioned that one of the priorities at the Canadian Museum of Nature is implementing a new database system for the collection.

In Quebec, Dr. Wheeler reported that in Ste.-Foy, Mr. Georges Pelletier has been doing some insect surveys in a variety of forest areas that were affected by the ice storm. The vote for the official Quebec insect emblem is in its final stages. The Redpath Museum at McGill has recently received a grant from the museums' assistance program to pay a programmer / biologist to put together a virtual exhibit on Quebec biodiversity. Arthropods will figure prominently in this database. A grant proposal has been prepared to develop an interactive multimedia insect identification game, which would involve major input from the Lyman Museum to assemble images and other biological information. McGill University has recently taken possession of a large donation of land on Île Perrot. It is hoped that arthropod survey work will be done there next summer. Dr. Wheeler reminded the Committee of McGill University's desire to upgrade their field stations. A proposal was submitted to the Canadian Foundation for Innovation to upgrade the infrastructure at all field stations. The proposal has passed the first screening phase and a more detailed proposal must now be submitted. Many graduate students in systematics and diversity projects are working or will soon begin at Macdonald College.

In Newfoundland, the Newfoundland Insectarium in Deer Lake is now open.

For the Arctic, Dr. Ring commented on a recent item in the Globe and Mail newspaper that pointed out that in Canada only about 20 cents per capita is spent on polar research whereas in Australia the amount spent is $2.30 per capita; the U.S. spends $3 per capita; and even Russia, which is under a lot of financial pressure, spends more than Canada. He noted some planned studies in Canada next year by overseas researchers. The Northern Scientific Training Program (NSTP) is alive and well and will be on the agenda at the upcoming meeting of the Association of Canadian Universities for Northern Studies (ACUNS). One of the items on the agenda is the new concept of a university of the arctic. This would be a circumpolar university without a central campus but with campuses throughout the north probably administered from Ottawa and Copenhagen and involving all the circumpolar nations. Dr. Ring also noted and circulated some relevant publications, for example on global change.

2. Other matters

The Committee also discussed such matters as operations of the Biological Survey Secretariat, Survey publicity, damaged ecosystems, liaisons with other countries including Russia, and membership of the Committee (several members retired by rotation).

EMAN National Meeting

The national meeting of the Ecological Monitoring and Assessment Network took place in Victoria, B.C., 19-23 January 1999. The meeting was preceded by field trips, workshops and other activities. More than 350 people attended the meeting, which covered a range of subjects. Plenary and other sessions considered the EMAN program and its current general activities, designed to consolidate an EMAN business plan, to design and promote core monitoring as an early warning system, and provide input to Canada's biodiversity agenda. Several presentations and posters focussed on liaisons

and cooperative endeavours and the necessary plans, involving EMAN and other agencies. Scientific studies covering a wide range of topics related to monitoring or impacts especially at various EMAN sites were reported on. One day was devoted to field trips, focus groups and public involvements. One morning considered environmental research in aboriginal communities and traditional knowledge.

In all, nearly 100 presentations (in plenary or joint concurrent sessions) were made, and numerous posters were presented. The Biological Survey of Canada (Terrestrial Arthropods) displayed a poster about the coordination and scientific roles of the Survey, and provided information leaflets about the Survey and its publications.

MacMillan Coastal Biodiversity Workshop

including a component on biodiversity of rainforest arthropods

A special series of workshops focusing on biodiversity in coastal zones of British Columbia and Canada will be held on May 16 - 28, 1999 at the Bamfield Marine Station.

These workshops, *for which enrolment for the individual parts is possible*, are offered to senior undergraduate students, graduate students, faculty and government employees interested in a unique hands-on experience in coastal biodiversity research and surveys.

Plenary Session

The first day of the program (May 16) includes a series of seminars by four leading scientists working in the field of biodiversity, Dr. Geoffrey Scudder, Centre for Biodiversity Research, UBC, Dr. Gerhard Pohle, Huntsman Marine Science Centre and the Atlantic Reference Centre, Dr. Max Taylor, Centre for Biodiversity Research, UBC, and Dr. André Martel, Canadian Museum of Nature, Ottawa, and BMS. These seminars will put the four special activities of the workshop in the general context of biodiversity issues in coastal Canada. A general discussion for all participants is scheduled.

Workshop Activities

Evaluating biodiversity of intertidal and subtidal invertebrates
(May 17 - 19)
Dr. Gerhard Pohle, HMSC and ARC

Algal diversity and use of molecular techniques in algal biosystematics
(May 19 - 21)
Dr. Gary Saunders, UNB; Dr. Louis Druehl, BMS and SFU

Arthropod diversity in the temperate rainforest
(May 22 - 24)
Dr. Neville Winchester, UVic

Diversity of plants and vertebrates on small coastal islands
(May 25 - 27)
Dr. Martin Cody, UCLA

Concluding Activities

Wrap-up Discussion (May 27)

Guided hike in the West Coast Trail area, Pacific Rim National Park Reserve (May 28)

Conservation of Arthropod Biodiversity in Temperate Rainforests

The workshop section on Conservation of Arthropod Biodiversity in Temperate Rainforests, led by Dr. Neville Winchester, Biology Department, University of Victoria, with par-

ticipation from guest speakers such as Dr. Richard Ring, provides a primer for participants to evaluate concepts of temperate forest arthropod biodiversity.

Lectures cover the evaluation of arthropod biodiversity concepts using examples from case studies. The focus will be on developing a project to establish a long-term baseline in terrestrial systems to assess differences (species and process) over time. Pertinent literature in relation to forests, insects and biodiversity studies will be reviewed as a basis for critical discussion. A set of presentations will also be devoted to canopy work from a provincial, national and international perspective.

Fieldwork includes access to the high canopy, and participants will be introduced to access techniques, sample design and use of canopy trapping techniques.

Laboratory work on selected arthropod groups will be used to train participants in identification, species taxonomy, trapping, and all aspects of specimen preparation, including an introduction to data management and diversity measures using BIOTA.

Application

Applications must include a statement of interest, university transcripts (undergraduate or graduate students only) and a short CV (no more than 4 pages). Please send your application by mail or fax to the address below before March 31, 1999; there is an enrolment limit of 15 participants.

Fees

(Fees include room and board; partial enrolment for one or more workshop activities is possible)

Undergraduate and graduate students $400 ($100/activity)

Postdoctoral fellows and faculty members $600 ($150/activity)

Other public and private sector employees $800 ($200/activity)

Location

Bamfield Marine Station

Bamfield, British Columbia V0R 1B0, Canada

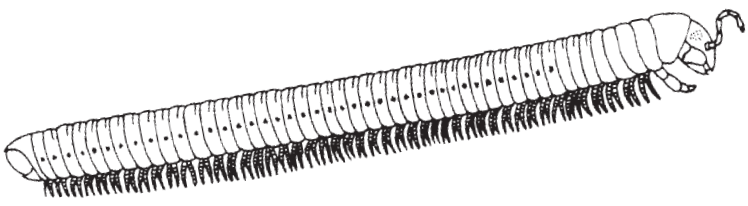
(250) 728-3301 (phone);

(250) 728-3452 (fax)

www.bms.bc.ca

Workshop on Biodiversity Monitoring

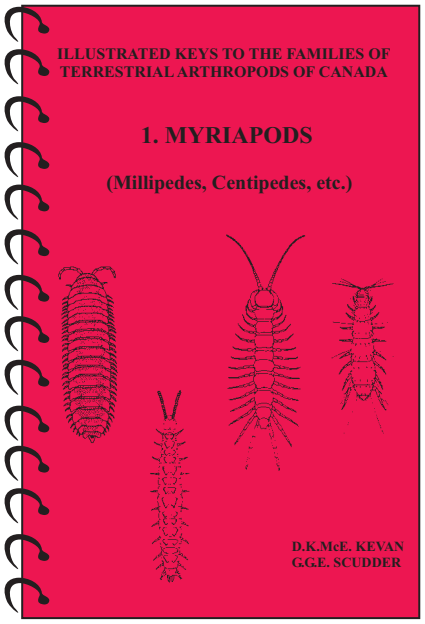
The Biological Survey of Canada (Terrestrial Arthropods) organized a one-day workshop on February 6, 1999, sponsored by the Ecological Monitoring and Assessment Network, to consider how recommendations for a scientifically-sound and cost-effective core set of monitoring activities for biodiversity at EMAN sites across Canada might be assembled. The 18 people attending the workshop represented expertise covering a wide range of taxa and subjects. Both specific procedures and general concerns and requirements were addressed. A report on the workshop will be made available on the EMAN web site (http://www.cciw.ca/eman/intro.hml) within a few months.



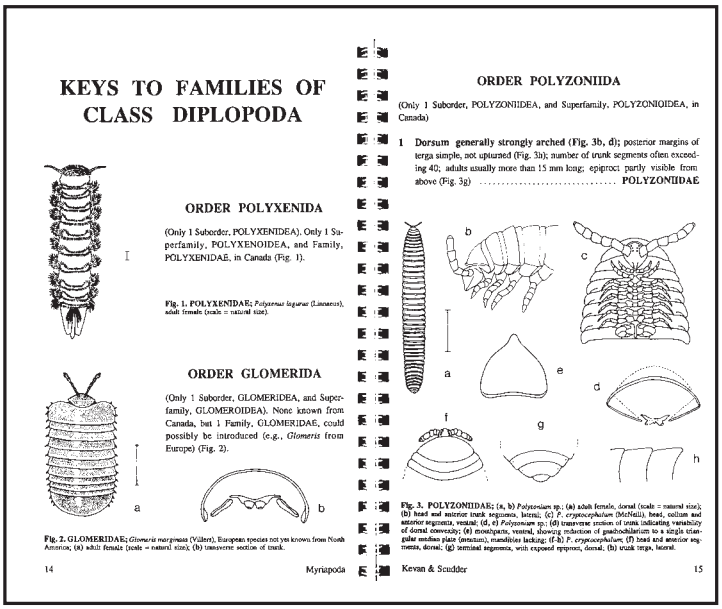
Project Update: Family Keys

Relatively early in the development of the Biological Survey of Canada, a plan was established for a series of up-to-date, readily usable and profusely illustrated keys to the families of insects and their relatives found or expected to be found in Canada. Without such keys, laboratory and field studies and teaching are hindered. The first fascicle, dealing with the myriapods and introduction to the arthropods, was published in 1989 [Kevan, D.K. McE. and G.G.E. Scudder. 1989. Illustrated keys to the families of terrestrial arthropods of Canada 1. Myriapods. BSC Taxonomic Series no. 1. Spiral bound, 88 pp.].

Subsequently Dr. Geoff Scudder, the author of the subsequent part of the keys (that would deal with apterygote and exopterygote insects), was indisposed for a substantial period. With other commitments, that slowed the progress of the project, but now it is moving forward again. In particular, the many illustrations are being prepared, in association with Mr. Rob Cannings, as part of a project on the insects of British Columbia. The text to the keys



themselves is essentially finished and only some general text remains to be written. Once the illustrations are complete (before the end of this year) publication of the second fascicle in the series can be scheduled.



KEYS TO FAMILIES OF CLASS DIPLOPODA

ORDER POLYXENIDA

(Only 1 Suborder, POLYXENIDEA. Only 1 Superfamily, POLYXENOIDEA, and Family, POLYXENIDAE, in Canada (Fig. 1).

Fig. 1. POLYXENIDAE; *Polyxenus lagurus* (Linnaeus), adult female (scale = natural size).

ORDER GLOMERIDA

(Only 1 Suborder, GLOMERIDEA, and Superfamily, GLOMEROIDEA). None known from Canada, but 1 Family, GLOMERIDAE, could possibly be introduced (e.g., *Glomeris* from Europe) (Fig. 2).

Fig. 2. GLOMERIDAE; *Glomeris marginata* (Villers), European species not yet known from North America; (a) adult female (scale = natural size); (b) transverse section of trunk.

14 Myriapoda

ORDER POLYZONIIDA

(Only 1 Suborder, POLYZONIIDEA, and Superfamily, POLYZONIOIDEA, in Canada)

1 Dorsum generally strongly arched (Fig. 3b, d); posterior margins of terga simple, not upturned (Fig. 3h); number of trunk segments often exceeding 40; adults usually more than 15 mm long; epiproct partly visible from above (Fig. 3g) ..... POLYZONIIDAE

Fig. 3. POLYZONIDAE; (a, b) *Polyzonium* sp.; (a) adult female, dorsal (scale = natural size); (b) head and anterior trunk segments, lateral; (c) *P. cryptocephalum* (McNeill); head, collum and anterior segments, ventral; (d, e) *Polyzonium* sp.; (d) transverse section of trunk indicating variability of dorsal convexity; (e) mouthparts, ventral, showing reduction of gnathochilarium to a single triangular median plate (stenum), mandibles lacking; (f-h) *P. cryptocephalum*; (f) head and anterior segments, dorsal; (g) terminal segments, with exposed epiproct, dorsal; (h) trunk terga, lateral.

Kevan & Scudder 15

Copies of the first fascicle on myriapods are still available from:

Entomological Society of Canada
393 Winston Avenue
Ottawa, Ontario, Canada
K2A 1Y8
tel. 613-725-2619
fax: 613-725-9349
email: entsoc.can@sympatico.ca

The cost is $8.00 including shipping: orders from Canada pay in Canadian dollars and add 7% G.S.T.; orders from other countries pay in U.S. dollars.

Canadian Spider Diversity and Systematics

Robb Bennett
British Columbia Ministry of Forests, 7380 Puckle Road, Saanichton BC V8M 1W4

Introduction

It can be stated accurately that spiders are to be found everywhere (with apologies to William Morton Wheeler who originally made this claim for ants). Spiders, unique among all organisms in their modes of silk production and usage and of reproduction, are common (if often inconspicuous) predatory arthropods in all terrestrial and many aquatic ecosystems throughout Canada. From marine intertidal zones to tundra and rocky peaks, and all points between, the ardent araneologist is always close to a wealth of species and numerous specimens of great intrinsic and biological interest. Among all organisms, spiders form the seventh largest order. Furthermore, spiders are ruthless storm troops in the matriarchal anarchy that is the arthropod world: theirs is the most diverse, female-dominated, entirely predatory order on the face of the earth. As such, spiders are key components of all ecosystems in which they live.

Twenty years ago, Dondale (1979) listed 33 spider families with 1256 known Canadian species. He estimated another 144 unrecorded or undescribed species were likely part of the Canadian fauna. Araneology is blessed with some of the very best systematists in the world and in the intervening years spider taxonomy and systematics have been highly active fields (e.g. see the Introduction in Platnick 1997). Canada's spider record now stands at 38 families: two families have dropped out of the list (one does not occur in Canada and the other is generally considered a subfamily), five families have been added through the apparent resolution of polyphyletic and paraphyletic groups, one family was apparently missed or perhaps included in Theridiidae, and one family (Bennett and Brumwell 1996) has been newly collected. Recent revisions have added considerable numbers of species to some groups, particularly those with predominantly cryptic, ground-dwelling members (e.g. Gnaphosidae – 63 species (Dondale 1979) *versus* 100 species (Platnick and Dondale 1992)). Such groups have historically been passed over in favour of those with larger, showier, or otherwise more obvious members (Alderweireldt and Jocqué 1993). Many genera within some cryptic spider groups with considerable numbers of Nearctic species such as Linyphiidae, Dictynoidea, and Amaurobioidea still await serious revision and within these groups may lie numbers of unknown species with Canadian representatives. Still, the number of spider species known or estimated to be awaiting discovery in Canada is relatively unchanged from Dondale's estimate – there are probably at most 1,500 spider species in Canada. This is about 35% and 4% of the world total numbers of spider families (108) and described species (nearly 40,000) respectively, not a bad representation for a land mass repeatedly bulldozed in the Pleistocene. Coddington and Levi (1991) have estimated a world total of 170,000 spider species and that 20% and 80% respectively of the world and Nearctic spider fauna have been described.

Although Canada's araneofauna is reasonably well known, precious little is known of the behaviour, ecology, habitat associations and other aspects of the biology of the majority of species. Furthermore, in spite of a rapidly growing interest world-wide in many aspects of spider biology (e.g. ecology, sexual selection, behaviour, taxonomy, and systematics) as well as in habitat-based spider inventories (see Introduction in Platnick 1997), there is currently not one professional araneologist in Canada and the vast majority of Canadian habitats have yet to

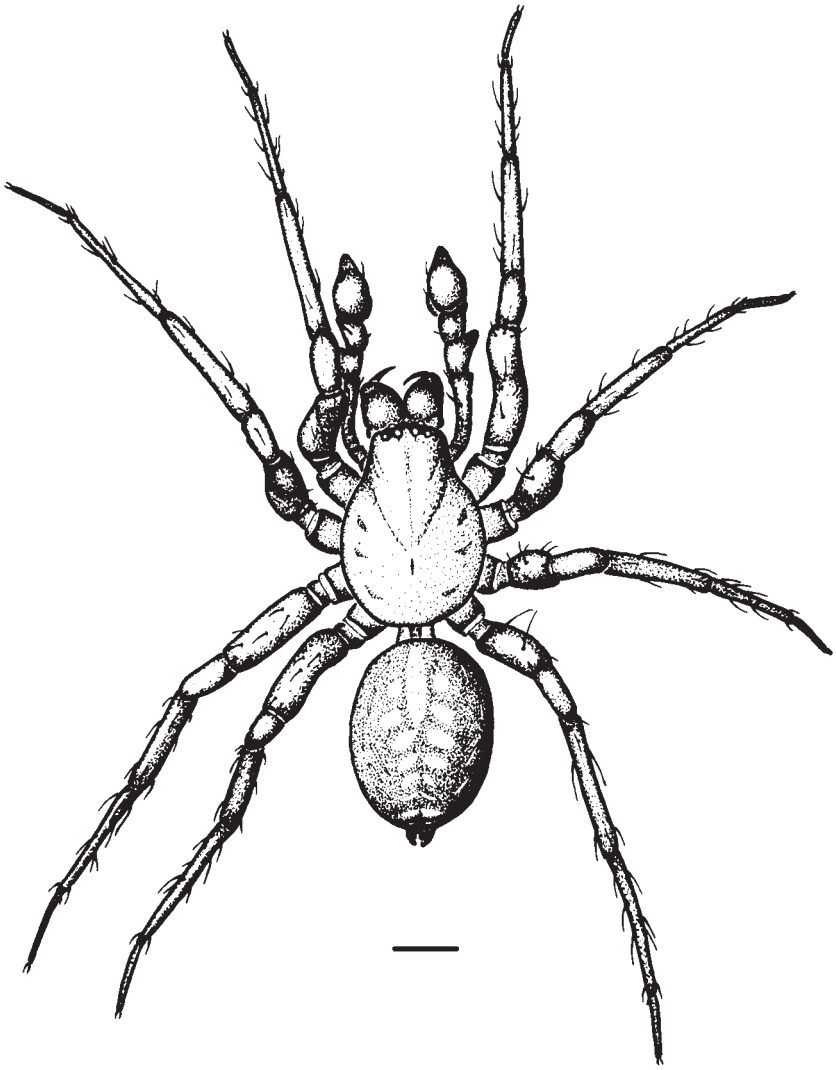


Fig. 1. Male *Cybaeus multnoma* Chamberlin and Ivie (RTA Clade, Dictynoidea, Cybaeidae). Scale bar = 2 mm.

Individuals of about two dozen species of this Holarctic genus are dominant but poorly known generalist predators in the forest floor arthropod community of the Pacific Northwest, especially in coastal regions. In Canada, six species are known to occur in British Columbia (with one species apparently endemic to the Rocky Mountains of BC and Alberta), one species may occur in southeastern Canadian forests. Many species of *Cybaeus* (most notably in Japan and unglaciated regions of the Pacific Northwest) have extremely restricted ranges and are known from only a few specimens.

be seriously sampled for spiders. Biologists seeking reliable identifications of Canadian spiders are forced to use the services of a small handful of amateur specialists located in Ontario, Saskatchewan, Alberta, and British Columbia or seek help outside the country. Under the auspices of Agriculture and Agri-Food Canada, the Canadian National Collection of Insects and Arachnids houses a large, world-class spider collection and taxonomic library. The federal government has effectively declared spider studies to be irrelevant to the agricultural needs of the nation (C. D. Dondale pers. comm.) and little use is now made of this resource.

Table: Classification of spider families with Canadian representatives (modified from Dondale 1979 and following Coddington and Levi 1990 and Platnick 1997) and estimated numbers of species in Canada. With greater knowledge of forest litter and canopy spiders, the number of species found in Canada should approach 1,500.

	Species*
ORDER ARANEAE	
Suborder Opisthothelae	
Infraorder Mygalomorphae	
Fornicephalae	
Atypidae	1
Antrodiaetidae	2
Tuberculotae	
Mecicobothriidae	1
Dipluridae	1
Infraorder Araneomorphae	
Neocribellatae	
Araneoclada	
Haplogynae	
"Scytodoidea"	
Scytodidae	1
Telemidae	1
Pholcidae	3
Dysderoidea	
Segestriidae	1
Dysderidae	1
Entelegynae	
Palpimanoidea	
Mimetidae	6
Eresoidea	
Oecobiidae	1
"RTA Clade"	
Lycosoidea	
Lycosidae	110
Pisauridae	7
Oxyopidae	2
Dictynoidea	
Dictynidae	75-80
Cybaeidae	11
Hahniidae	16
"RTA Clade" (cont'd)	
Dionycha	
Anyphaenidae	7
Liocranidae	18
Clubionidae	35
Corinnidae	11
Gnaphosidae	100
Zoridae	1
Philodromidae	47
Thomisidae	68
Salticidae	110
Amaurobioidea	
Amaurobiidae	30
Titanoecidae	4
Agelenidae	11
Orbiculariae	
Deinopoidea	
Uloboridae	3
Araneoidea	
Nesticidae	2
Theridiidae	100
Theridiosomatidae	1
Mysmenidae	1
Pimoidae	1
Linyphiidae	>500
Tetragnathidae	23
Araneidae	74
TOTAL	~1400

*Approximate number of species in Canada (1999 estimate)

All spiders produce and use silk and can be divided roughly into two behavioural groupings based on this usage: those that use their silk to snare prey and those that don't. Orbicularians, especially the araneoids (primarily sheet-web, orb-web, and cob-web weavers) dominate the former grouping. The latter is a diverse assemblage dominated by the "RTA clade" with major families including the salticids (jumping spiders), lycosids (wolf spiders), thomisids (one family of crab spiders), and gnaphosids (ground spiders). However, us-

age of silk for prey capture is not phylogenetically constrained and numerous groups span the gap. For instance many amaurobioid and dictynoid species (common and widespread in Canada) utilize greatly reduced webs (e.g. see Bennett 1985) and rely upon sit, wait, and pounce strategies. Other species within these groups build large and characteristic capture webs. Among the fascinating but mostly uncommon Canadian tarantula kin (Mygalomorphae) atypids (purse-web spiders), diplurids (funnel-web tarantulas), and mecicobothriids (no common name) use silk in prey capture. Antrodiaetid mygalomorphs (folding-trapdoor spiders) sit in the entrance of excavated burrows and wait for hapless creatures to come near enough to be grabbed and dragged deep into the dim recesses of their retreats and repeatedly stabbed to death (big-city downtown terror is far exceeded by the nightly mayhem on a seemingly peaceful suburban British Columbia lawn). Linyphiidae (including Erigonidae of various authors) and Salticidae, the major family in each behavioural grouping on a world-wide basis, are very difficult taxonomically and have many genera in need of revision and large numbers of undescribed species. Following is a summary of the diversity, abundance, and systematics of Canada's araneofauna.

Araneoidea

The superfamily Araneoidea includes many of the spiders most familiar to the layperson including the orb-weaving garden spiders (Araneidae) and the cob-web weaving widow spiders and house spiders (Theridiidae). However, the vast majority of araneoids, and the most numerous, are linyphiids (sheet-web weavers), only a few of which are encountered or collected regularly by the uninitiated generalist. On the world scale, Araneoidea is the most diverse and phylogenetically best understood superfamily of spiders (Griswold *et al.* 1998).

Linyphiidae

Linyphiidae accounts for over one third of all Canadian spider species (445 known Canadian species with probably over 70 unknown – Dondale 1979). Linyphiids are the largest spider family in Canada in terms of numbers of species and often are extremely abundant. On the world stage, they are second in diversity only to salticids. Many years ago, Bristowe (1938) made a well reasoned estimate of over 2.25 million spiders (mostly linyphiids) per acre of grassy meadow in late summer in England. He also cited a study which produced 159,000 spiders per acre from the soil alone of a similar habitat. (These figures should be kept from the poor arachnophobes who recoil from the small handful of spiders they encounter annually.) The bulk of linyphiid diversity is made up of erigonine species. Dondale (1979) listed over 300 erigonine linyphiids in Canada with an estimate of 50 remaining to be recorded or described. These species are characterized by their undistinguished appearance and small to minute size: not only are a majority of erigonines tiny, most of them look alike. Usable taxonomic keys are virtually non-existent and most genera and species are very difficult to determine even for the specialist. Identification is based largely upon microscopic characters of the very complex male genitalia; in contrast, females usually are unremarkable morphologically and often are unidentifiable if not collected with male conspecifics.

Few comprehensive spider lists have been published for any habitat in Canada except some peatlands (but note that only pitfall trapping was used in most of those studies and therefore the resultant lists likely are incomplete) but a casual glance at the generated species lists shows a preponderance of linyphiids (especially erigonines): 51 of 106 species collected (Aitchison-Benell 1994); 28 of 49, 37 of 108, 27 of 59, 32 of 97, 26 of 76, and 22 of 77 (Dondale and Redner 1994; Blades and Marshall 1994); and 95 of 169 (Koponen 1994). No other family comes close in diversity. This pattern is common throughout the Holarctic region and erigonines increasingly dominate the spider fauna the farther north one travels: Dondale *et al.* (1997) recorded 154 known or expected linyphiid species (34+3 linyphiines, 102+5 erigonines) in the Yukon fauna of 336 spider species. Fully 56% of all Yukon arctic spider species are erigonine. The world is bottom

heavy in terms of plant and animal diversity: most species are found in the tropics and south temperate areas (Platnick 1991). However, among spiders, linyphiids are most diverse in the north and predominate in the Holarctic fauna (Coddington and Levi 1991).

Theridiidae

Theridiidae is the second most diverse araneoid family in Canada with about 100 species (Dondale 1979). Overall, theridiids are as diverse as gnaphosids; both share fourth place in Canada after the hunting salticids and lycosids. Theridiids also are a dominant group on the world scale although, as in most spider families other than Linyphiidae, theridiid diversity primarily occurs south of the Holarctic region. Taxonomically, the Nearctic theridiids are well known and most genera have been revised recently by Levi and co-authors (references in Roth 1993). A field guide to Canadian theridiids is in preparation but is on hold because of shifting government funding priorities (C. D. Dondale pers. comm.).

Theridiids are common and abundant spiders throughout southern Canada in most habitats but are relatively minor components of the fauna of the northern Nearctic region. They are rather more conspicuous than linyphiids as most build their webs above ground level and therefore are more often collected by the generalist. However, a number of genera are - like erigonines - tiny, inconspicuous members of the soil and deep-litter fauna (Dondale 1990). Several genera are regularly and easily misidentified by inexperienced workers and often are found in collections labelled as unidentified clubionids and agelenids. Two theridiid genera, *Steatoda* and *Achaearanea*, are very common in Canadian homes where they kill most other arthropods unfortunate enough to become entangled in their cob-webs and thus are particularly efficient, if not particularly welcome, house-cleaners. These synanthropic species are routinely misidentified as black widows (*Latrodectus* spp., which are closely related theridiids) or the infamous (and completely non-Canadian) brown recluse (*Loxosceles* sp., Sicariidae).

Araneidae and Tetragnathidae

Araneids are probably the most familiar spiders to the average Canadian. Almost all the araneids as well as the closely related tetragnathids (long-jawed orb-weavers) build characteristic, radially symmetric orb webs and together these two families have about 100 species with Canadian representatives. As with the theridiids, the Nearctic tetragnathid and araneid genera have been well revised by Levi and others (references in Roth 1993). A field guide to Canadian species is being readied for publication by volunteers on a part-time basis (C. D. Dondale pers. comm.). In Canada, Araneidae is about as diverse as Dictynidae with which it shares honours for sixth and seventh largest families after Linyphiidae, Salticidae and Lycosidae (equally diverse), and Theridiidae and Gnaphosidae (equally diverse). In the world, Araneidae is the third largest family (Griswold *et al*. 1998), a reflection of its great diversity in the tropics.

Araneids and tetragnathids usually are abundant in fields, open woodlands, and other similar habitats (but note that a significant number of araneids are litter inhabitants). Tetragnathids often are especially common around water or in wet areas. Several species are abundant around homes and outbuildings and in gardens. The classic araneid orb web was for many years considered to be a highly derived structure but now is generally accepted to be a relatively primitive structure, and theridiid cob-webs and linyphiid sheet-webs are derived from it (see papers in Shear 1986).

RTA clade

Sister to Orbiculariae (Araneoidea plus Deinopoidea, a superfamily poorly represented in Canada) is the large and diverse "RTA clade" (Coddington and Levi 1991). (The name is derived from the probable synapomorphy of a distinctively placed apophysis on the male palpal tibia.) Resolving the familial and superfamilial relationships within the RTA clade is the last major hurdle for spider systematics. RTA clade families with Canadian representatives are placed in Dionycha, Lycosoidea, Dictynoidea, and Amaurobioidea. Species in the former two

groupings, Dionycha and Lycosoidea, are common and familiar components of the Canadian araneofauna. Dictynoidea and Amaurobioidea are also common components but mostly unfamiliar to the majority of Canadian biologists. Dionycha encompasses families of two-tarsal-clawed, primarily sedentary (ambushing) or active hunters. Dominant Canadian groups are Salticidae, Clubionidae (sac spiders), Gnaphosidae (ground spiders), Thomisidae, and Philodromidae (philodromid crab spiders). Lycosoidea is represented in Canada primarily by the diverse and extremely abundant lycosids. In Canada, Dictynoidea and Amaurobioidea are dominated by their family namesakes. The Nearctic lycosoid and dionychan genera are taxonomically well known (except for the salticids) and excellent keys exist for the Canadian genera and species (Dondale and Redner 1978, 1982, 1990; Platnick and Dondale 1992). Some Nearctic amaurobioid and dictynoid genera have been revised (e.g. Bennett 1987, 1991; Chamberlin and Gertsch 1958; Leech 1972) but many others are poorly known and no comprehensive guides to the Canadian fauna exist.

Lycosidae

In Canada, Lycosidae has just one fifth as many species as Linyphiidae but shares with Salticidae the honour of being the second most diverse spider family here. Dondale (1979) estimated a Canadian wolf spider fauna of 110 species with roughly 10% of these undescribed or unrecorded. On the world scale, lycosids make up the fifth largest family (Coddington and Levi 1991). Although lycosid diversity is much greater elsewhere, the abundance of individual species often is astounding in Canada. Pitfall traps in any sort of open habitat are regularly swamped with wolf spiders (see abundance tables in Blades and Marshall 1994, Dondale and Redner 1994, and Koponen 1994). Fields, tundra, shorelines, and open wooded areas may literally be alive with wolf spiders (often a single *Pardosa* species) particularly in the spring. Lycosids are diverse and abundant in the far north of the Holarctic and account for 18% of the known Canadian arctic araneofauna (Dondale *et al.* 1997). Lycosids are unique in the transportation by mature females of egg sacs on their spinnerets (giving rise to apocryphal tales of spiders with three body sections) and of young spiderlings dorsally on their abdomens (giving rise, among arachnophobes who have bravely dispatched a large, fuzzy spider only to watch countless small spiders magically appear and scatter in all directions, to nightmares and apocryphal tales of spontaneous generation).

Two other lycosoid families are common but have few species in Canada. Pisaurids (nursery-web spiders) often are encountered along the edges of freshwater systems where they hunt actively above and below the water surface. Two pisaurid species are the largest native spiders in Canada and probably have struck fear into countless cottagers in Ontario and Quebec. Some oxyopids (lynx spiders) may occur in large numbers in agricultural fields and have been the subject of studies on natural pest control (see references in Young and Lockley 1985).

Salticidae

Salticids are the charismatic "cute/fuzzies" of the spider world: many are highly photogenic and, deservedly, they feature regularly on the pages of glossy natural history magazines. Jumping spiders are renowned for their often fantastic degree of sexual dimorphism and colouration and wild and interesting range of behaviours. Much of this is due to the highly developed visual sense in salticids: the huge main eyes are complex, high-resolution structures capable of focusing on objects by retinal movement. Throughout the twentieth century salticids have been the focus of many optical studies (see references in Foelix 1982, 1996). Jumping spiders are agile, visually orienting, day-active predators commonly found among foliage in sunny locations. Some are synanthropic.

World-wide, Salticidae is the largest family of spiders: well over 10% (about 5,000) of all described spider species are jumping spiders. Salticid taxonomy and systematics are very active fields of study (see current review by D. B. Richman at:

http://dns.ufsia.ac.be/Arachnology/Pages/Documents/Salticid.html) but primarily with tropical groups. Some excellent revisions of Nearctic groups have been published recently (e.g. Maddison 1996 and references in Roth 1993) but the bulk of the genera found in Canada are badly in need of revision. Taxonomically they are a trying group with identifications difficult even for specialists. In Canada, Salticidae is about as diverse as Lycosidae with about 110 species including close to 20% of this number yet to be described or recorded (Dondale 1979). As with most spiders except lycosids and linyphiids, salticids are more diverse and abundant in Canada's southern latitudes than in the far north.

Gnaphosidae

Gnaphosidae is the sixth largest spider family in the world (Coddington and Levi 1991) and a major player in spider diversity in the tropics. In Canada, Gnaphosidae, with about 100 species known or expected to live here (Platnick and Dondale 1992), is about as diverse as Theridiidae and slightly less so than Salticidae and Lycosidae. In general, gnaphosids are common ground-dwelling hunters and are important in the natural control of forest and agricultural insects (Platnick and Dondale 1992). However, few are encountered by general collectors because most are inconspicuously coloured and nocturnal hunters. Members of one genus (*Herpyllus*) are found regularly in buildings.

Over the last quarter of this century, Platnick and others (references in Roth 1993) have revised many of the world's gnaphosoid genera including all of those with Canadian representatives. As a direct consequence, an excellent taxonomic guide to the Canadian gnaphosids (Platnick and Dondale 1992) has been published and few new Nearctic species probably await discovery. However, the biology of the majority of gnaphosid species is not well known, a reflection of our relatively poor grasp of ground-dwelling spiders in general. For instance, in a 1998 study of arthropods of cranberry bogs in an area with a high concentration of Canadian entomologists (southwestern BC), J. Troubridge and S. Fitzpatrick (unpublished data) collected hundreds of specimens of *Gnaphosa snohomish* Platnick and Shadab, a large species previously known only from a pair of specimens taken in central Washington. After lycosids, one or a couple of species of gnaphosids may be among the numerically dominant and visually conspicuous spiders pitfall-trapped in bogs (see Table 2 in Aitchison-Benell 1994; Table 1 in Dondale and Redner 1994). Typical of groups with a preponderance of tropical species, Canadian gnaphosids become increasingly scarce with increasing latitude. However, Gnaphosidae is still a dominant group in subarctic and alpine regions in Canada although few species occur in the far north (Dondale *et al*. 1997).

Clubionidae

The "old" Clubionidae was paraphyletic (Coddington and Levi 1991) and the family was relimited after Dondale's (1979) estimate of a Canadian fauna of about 64 species was made. At least 29 of these species have been transferred to Corinnidae and Liocranidae which together may be sister to Gnaphosidae and its relatives (Coddington and Levi 1991). The remaining species are likely most closely related to Salticidae and Anyphaenidae. Although a field guide to Canada's (paraphyletic) clubionids (and our few species of anyphaenids) has been prepared (Dondale and Redner 1982), the ground-dwelling genera placed now in Liocranidae are poorly known. In Canada, the relimited Clubionidae is comprised primarily of nocturnal species actively hunting on herbs, shrubs, trees, and other plants. A very few species occur in litter or under stones. The majority of Canadian clubionids are found in southern regions with a few species ranging into the subarctic.

Thomisidae and Philodromidae

The two crab spider families with Canadian representatives, Thomisidae and Philodromidae, are dionychans of uncertain affinities (Coddington and Levi 1991). Thomisidae is seventh in terms of world spider diversity with a majority of its species occurring in the tropics. Together, about 115 species in the two families occur in Canada. Thomisids,

with their two anterior pairs of long legs and habitual sideways gait, are distinctly more crab-like than philodromids. Both are dorso-ventrally flattened spiders; thomisids tend to be sparsely bristled and slow moving, philodromids hairy and quick. Crab spiders are primarily diurnal ambush hunters. Thomisids are more common on the ground, philodromids on foliage. Some thomisids are famous for waiting in flowers to grab visiting nectar and pollen feeding insects. Both families are well represented in Canada's boreal north and some species range into the Arctic (Dondale *et al*. 1997) but the bulk of thomisid and philodromid diversity is encountered in the south.

Dictynoidea and Amaurobioidea

Although generally accepted as valid superfamilies, Dictynoidea and Amaurobioidea remain poorly defined and their family level systematics is in disarray (Coddington and Levi 1991). Classically, all members of both groups were considered to be cribellate (the cribellum is a distinctive silk production organ found in some spiders and derived from the ancestral anterior median spinnerets). Lehtinen's (1967) exposure of "Cribellatae" as paraphyletic and defined by a plesiomorphic character (the cribellum) marked the beginning of the current era of spider systematics which has resulted in massive restructuring of the classification of Araneae from family to subordinal levels. Dictynidae and Amaurobiidae are now seen to contain both cribellate and ecribellate genera, many of the latter transferred there after the sundering of the old, paraphyletic Agelenidae (e.g. *Blabomma* and *Cicurina* are ecribellate dictynids; *Coelotes*, *Coras*, and *Wadotes* are ecribellate amaurobiids). The two superfamilies have Canadian representatives in Dictynidae, Cybaeidae, and Hahniidae (Dictynoidea) and Amaurobiidae, Agelenidae, and Titanoecidae (Amaurobioidea). The taxonomy and systematics of amaurobioids and dictynoids has been studied actively in recent years (e.g. Bennett 1987, 1988, 1991, 1992; Griswold 1990) but little has been well resolved above the genus level, various genera are placed only tentatively or uncertainly within one or the other superfamily, and most of the families lack clear diagnosis (except for Amaurobiidae – Griswold 1990). No doubt, if this area remains active, major changes are yet to come.

Dictynidae

With the addition of two genera from the agelenids, the Canadian dictynid araneofauna has grown from about 65 (Dondale 1979) to perhaps 75-80 species, making the regional diversity of this family on a par with Araneidae. The cribellate dictynids were revised by Chamberlin and Gertsch (1958) but they remain exceedingly difficult to identify without comparison to voucher specimens. Most species are quite small and cryptic. The ecribellate taxa need revision and there are no usable species level keys for the family. Both cribellate and ecribellate dictynids weave tangled, relatively shapeless webs although some species build specialized tube-like structures (Bennett 1985). The ecribellate species are found primarily under objects on the ground in wooded areas. Rotting logs may harbour considerable numbers of individual webs. Many of the cribellate species are distinctly arboreal, building their small webs on branch tips. The current growing interest in canopy arthropod surveys may boost the number of dictynid species recorded from Canada. Several dictynids are widespread in Canada's Boreal zone forests and a very few are found in Arctic and Subarctic regions (Dondale *et al.* 1997). The majority of Canada's dictynids have southern distributions.

Other Dictynoidea

Hahniidae and Cybaeidae together have about 30 species with Canadian representatives. Both groups are very common but infrequently collected litter inhabitants. Cybaeids are forest floor spiders; hahniids may be found in a variety of litter habitats. Hahniidae has been considerably augmented by genera transferred from Agelenidae. Cybaeidae is comprised entirely of taxa formerly placed in that family. The Nearctic cybaeids have been revised in recent years (references in Roth 1993) but much of this work remains unpublished and the family is not clearly defined. Most of the Nearctic hahniid taxa have also been revised (references

in Roth 1993) but all the genera transferred from Agelenidae need major work. A few hahniids are found in the far north (Dondale *et al*. 1997) but most Canadian species in both families have southern distributions. Some hahniids are very abundant in peatlands (see Table 1 in Dondale and Redner 1994; Koponen 1994). Cybaeids and coelotine amaurobiids are similar morphologically and ecologically but have different areas of endemism in North America. Coelotines are abundant in eastern forests and none is found in the west. Cybaeids are diverse in the west but are nearly absent from eastern North America.

Amaurobiidae

The cribellate amaurobiids were revised by Leech (1972) and had 25 species with Canadian representatives (Dondale 1979). Since then, the Canadian fauna has lost three species to Titanoecidae but has gained eight ecribellate species from Agelenidae for a total of about 30. Two of the three ecribellate genera in Canada need revision. Most Canadian amaurobiids are forest floor dwellers and build rather amorphous, tangled webs under various objects in woodlands, especially the loose bark of trees and logs. Spiders of this family often are abundant but only the larger species are found commonly in general collections. Most species have southern distributions in Canada but a few are widespread in the Boreal zone and into alpine and subarctic areas (Dondale *et al*. 1997).

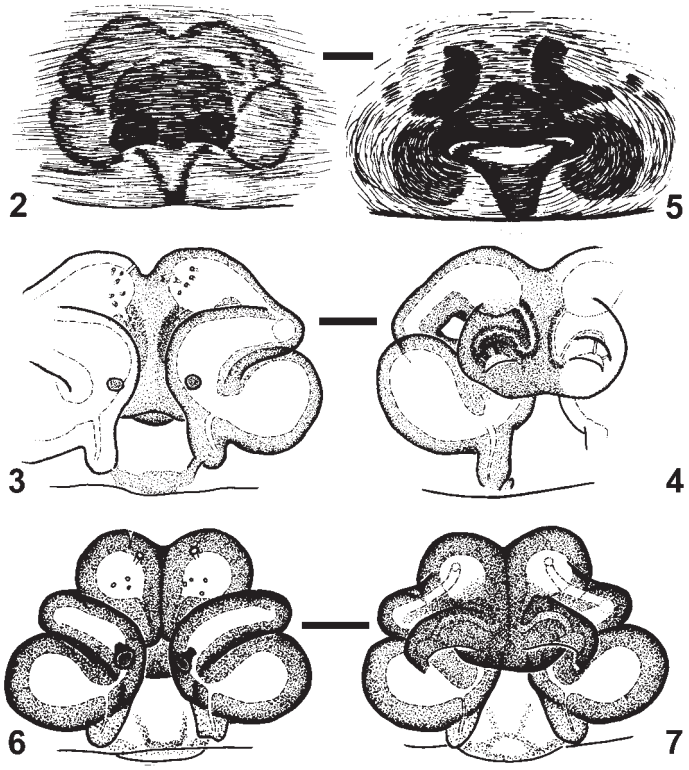
Other Amaurobioidea

In Canada, Dondale (1979) estimated there to be some 65 agelenid species. Agelenidae has long been an acknowledged dump heap for amaurobioid and dictynoid genera of uncertain affinities and the family has undergone major relimitation in recent years (see above). Today in Canada, Agelenidae is a mere shadow of its former self with perhaps 11 species in two common and one rare genus. Several of these species are very well known because of their abundance and/or synanthropic habits. True agelenids all spin distinctive large, non-sticky sheet webs narrowing to a funnel at one edge wherein the builder is usually found waiting for prey to become entangled. Virtually all true agelenid genera need revision. Titanoecidae, a cribellate group extracted from Amaurobiidae, is represented in Canada by only four forest floor inhabiting species.

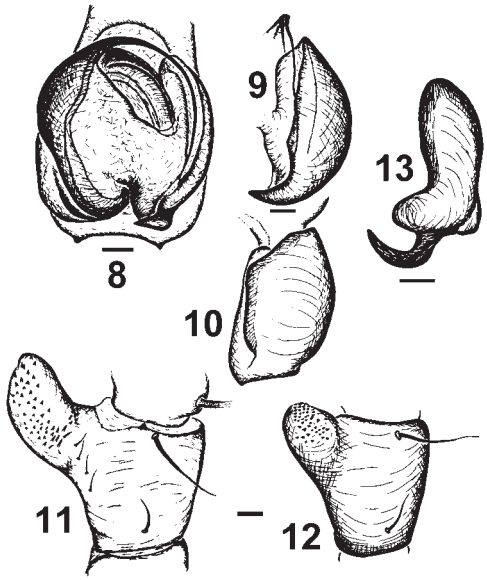
Mygalomorphs and other spider groups

All other spider families with Canadian species are much more diverse elsewhere and, for the most part, rarely encountered here. Pimoidae (previously considered part of Linyphiidae) has one species in Canada which is abundant on the west coast. Mysmenids, nesticids, and theridiosomatids are small araneoids with a single rare species each in the southernmost reaches of Canada. Three species of uloborids (small and interesting cribellate, deinopoid orb-web weavers) are widespread but not abundant across southern Canada. One zorid (small, lycosid-like dionychans) was recently discovered in disturbed areas on southern Vancouver Island. A small handful of mimetid pirate-spider species are the only Canadian representatives of Palpimanoidea (an interesting group, probably sister to Orbiculariae + RTA clade, containing many specialized araneophagous species). One ecribellate oecobiid is an uncommon synanthrope across southern Canada. Haplogynae, originally believed to be paraphyletic, is probably sister to all the "higher" spiders (Entelegynae) including all those discussed above. In Canada, Haplogynae is represented by one synanthropic species each of Scytodidae (spitting spiders) and Dysderidae, a single tiny and very rare species of Telemidae found deep in forest leaf litter in British Columbia, a single segestriid species each in the southern reaches of eastern and western Canada and three or four pholcids (two of which are common in cellars) in various southern localities. Centres of diversity for all these groups are austral or elsewhere other than north temperate.

Four mygalomorph families (Mygalomorphae is sister to Araneomorphae) each have one or two species found in Canada, mostly in the west. One atypid purse-web spider used to be found on the Niagara Peninsula but this species has not been collected recently



Figs. 2-4 *Cybaeus constrictus* Chamberlin and Ivie, Figs. 5-7 *C. conservans* Chamberlin and Ivie; female genitalia. 2, 5 epigynum (external), ventral views; 3, 6 vulva (internal), dorsal views; 4, 7 same, ventral views. Scale bars = 0.1 mm.



Figs. 8-11 *C. angustiarum* L. Koch, Figs. 12-13 *C. tetricus* (C. L. Koch); characters of male left pedipalp. 8 genital bulb, ventral view; 9, 13 apical apophysis, retrolateral views; 10 carinate retrolateral tibial apophysis, retrolateral view; 11, 12 patellae, dorsal views. Scale bars = 0.1 mm.

Figures: In spiders, species within genera are normally very similar in general morphology and usually only can be distinguished by careful comparison of sexual characters with published drawings or expertly identified voucher specimens.

and may have disappeared from Canada. One tiny funnel-web weaving diplurid is found at a single montane locality in southern British Columbia. A disjunct population of one mecicobothriid sheet-web weaver is found on southwestern Vancouver Island. One antrodiaetid trapdoor spider species is common and abundant in reasonably undisturbed habitats along the entire British Columbia coast. Another antrodiaetid is occasionally collected in the dry southern interior valleys of that province. The vast bulk of mygalomorph diversity is found in the tropics and subtropics.

Conclusion

"This is an exciting time in the study of spiders" (C. E. Griswold *in* Dippenaar-Schoeman and Jocqué 1997). Major advances are being made in the taxonomy and systematics of spiders at all classification levels. Publication of taxonomic papers has been very high over the last several decades and shows no sign of levelling off (see Platnick 1997). The Smithsonian Institution and the American Museum of Natural History support active graduate programs that are training new arachnid systematists. These programs have taken up the slack from Harvard University as its highly regarded program winds down (Coddington *et al*. 1990). And there is much work available for spider systematists in North America: ecological interest in spiders is at an all-time high and many families are in urgent need of revision, particularly Linyphiidae and Salticidae but also most families with cryptic, ground-dwelling genera.

Yet there is little in the way of funding or support for systematists beyond the graduate level. Trained arachnid systematists are finding it increasingly difficult to find paid work and often when work is found, research is not a component of it (Coddington *et al.* 1990). Many of the North American arachnid systematists are retired or aging and there is little incentive for younger researchers to enter the field: nearly three-quarters of all active workers receive nothing or less than $1,000 annually in support of their research (Coddington *et al*. 1990). Here in Canada, Agriculture and Agri-Food Canada has shut the doors on its arachnid research program, effectively mothballing its collection of close to 150,000 specimens and the only complete research library in the country.

Basic taxonomic and systematic research provides the foundation for all other aspects of biological research and will continue to do so long into the future. The alpha-level taxonomy (i.e. basic descriptive work, comparative morphology) of the vast majority of arthropod groups including most spiders is in relatively poor shape. Research dollars tend to be directed at the macroflora and macrofauna at the tips of terrestrial ecosystem icebergs. The organisms, primarily arthropods and fungi, comprising the huge and invisible foundations of these icebergs (vital to the existence of the tips) are too often ignored except for those taxa aspiring to "pest" status. Can we expect to understand the functioning of any ecosystem without basic knowledge of the hidden organic and inorganic network supporting the visible component? "Can't see the forest for the trees" is an apt expression: trees obscure our vision of the real machinery of the system. Within ecosystem machinery, spiders are diverse and important cogs. With luck, in the new millenium, Canada will rediscover the inherent value of its declining cadre of systematic araneologists (to say nothing of entomologists) and ecosystem research biologists will no longer have to rely upon the volunteer services of accomplished amateurs to provide names for their data points.

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The Quiz Page

— test your knowledge of Canada and its fauna —

1. What are the main differences between the continental climates of the Canadian interior and the oceanic climates of the coasts?

2. What is the difference between barrens and badlands in Canada?

3. Why are rocks in northern streams important to insects?

4. Many species of insects that feed on the cones of evergreen trees have diapauses that last for more than one year, an adaptation presumed to respond to the fact that cone production is widely variable from year to year. Name five families of insects that include cone-feeding species with prolonged diapause.

5. What do the following abbreviations of relevance to Canada or its environment or fauna stand for?
   a) ka B.P.
   b) dd
   c) PFC
   d) MB
   e) dbh
   f) PFRA
   g) CNC

[answers on page 31]

[Correction: In the quiz in the last issue of the newsletter (17(2), answer no. 5), the spider *Xysticus labradorensis* was inadvertently noted as a lycosid. It is, of course, a thomisid.]

Selected Future Conferences

Organization	Date	Place	Contact
Entomological Conferences			
Entomological Society of Canada	**1999**	Saskatoon, SK	(with Entomological Society of Saskatchewan); Dr. Dwayne Hegedus, Organizing Committee Chair (Agriculture and Agri-Food Canada, 107 Science Place, Saskatoon, SK, S7N 0X2; hegedusd@em.agr.ca) or Dr. Cedric Gillott (Department of Biology, University of Saskatchewan, 112 Science Place, Saskatoon SK, S7N 5E2; gillott@duke.usask.ca)
	2000, 2-7 Dec.	Montréal, QC	(with Societé d'entomologie du Québec and the Entomological Society of America)
Entomological Society of America	**1999**, 12-16 Dec.	Atlanta, GA	ESA, 9301 Annapolis Rd., Lanham, MD 20706-3115; meet@entsoc.org
	2000, 2-7 Dec	Montréal, QC	(joint meeting with ESC, see above)
	2001, 9-13 Dec.	San Diego, CA	ESA, see above
	2002, 10-15 Dec.	Philadelphia, PA	ESA, see above
International Congress of Odonatology and First Symposium of the Worldwide Dragonfly Assocation	**1999**, 11-17 July	Hamilton, NY	Vicky McMillan, Dept. Biology, Colgate University, 13 Oak Dr., Hamilton, NY 13346-1398; vmcmillan@mail.colgate.edu
Annual Meeting of the Lepidopterists' Society	**1999**, 4-8 Aug.	Sierra Vista, Arizona	Paul Opler, P.O. Box 2662, Loveland, CO 80539-8921; http://www.furman.edu/~snyder/snyder/lep/meeting.html

Organization	Date	Place	Contact
10th Auchenorrhyncha Congress	**1999**, 6-11 Sept.	Cardiff, UK	Su Hayward-Lewis, Conference Co-ordinator, Cardiff University, Southgate House, Bevan Place, PO Box 533, Cardiff CF$ 3XZ, UK; auchen@cardiff.ac.uk
2nd International Lepidopterist Conference of Africa	**1999**, 4-6 Nov.	Capetown, South Africa	Jenny Heath, 209 ringwood Dr., Pinelands, 7405 South Africa; aheath@mweb.co.za
XXI International Congress of Entomology	**2000**, 20-26 Aug.	Iguassu Falls, Brazil	details from http://www/sede/embrapa.br/ice/
Collections / Museums / Systematics			
Association of Systematics Collections Annual Meeting	**1999**, 24-25 April	Cleveland, Ohio	(with the American Association of Museums) Association of Systematics Collections, 1725 K Street NW, Suite 601;Washington, DC 20006-1401; asc@ascoll.org
Society for the Preservation of Natural History Collections Annual Meeting	**1999**, 28 June - 3 July	Washington, DC	David Von Endt, Smithsonian Center for Materials Research and Education (SCMRE), Museum Support Center, D2002, 4210 Silver Hill Road, Suitland, MD 20746 USA; dve@scmre.si.edu; www.spnhc.org
Other subjects (especially those relevant to Survey projects)			
North American Benthological Society 47th Annual Meeting	**1999**, 25-28 May	Duluth, MN	Carl Richards, Co-Chair, Natural Resources Research Institute, University of Minnesota Duluth, 5013 Miller Trunk Hgwy, Duluth, MN 55811; crichard@d.umn.edu
Australasian Conference on Grassland Invertebrate Ecology	**1999**, 21 Sept. - 1 Oct.	Perth, Western Australia	John Matthiessen, CSIRO Entomology, Private bag, PO Wembly, Western Australia 6014; johnm@ccmar.csiro.au
7th Triennial International Symposium on Insect/Invertebrate and Plant Cold Hardiness	**2000**, 28 May - 2 June	Victoria, BC	R.A. Ring, Biology Dept., University of Victoria, Victoria, BC V8W 3N5; raring@uvic.ca

Answers to Faunal Quiz

[see page 28]

1. Climates at the centre of the continent have hot summers (e.g. 19°C daily mean in July for Saskatoon, SK) and very cold winters (–18°C in January). Climates there also tend to be relatively dry (35 cm annual precipitation for Saskatoon), especially closer to the Cordillera. Coastal climates, ameliorated by the nearby ocean, have much less difference between the coldest and warmest months (e.g. 15°C and –4°C for St. John's, NF; annual precipitation 155 cm).

2. Barrens are areas relatively barren of vegetation in comparison with adjacent areas because of adverse soil or climatic conditions or other adverse environmental factors, for example sand barrens, rock barrens and extensive arctic barrens in northern Canada. Badlands are regions nearly devoid of vegetation where erosion, instead of carving hills and valleys of the ordinary type, has cut the land into an intricate maze of narrow ravines and sharp crests and pinnacles, as in parts of Alberta and Saskatchewan.

3. Rocks in northern streams affect the often rapid flow and thereby provide both habitats and food for insects. For example, some species shelter under rocks (e.g. some mayflies), and others cling to them in areas of suitable flow (e.g. blackflies). Several species use disturbed flow patterns (e.g. eddies) to acquire food from the current, and others scrape periphyton from rock surfaces.

4. Families of insects that include cone-feeding species with prolonged diapause include Scolytidae (Coleoptera), Anthomyiidae, Cecidomyiidae, and Lonchaeidae (Diptera), Tortricidae and Yponomeutidae (Lepidoptera), and Torymidae (Hymenoptera) [see for example Insect Dormancy 1987, table 27]

5. The listed abbreviations stand for the following:
   a) ka: 1000 years before present
   b) dd: day degrees
   c) PFC: Pacific Forestry Centre
   d) MB: Manitoba
   e) dbh: diameter (of a tree) at breast height
   f) PFRA: Prairie Farm Rehabilitation Administration
   g) CNC: Canadian National Collection

   [Note that especially in the United States many abbreviations are used for common names of insects (such as SBW for spruce budworm), but they are not encouraged here.

Quips and Quotes

"Light minds are pleased with trifles"
(Latin proverb)

"If I cannot brag of knowing something, then I brag of not knowing it"
(Emerson)

"Cleverness is not wisdom"
(Euripides)

"Think much, speak little and write less" (Italian proverb)

No comment

"The poor weather combined with the fact that a number of noctuid species mainly appear as adults in even years, have kept most lepidopterologists in the warmth further south this season. Consequently the number of reports is relatively low . . ."
(A. Ohlsson and N. Ryrholm in *Entomologisk Tidskrift* 117: 64-64 (1996)).

The rearing of blow flies "is technically simple, but can be expensive, malodorous and wasteful of space".
(R.A. Sherman and F.A. Wyle in *Am. J. Trop. Med. Hygiene* 54: 38-41 (1996))

List of Requests for Material or Information Required for Studies of the Canadian Fauna 1999

This list is intended to facilitate cooperation among entomologists by encouraging those who visit suitable areas while engaged in other studies to collect material of particular interest to workers elsewhere. Similar lists that were circulated in previous years prompted the transmission of several useful sets of material, and the efforts of the various cooperators were much appreciated.

Minimum data requested with all specimens are, of course, locality, date, collector and habitat.

(**denotes address reference; listed on page 41)

	Material Requested	Areas of Interest	Collecting Methods, Notes	Name of Requester	**
1	Acari (free living and parasitic terrestrial and aquatic mites)	Anywhere, but especially subarctic and arctic Canada, Canadian grasslands	Berlese-Tullgren funnel extraction from subaquatic substrates, from grasses and sedges, and from bird and mammal nests, would be especially fruitful (preserve in 75% ethanol +5% glycerine).	V.M. Behan-Pelletier; E.E. Lindquist; I.M. Smith	1
2	Adelgidae (conifer woolly aphids)	Anywhere	Preserve insects and bark, needles or galls in 70% ethanol. Specimen records and host plant records.	R. Foottit	1
3	Aleyrodidae (whiteflies)	North America	Preserve insects and host plant material in 70% ethanol. Adults may be dried. Specimen records and host plant records. (Canadian National Collection deficient in all species, including pest species).	R. Foottit	1
4	Anthomyzidae	New World	Adults from any habitat, but often associated with graminoids. Preservation in 70% ethanol preferred. Maliase and especially pan trap residues are acceptable and valuable. General description of herbaceous cover and soil moisture advantageous.	K.N. Barber	2

	Material Requested	Areas of Interest	Collecting Methods, Notes	Name of Requester	**
5	Aphididae (aphids)	Anywhere	Preserve in 70% ethanol. Specimen records and host plant records.	R. Foottit	1
6	Asilidae (robber flies)	North America	Pinned adults.	R.A. Cannings	3
7	Braconidae	Anywhere	Pointed or in ethanol.	M. Sharkey	4
8	Bumble bees	Anywhere in Canada	Include floral host if any. Collect and preserve dry (but specimens that have already been put into ethanol are acceptable).	R.C. Plowright	5
9	Butterflies (see also 35)	Arctic	Preserve papered or pinned (collecting / preserving information supplied on request) [for Alaska Lepidoptera Survey]	K.W. Philip	6
10	Ceratopogonidae	Anywhere in Canada	Send in fully topped-up vials of 70% ethanol. Reared material is especially valuable; provide type of substrate or habitat if material is reared.	A. Borkent	7
11	Cercopidae (froghoppers, spittlebugs)	Canada and Alaska	Specimens (preferably not in ethanol if possible), records and host records.	K.G.A. Hamilton	1
12	Chalcidoids, especially Eupelmidae	Holarctic	Incl. sweep-net samples (see also 43) (collect into ethanol). Reared material is especially useful.	G.A.P. Gibson (see note under email address)	1
13	Chironomidae: *Larsia* (Tanypodinae)	Nearctic and Palearctic fresh waters	Reared material preferred but will accept all stages in ethanol or on slides.	Bohdan Bilyj	8
14	Chironomidae: *Eukiefferiella*, *Tvetenia* (Orthocladiinae)	All areas, especially Ontario	Include sampling method, habitat information.	W.B. Morton	9
15	Chrysomelidae (leaf beetles)	Anywhere, but especially in Canada	Mounted or unmounted and preserved in acetic alcohol (70 ethanol: 25 water: 5 parts glacial acetic acid). Include accurate (species level) host plant information.	L. LeSage	1
16	Cicadellidae (leafhoppers)	Canada and Alaska	Specimens (preferably not in ethanol), records and host records.	K.G.A. Hamilton	1
17	Coccoidea (scale insects)	North America	Preserve insect and host plant material in 70% ethanol. Specimen records and host plant records.	R. Foottit	1

	Material Requested	Areas of Interest	Collecting Methods, Notes	Name of Requester	**
18	Coleoptera (adults or immatures)	Canada	For teaching. Material from mass collections accepted. (Kill larvae in boiling water removed from the heating element, let cool and transfer to 70% ethanol.)	Y.H. Prévost	10
19	Coleoptera (identified)	Northern Canada	Will collect S. Ont. in exchange; has N.W.T. duplicates to exchange for identification.	A. Morgan	11
20	Collembola (literature)	Nova Scotia	Taxonomic literature required in the study of Collembola in N.S.	B. Wright	12
21	Curculionidae (weevils)	Anywhere, but especially northern Canada	Adults can be pinned, pointed, or preserved in ethanol. Record host plant information if possible.	D.E. Bright	1
22	Cynipidae: insect galls from domestic and wild roses	Anywhere	Maturing to mature galls. Remove galls from plants and place in plastic bags. Try to segregate galls of different species. Preserve any emergents in 70% ethanol.	J.D. Shorthouse	13
23	Dermaptera: *Forficula auricularia* (perce-oreille européen / European earwig)	Amérique du Nord et autres régions si possible	A sec ou dans l'alcool.	J.C. Tourneur	14
24	Diprionidae (diprionid sawflies)	North America	Living diprionid sawflies of any species, identified or unidentified. Record foodplant. Contact in advance about shipping.	L. Packer	15
25	Dytiscidae (predaceous diving beetles)	Canada, Alaska and northern USA	Adults and larvae; adults should be pinned or if in ethanol preliminarily sorted.	D.J. Larson	16
26	Eupelmidae: *Anastatus*	North America	Reared materials with associated sexes are particularly important, regardless how few in number.	G.A.P. Gibson (see note under email address)	1
27	Formicidae (ants)	Anywhere	Record type of habitat and nest site. Include brood if possible (preserve in ethanol).	A. Francoeur	17

	Material Requested	Areas of Interest	Collecting Methods, Notes	Name of Requester	**
28	Fungal pathogens of insects (esp. deuteromycetes and ascomycetes)	Anywhere	Place any fungus-infected specimens in a vial. (Identification of the fungus available on request.)	D. Strongman	18
29	Halictidae (sweat bees) brown and black spp. only	North America	Particularly from blueberries. Pinned or preserved. Include flower record if available.	L. Packer	15
30	Hemiptera: Heteroptera (bugs)	Anywhere	Aquatic and semi-aquatic Heteroptera from acid waters (an indication of pH would be useful). Terrestrial Heteroptera from bogs. Preserve in ethanol.	G.G.E. Scudder	19
31	Hydracarina: *Sperchon* (Unionicolidae)			J.C. Conroy	20
32	Insects on snow	Especially western mountains	*Chionea* (Tipulidae), *Boreus* (Mecoptera), Capniidae (Plecoptera): preserve in 70% ethanol.	S. Cannings	21
33	Isoptera (termites)	N. America incl. Mexico	Preserve in 75% ethanol; try to collect as many soldiers as possible.	T.G. Myles	22
34	Leiodidae (=Leptodiridae)	Northern forest and tundra areas; prairies and grasslands	Most easily collected by window traps or flight intercept traps; and car nets (*Can. Ent.* 124: 745, 1992) (collect into ethanol).	S.B. Peck	23
35	Lepidoptera (see also 9)	Arctic	For revisionary work on the holarctic fauna.	J.D. Lafontaine	1
36	Lepidoptera	Manitoulin Island and surrounding islands	Records for use in monograph of the region. Information on old records from collections would be particularly welcome.	J.K. Morton	24
37	Lygaeidae	Anywhere	Material can be collected in ethanol.	G.G.E. Scudder	19
38	Mallophaga	Anywhere	Preserve specimens in 70% ethanol; host species is extremely important.	T.D. Galloway	25
39	Microlepidoptera (excluding Pyralidae and Tortricidae)	North America, esp. west in dry/arid habitats and prairies (CNC deficient in all western species)	Include collecting method and time of day collected. Kill with ammonia fumes. Field-pin; instruction leaflet and field kit available on request.	J.F. Landry	1

	Material Requested	Areas of Interest	Collecting Methods, Notes	Name of Requester	**
40	Milichiidae	Anywhere	Malaise traps are particularly productive; also any found in association with ant nests extremely appreciated. Preserve in 70% ethanol.	J. Swann	26
41	Odonata (dragonflies)	North America	Include 2-3 word habitat description. Adults preferably in envelopes or papered, prepared by immersing in acetone for 24 hours, then dried; larvae in 70% ethanol.	R.A. Cannings	3
42	Opiliones (harvestmen)	Canada and adjacent states	Preserve in 75% ethanol, especially adults with notes on habitats.	R. Holmberg	27
43	Parasitic Hymenoptera	Anywhere	Including selected unsorted Malaise, suction, pan or pitfall trap collections (pan trap kits and instructions supplied free on request).	L. Masner	1
44	Phoridae	Anywhere; especially boreal	Collect into 70% ethanol: especially interested in Malaise trap samples from boreal forest.	B.V. Brown	28
45	Pipunculidae (big-headed flies)	Anywhere in North America	Adults can be pinned, pointed or preserved in ethanol.	E. Georgeson	29
46	Psyllidae	North America	Preferably preserve in glycerine or dried. Specimen records and host plant records.	R. Foottit	1
47	Pteromalidae: *Pachyneuron*	North America	Reared materials with associated sexes are particularly important, regardless how few in number.	G.A.P. Gibson (see note under email address)	1
48	Scelionid egg parasites of Orthoptera	Anywhere	Especially from Grylloidea; preserve in ethanol.	L. Masner	1
49	Silphidae	Canada	Include habitat and trapping method. Malaise trap material welcome.	R. Lauff	30
50	Simuliidae (black flies)	North America, esp. western and northern species	Preserve larvae in Carnoy's solution (1 glacial acetic acid: 3 absolute ethanol). Reared adults with associated pupal exuviae preferred. Instructions available on request.	D.C. Currie	26

	Material Requested	Areas of Interest	Collecting Methods, Notes	Name of Requester	**
51	Siphonaptera (fleas)	Anywhere	Preserve specimens in 70% ethanol; host species is extremely important.	T.D. Galloway	25
52	Solpugida (sun spiders)	Canada	Preserve in 75% ethanol, especially adults with notes on habitat.	P. Holmberg	27
53	Sphaeroceridae	Anywhere, esp. arctic or high elevations	Collect into ethanol. Acalyptrate fraction of trap samples welcomed.	S.A. Marshall	31
54	Symphyta (sawflies)	Boreal and arctic Canada	Larvae and adults collected by Malaise trap, sweeping, etc. (collect into 70% ethanol). Identify larval food plant as far as possible.	H. Goulet	1
55	Tabanidae	Canada	Include habitat and trapping method. Malaise trap material welcome.	R. Lauff	30
56	Thysanoptera (thrips)	North America	(Preserve in 70% ethanol). Specimen records, habitat, host plant records where applicable.	R. Foottit	1
57	Trichoptera (caddisflies)	Anywhere	Larvae, pupae and adults, especially collections that might lead to species identification of larva through association with adult. Preserve adults dry or in 80% ethanol, larvae and pupae in Kahle's fluid or 80% ethanol.	G.B. Wiggins	26
58	[Identifications]	British Columbia	Material from B.C. will be exchanged for identification: B.C. species of Hymenoptera-Apoidea; Diptera-Sciaridae, Trichoceridae, Syrphidae, Heleomyzidae, Platypezidae, Tachinidae, other anthophilous and fungicolous taxa; Coleoptera-Nitidulidae, Cerambycidae, Malachiidae, Dasytidae, Buprestidae, Mordellidae.	H. Nadel	3
59	[Identifications]	High Arctic	Specimens of soil animals in return for identifications	G. Søvik	32

Cooperation Offered

a.	Identification of groups of interest in return for a sample of duplicate specimens	Most but not all of entries in list above.
b	Willing to sort material from certain residues, bulk samples, etc.	See entries 4, 12, 18, 43, 49, 53, 55 above
c.	Field kits or instructions available on request.	See especially entries 39, 43, 50 above.
d.	Exchange of specimens.	Several requesters, including entries 6, 19, 41, 51 above.
e.	Limited collecting in Coppermine area, N.W.T., if particular material required.	A. Gunn (address 33 below).
f.	Collecting of soil animals on Ellesemere Island, arctic Canada	G. Søvik (see entry 59 above)
g.	Material in exchange for identifications.	H. Nadel, G. Søvik (see entry 58, 59 above)
h.	Caterpillars, larval sawflies, aphids and mites available on request from trapnests for solitary bees and wasps.	P. Hallett (address 34 below)

List of Known Email Addresses

(by requester name)

Barber, K.N.. . . . . kbarber@forestry.ca

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. . . . . (guldborg@sverdrup2000.org after June 24, 1999)

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Swann, J. . . . . johns@rom.on.ca

Tourneur, J.C. . . . . tourneur.jean-claude@uqam.ca

List of Addresses

1. Crop Protection Program, Eastern Cereal and Oilseed Research Centre, Agriculture and Agri-Food Canada, Ottawa, Ontario K1A 0C6
2. Canadian Forest Service, 1219 Queen St. E., Sault Ste. Marie, Ontario P6A 5M7
3. Royal British Columbia Museum, P.O. Box 9815, Stn. Prov. Govt., Victoria, British Columbia V8V 1X4
4. Department of Entomology, University of Kentucky, 5 - 225 Agricultural Science Center North, Lexington, Kentucky 40546-0091, U.S.A.
5. 482 Montée de la Source, Cantley, Québec J8V 3H9
6. University of Alaska, Institute of Arctic Biology, P.O. Box 757000, Fairbanks, Alaska U.S.A. 99775-7000
7. 1171 Mallory Road, R1-S20-C43, Enderby, B.C. V0E 1V0
8. 12 Westroyal Road, Etobicoke, Ontario M9P 2C3
9. 3 Woodridge Dr. , Guelph, Ontario N1E 3M2
10. School of Forestry, Lakehead University, Thunder Bay, Ontario P7B 5E1
11. Department of Earth Sciences, University of Waterloo, Waterloo, Ontario N2L 3G1
12. P.O. Box 1255, Lunenburg, Nova Scotia, B0J 2C0

13. Department of Biology, Laurentian University, Sudbury, Ontario P3E 2C6

14. Département des Sciences biologiques, Université du Québec à Montréal, C.P. 8888, Montréal, Québec H3C 3P8

15. Department of Biology, York University, 4700 Keele Street, Downsview, Ontario M3J 1P3

16. Department of Biology, Memorial University of Newfoundland, St. John's, Newfoundland A1B 3X9

17. Département des Sciences fondamentales, Université du Québec à Chicoutimi, 9555 boul. de l'Université, Chicoutimi, Québec G7H 2B1

18. Department of Biology, St. Mary's University, Halifax, Nova Scotia B3H 3C3

19. Department of Zoology, University of British Columbia, Vancouver, B.C. V6T 1W5

20. Department of Biology, University of Winnipeg, 515 Portage Ave, Winnipeg, Manitoba R3B 2E9

21. B.C. Conservation Data Centre, Wildlife Branch, Ministry of Environment, Lands and Parks, 780 Blanchard Street, Victoria, British Columbia V8V 1X4

22. Faculty of Forestry, University of Toronto, 33 Willcocks, Toronto, Ontario M5S 3B3

23. Department of Biology, Carleton University, Ottawa, Ontario K1S 5B6

24. Department of Biology, University of Waterloo, Waterloo, Ontario N2L 3G1

25. Department of Entomology, University of Manitoba, Winnipeg, Manitoba R3T 2N2

26. Centre for Biodiversity and Conservation Biology, Royal Ontario Museum, 100 Queen's Park, Toronto, Ontario M5S 2C6

27. Athabasca University, Centre for Natural and Human Science, Athabasca, Alberta T9S 1A1

28. Entomology Section, Natural History Museum of Los Angeles County, 900 Exposition Blvd., Los Angeles, CA 90007, U.S.A.

29. Department of Natural Resources, P.O. Box 130, Shubenacadie, Nova Scotia, B0N 2H0

30. Department of Biology, St. Francis Xavier University, Antigonish, NS B2G 2W5

31. Department of Environmental Biology, University of Guelph, Guelph, Ontario N1G 2W1

32. Biological Institute, Department of Zoology, University of Oslo, P.O. Box 1050 Blindern, N-0316, Oslo, Norway

33. Renewable Resources, Government of the Northwest Territories, Coppermine, N.W.T. X0E 0E0

34. Department of Physiology, University of Toronto, Toronto, Ontario, M5S 1A8

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