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# Proposals for Expansion of the Biological Survey of Canada

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A long-standing intention of the Canadian Museum of Nature has been to expand the Biological Survey of Canada into groups other than the terrestrial arthropods. However, expansion has two particular requirements: interest from other disciplines (as focussed through disciplinary societies), and resources within the CMN to support the coordinating nucleus for such a Survey. Interest has developed to a considerable degree in the parasitology section of the Canadian Society of Zoologists, which has carried out several initiatives already including an inventory of personnel and a pilot cooperative project, and most recently prepared specific proposals for the attention and information of the Museum.

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Given these developments, readers may be interested in discussion and recommendations prepared by the Survey some years ago, and recently confirmed, about how the Survey should be expanded. A key conclusion is that expansion should take place by founding further modules, and not by diluting the existing terrestrial arthropod module's disciplinary expertise by adding responsibility for other taxa.

## 1. Introduction

The Biological Survey of Canada (Terrestrial Arthropods) comprises a small Secretariat, and a larger expert advisory scientific committee, representative of various regions and interests, constituted through the Entomo-

logical Society of Canada. This organization has been shown to provide effective national coordination in exploring and characterizing the biota of Canada, primarily because it is based in the scientific community through the membership of the scientific committee and

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the general support and cooperation of individual entomologists. This support reflects the fact that the aims of the Biological Survey are scientific: to explore and study the fauna and its content (inventory, taxonomy), nature (ecology, environmental relationships, adaptations, etc.), and origins (evolution, speciation, distributional history).

The organization just described provides a model for the most efficient way to marshal disciplinary expertise and so encourage orderly scientific progress. Each module of this sort can be effected with very modest resources. Moreover, such a modular concept permits a Biological Survey of Canada to be expanded to cover other groups in a gradual and therefore feasible manner, by addition of one or a few modules from time to time as funds and circumstances allow. Such an incremental approach is essential to establish and maintain the scientific quality of the modules, and to ensure that each module has sufficient logistic support.

This document considers how additional modules can be added. An expanded Biological Survey should be scientifically workable, administratively efficient, and able to make best use of available limited resources. Based on these principles, possibilities for such expansion

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sion can be addressed by answering the following questions.

- What are the general characteristics of a module?
- How can appropriate additional modules be identified?
- What minimum organization is essential for proper coordination among modules?

Some suggestions are also made here on how an expansion beyond the terrestrial arthropods can be initiated, but the Museum would want to involve other biologists in developing these suggestions further.

The necessity, before expansion into other modules, for the Terrestrial Arthropods module to be completed to its originally recommended size, with two Secretariat scientists, is explained in a further section.

## II. General Characteristics of a Module

### General Principles

The two essential components of each module are a scientific committee and a secretariat. The *scientific committee* focusses informed discussion in an area of study for which a cohesive body of information exists, and helps to distil useful scientific and general conclusions for action in this area. Such discussions lead for example to synthetic publications summarizing the state of knowledge and supporting further progress; to the organization of joint symposia and conferences; and to the development of various cooperative scientific projects that further study in areas of particular importance to an understanding of Canada's fauna.

The cohesion of the information (and the Committee) in any area of study stems from scientific realities, and can be based on either taxonomic or environmental considerations. For example "parasites" or "freshwater organisms" as well as "fish" or "vertebrates". A module can be supported for any focus in which a *guild of individuals* above a critical size exists.

A critical size supports both the general functions of the module (see below), and provides a committee large enough to reflect diversity of representation and expertise, and to engender appropriate committee dynamics. For these reasons, individual scientists on the committee should comprise no less than seven and no more than 15 individuals.

The *Secretariat* engenders cooperation through discussion and travel, scientific analysis, and maintenance of up to date inventories of resources (personnel, facilities, etc.) for faunal study. These roles of the secretariat in putting into effect the ideas generated by each module require that a full time professional be responsible for the affairs of each module. In most cases, however, a single scientist in the secretariat would be sufficient, since secretariat activities interface with those of a larger guild of scientists. A large secretariat (e.g. three or more scientists plus secretarial assistance) would not be efficient for any single module, because a smaller staff can fulfil the major roles of catalysis and coordination.

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Substantial secretarial assistance committed to each module is also essential to the proper functioning of the survey. Many secretarial tasks are involved in the organization of meetings, preparation of reports, and maintenance of registers of information, as well as in the synthesis of information and survey liaison through correspondence and travel. Secretarial assistance might however be shared among a few smaller modules with somewhat related interests.

### Conclusions about module characteristics

1. The two essential components of a module are a widely representative expert scientific

committee, and a full time professional secretariat.

2. The scientific committee should have between 7 and 15 individual scientists as members, in addition to appropriate museum representatives, etc.
3. The secretariat should normally consist of one (and no more than two) scientists, plus secretarial assistance.
4. Not all modules need to be taxon-orientated, but may instead reflect a cohesive body of information based on habitat or other conceptual or practical approaches.

### III. Definition Of Appropriate Additional Modules

#### General Principles

The ultimate choice of which modules are workable depends on the focus and enthusiasm of the scientific community. The Biological Survey of Canada (Terrestrial Arthropods) has indicated ways in which modules can be initiated, and would assist other guilds to develop their ideas for a module. A module can be developed for any scientifically appropriate guild which is large enough and sufficiently well organized. This allows an expert group

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of people committed to an organized scientific effort to be assembled, and this would be done through the interests of a professional society. The Biological Survey of Canada (Terrestrial Arthropods) could not have developed without the Entomological Society of Canada, and this continuing association is essential for access to the base of entomological expertise.

Because the Biological Survey depends on cooperation, the basic need for any module is a large enough group of potential cooperators, that is to say of scientists with a general interest in characterizing the biota in question.

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For the terrestrial arthropods module it is those primarily interested in taxonomy and ecology, but broader projects might be possible in the later years of this module (as some of the basic taxonomic and ecological problems are solved), and other aspects, for example behaviour, might be emphasized in other taxa which have different main needs for a biological survey.

Inventories maintained by the Biological Survey of Canada (Terrestrial Arthropods) show that there are about 1500 entomologists of all types in Canada. Among this number, scientists primarily interested in non-faunistic specialities (e.g. insect biochemistry) or in specific applied fields of limited scope (e.g. local public health) are less likely to be involved in the survey. Nevertheless, some of these entomologists have wider general interests and do in fact cooperate with the survey to various degrees. Potential cooperators of all kinds, basically entomologists (including amateurs and graduate students) who have some interest in systematics and faunistics, number about 500 individuals. However, the number of people strongly involved in the survey is much smaller. This suggests that whether a module can be justified depends on the cohesiveness and vigour of the guild as well as the absolute number of individuals in it. Of course, enough individuals must have strong appropriate interests to allow a representative scientific committee to be appointed. In any event, the taxonomic or conceptual coverage of a module must be broad enough to include a substantial number of workers. However, the number of species in the taxa being dealt with is less important than the number of potential cooperators, though it would not be appropriate to develop several modules for each of several relatively small

and related taxa, even if there were many students of each. Work on such related taxa could best be coordinated and stimulated by a single module. Indeed, a Biological Survey of Canada eventually completed for all groups would best comprise rather few modules, each of them broad in scope.

The criterion for a module of the number of potential cooperators might vary somewhat according to other resources for work in the

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area, suggesting that a preliminary inventory of available expertise and resources should be prepared by any guild wishing to participate in organizing a further module (and see below).

Although the basic aims of the Biological Survey would be the same for each module, differences among groups would lead to differences in emphasis among the modules. These differences stem from differences in the size of taxa (e.g. terrestrial arthropods over 66,000 species; terrestrial and freshwater vertebrates less than 1,000 species); the state of alpha-taxonomy (e.g. terrestrial arthropods and some other invertebrate groups only 50% described; some vertebrate and most vascular plant groups virtually 100% described); and differences in the state of experimental systematics and the knowledge of bionomics (terrestrial arthropods not well developed in most areas; some other groups with excellent information). Again, certain groups of organisms present particular opportunities for work, for example on systematic procedures, sibling species, geographic races, population dynamics, environmental adaptations, or behaviour.

#### **Conclusions about appropriate modules**

5. A module is appropriate for any discipline which involves a reasonably large number of species and has a guild of potential coop-

erators which is sufficiently large, vigorous and well organized.

6. The organization of a guild would take place through a scientific society, and would require a small group within the guild that had a very keen interest in survey-related objectives.
7. The emphasis on taxonomy, ecology, behaviour, evolution, etc., within different modules may be different depending on the characteristics and state of knowledge of different taxa or groups of taxa.

## **IV Coordination Among Modules**

### **General principles**

Modules perform three kinds of tasks. First, there is discipline-orientated work steered by the scientific committee, which overlaps to a

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varying degree with the work of other modules; coordination of some sorts of geographic, conceptual or taxonomic overlap would generate especially useful results. Second, general coordination (e.g. cooperation between field parties), undertaken by the secretariat, would profit from coordination among modules in different disciplines. Third, general topics of interest to biologists (series of faunal publications, collections, etc.) are shared among modules.

In addition, the Biological Survey of Canada must retain a coherent identity and image in the broader scientific community. The scientific leadership provided through the Museum in this way is distinct from ongoing studies of the biota conducted at the Museum and elsewhere. A distinct identity is essential for the Survey's role as a catalyst. Consequently, modules of a Biological Survey of Canada should develop in a coordinated way, and not be al-

lowed to fragment into separate exclusively discipline-orientated components.

Two basic systems could be used to coordinate the modules. The first, the "line authority model" would envisage a small group (e.g. the chief of the Survey and his assistant) which oversees the other modules, the Secretariat heads of which report to the chief of the Survey. We believe that this is relatively inefficient and unworkable scientifically because it is likely to limit cooperative discussion and exchange of ideas among modules, and it requires significant extra-modular resources. We believe that a "coordination model" is to be preferred, in which the chief of the Survey is a senior module head who chairs a committee of the heads of each module. This group would steer broader aspects of survey work, profiting from the input of all of the modular scientific committees. Its effectiveness would also be en-

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sured by providing a modest "central" budget for these broader purposes.

When there are only two or three modules, a module with two scientific staff might be able to provide for the requirements of the committee of heads without further addition of staff. With several modules developed, an assistant to the chief of the survey would be required to carry out general survey tasks. In due course, additional central "resource" staff might also be required to deal with more complex aspects common to the various modules, such as handling of faunal data, or implementing regional collections policy. These shared aspects would allow significant economies of scale.

#### **Conclusions about coordination**

8. The Biological Survey of Canada should be made a coherent entity by ensuring extensive coordination among modules.
9. This coordination should take place chiefly through collective discussions among the heads of the Secretariats for each module, rather than through a separate group which directs the modules.
10. The chief of the Biological Survey of Canada should be one of the module heads, supported by an assistant responsible for tasks related to the broader survey.
11. While the survey is still small (e.g. 2 modules only), these broader tasks might be taken on by the staff on an existing module which has 2 scientific staff.
12. When the survey is expanded further, one to a few additional staff will be required for central duties and facilities.

#### **V. Procedures for Expansion**

##### **General principles**

Expansion of the Survey to other groups of organisms requires that a variety of other biologists are consulted to determine their interests and ideas for development of additional modules: the Biological Survey depends on the interest and participation of the scientific community, especially as focussed through scientific societies. This consultation could be initiated through informal discussions, or through a national conference among key individuals

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and societies; or biologists and societies could be consulted more broadly through questionnaires or other means.

Some way of evaluating whether a module is feasible, that is whether it meets the criteria outlined above, is required. The necessary cohesion could best be demonstrated by asking for a baseline document, prepared with the guidance of a small "scientific committee", which outlines the aims of and resources for the proposed module.

Such a document would fulfil the same purposes as the Final Report of the Pilot Study which launched the Biological Survey of Canada (Terrestrial Arthropods). This was prepared through a 1 1/2 year contract based on an unsolicited proposal by the Entomological Society of Canada and funded by the Canadian govern-

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ment. In some other groups, especially those which are rather well known taxonomically, much of the information required for such a baseline document may already be available.

The timing of consultations or invitations to other biologists should depend on the likelihood that Museum resources for a wider survey will be available. Any survey module successfully initiated should be supported to continue, as it is unlikely that disciplinary interest and commitment will survive to develop any given module a second time after an earlier failure to fund its continuation.

#### **Conclusions about expansion procedures**

13. Addition of other modules will require extensive consultation with other biologists by the Museum.
14. Feasibility of a proposed module can be evaluated by requiring a document setting out salient features (aims, resources) of that module.
15. Any module successfully launched (i.e. preparing a baseline document judged

fully satisfactory) should be supported to continue.

## **VI. Completion of the Terrestrial Arthropods Module**

### **General principles**

The Pilot Study for a Biological Survey of the Insects of Canada concluded that the module for terrestrial arthropods requires two scientific staff as well as a secretary to be fully effective, because of the diversity of the group and the numbers of people who study it. (Final Report. 1978. Pilot Study for a Biological Survey of the Insects of Canada. Entomological Society of Canada, Ottawa. 249 pp.). Subsequent experience has confirmed this requirement. Nevertheless, the terrestrial arthropods module deals with by far the most diverse group of organisms, and may be the only module for which a second scientist on the secretariat is essential.

The Terrestrial Arthropods module will undoubtedly provide leadership for any expansion. Inevitably, the staff of that module will help to coordinate the first one or two modules, whether or not this is done in a formal way (see above), and such an involvement with the organization of future modules significantly furthers the probability that the new modules will be successful. It would therefore be in the Museum's best interests to complete the Terrestrial Arthropods module to the level at which it is most effective, and able to provide the necessary leadership, before undertaking further expansion. The operation will be weakened if it is spread too thinly.

### **Conclusions about the existing module**

16. The Terrestrial Arthropod module requires two scientific staff to be fully effective.
17. Because the Terrestrial Arthropods module would help to catalyse any expansion, and would provide leadership and organization for it, the best investment of further resources to ensure the future success of

the expanded Survey would be for a second Secretariat scientist before any new module.

## VII. Appendix: The Nature of Potential Modules

Each new module of the Survey must be based on a large enough working group of scientists, with interest in a given field of broad enough scope, to make it feasible. Some possible orientations for new modules are given here as a basis for discussion, but it must be emphasized that the establishment and scope of new modules rests primarily on the practical judgement of the biologists most directly concerned.

### Taxonomic orientation

This is the system by which a "complete" Biological Survey of Canada can most easily be envisaged. The modules chosen would depend, for example, on the number of species in each taxon, on their habitats or relationships, and on the number of students of those taxa, as modified by factors such a wish to include groups otherwise likely to be too small, or to be overlooked, by associating them with related larger ones.

An appropriate set of modules might then be:

- terrestrial arthropods (approximate Canadian species 66,000; 34,000 described)
- other invertebrates, either in one comprehensive module, or as several smaller modules, for example:
  - \* crustaceans (est. 5-10,000 spp.)
  - \* molluscs (est. 2,500 spp.)
  - \* nematodes and platyhelminths (thousands of species)
  - \* other invertebrates (thousands of species) \* vertebrates (approx. 2,000 spp.)
  - \* one or more plant modules, for example:
    - \* vascular plants (4,200), mosses (1,000), and lichens (2,000) (est 7,200 spp.)

\* fungi (15,000) and algae (14,000) (est. 29,000 spp.)

### Habitat or functional orientation

Some groups of people might be coordinated most effectively through an orientation which cuts across taxonomic arrangements. Each such group, however, would again require a reasonably wide focus of scientific activity, with a sufficient number of practitioners. Examples of such modules might be:

- parasites
- soil fauna and flora
- marine fauna and flora (probably subdivided)

### Analytical or methodological orientation

Setting up modules from the viewpoint of the sort of information they acquire might lead to modules such as:

- a "survey" module (in the narrow sense), which might contain
- distribution records unit (distribution mapping, changes of range, etc.)
- documentation unit (specimen data management, etc.)
- ecological modules (e.g. community ecology)
- evolutionary module (which might be orientated, for example, toward evolutionary processes - speciation, genetics, etc. - and experimental work)

### Conclusion

Presumably, a "complete" survey could be a hybrid of these types, with or without overlap among modules. For instance, if there were parasitological, soil, or marine, sections, these might reduce certain needs for taxonomically aligned modules. The key is to develop those modules, of whatever orientation, that will work to augment our understanding of the fauna because they focus the expertise of an appropriate and interested section of the scientific community."