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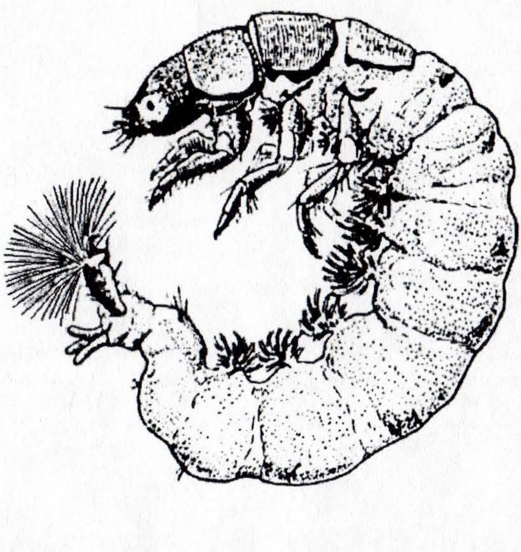
BULLETIN



ENTOMOLOGICAL SOCIETY OF CANADA

LA SOCIÉTÉ D'ENTOMOLOGIE DU CANADA

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BULLETIN

VOL 27(3) - September / septembre, 1995

Contributions and correspondence regarding the *Bulletin* should be sent to the *Bulletin* Editor. Inquiries about subscriptions and back issues should be sent to the E.S.C. at:
Faites parvenir vos contributions au *Bulletin* ou votre correspondance à l'Editeur du *Bulletin*. Pour renseignement sur l'abonnement ou les numéros passés, prière de s'adresser à la S.E.C.:

Entomological Society of Canada
393 Winston Ave.
Ottawa, Ontario
K2A 1Y8

SOCIETY BUSINESS / AFFAIRES DE LA SOCIÉTÉ

45th Annual General Meeting

The Annual General Meeting of the Entomological Society of Canada will be held at the Victoria Conference Centre in Victoria, British Columbia on October 17, 1995.

Governing Board Meeting

The Annual Meeting of the Governing Board will be held at the Harbour Towers in Victoria, B.C. on October 14, 1995. If necessary, the meeting will continue on October 15.

Matters for consideration at any of the above meetings should be sent to the Secretary, Dr. Peggy L. Dixon, at the address given below.

45e réunion annuelle générale

La réunion annuelle générale de la Société d'entomologie du Canada aura lieu au Victoria Conference Centre de Victoria, Colombie britannique, le 17 octobre 1995.

Réunion du Conseil d'administration

La réunion annuelle du conseil d'administration se tiendra au Harbour Towers de Victoria, Colombie britannique, le 14 octobre 1995. Au besoin, la réunion pourra se poursuivre le 15 octobre.

Veuillez faire part au secrétaire de tout sujet pouvant faire l'objet de discussion de l'une ou l'autre de ses réunions en communiquant de l'adresse suivante:

Dr. Peggy L. Dixon, Agriculture and Agri-Food Canada, P.O. Box 37, Mount Pearl, Newfoundland A1N 2C1; Fax 709-772-6064; Tel. 709-772-4763; email address: dixonp@nfrssj.agr.ca

Call for Nominations - Honorary Membership

Nominations are invited for two Honorary Memberships in the Entomological Society of Canada. Honorary Members may be active members or former active members of the Society who have made outstanding contributions to the advancement of entomology.

Nominations must be signed by at least five active members of the Society and are then reviewed by the Membership Committee, who will select two names to be placed on the ballot. Nominations should include a brief biography of the candidate and a statement of her/his contributions to the advancement of entomology.

Nominations should be received by the Chair of the Membership Committee by **31 January 1996.** They should be sent in an envelope marked "Confidential" to the following address: Dr. H.V. Danks, Biological Survey of Canada (Terrestrial Arthropods), P.O. Box 3443, Station D, Ottawa, Ontario K1P 6P4 , Fax. 613-954-6439

Please send correspondence concerning the *Bulletin* to:

Dr. Fiona F. Hunter, *Bulletin* Editor, Department of Biological Sciences, Brock University, St. Catharines, Ontario, L2S 3A1; Fax. (905) 688-1855; Email: hunterf@spartan.ac.BrockU.ca

Please send correspondence concerning Book Reviews for the *Bulletin* to:

Dr. Al Ewen, Book Review Editor, Box 509, Dalmeny, Saskatchewan, S0K 1E0; Tel. (306) 254-4380; Email: ewenal@duke.usask.ca

Message from the ESC President - Dr. Les Safranyik

During the past three months, The Society addressed a number of issues of financial and technical concern. I am pleased to inform you that the book *Diseases and Insect Pests of Vegetable Crops* continues to sell well. The ESC Office is managing all the sales and informed me that the hard cover copies of the French edition will likely be sold out in the near future. Since the hard cover copies of the English edition had been sold out since last fall, and in view of the continuing steady sale of the soft cover copies, the ESC and CPA Executive Councils need to make a decision by early 1996 if possible whether or not to proceed with a reprinting.

I have little progress on plans for a joint meeting of ESA and ESC in year 2000. During the fall, 1993, ESA approached ESC with the idea of holding a joint meeting of the two Societies in year 2000. The ESC Executive approved the concept in principle and Past President George Gerber informed ESA accordingly by letter as well as in person at the 1994 ESA Annual Meeting. A decision was made to form a site selection committee to decide on the location of the joint meeting. George Gerber was appointed as the ESC representative on this committee. Based mainly on the availability of facilities to hold a large meeting, Montreal and Toronto were suggested as sites if the joint meeting were to be held in Canada. Late in 1994, I sent a letter to ESA asking for information regarding planned activities by the site selection committee but received no reply. Dr. Eldon E. Ortman, ESA President, contacted me last spring to explore the possibility of ESA and ESC jointly producing a list of common names, with due consideration for existing protocols in the two countries. I have discussed Dr. Ortman's suggestion with the ESC Executive at the spring meeting in Ottawa, seeking approval for the project with the proviso that it be a contribution by ESA and ESC as part of a joint meeting of the two Societies in year 2000. The ESC Executive approved the idea in principle and I informed Dr. Ortman by letter accordingly. In this letter, I asked him to send me information, as soon as possible, on any further developments regarding plans for a joint meeting of the two Societies. He informed me that he will discuss this matter with his executive but to date I have received no further information.

The various sub-committees of the *ad hoc* committee to review the organization and operation of the Society are hard at work in assembling material for a progress report for the next meeting of the Governing Board. One of the foci of this committee is an in-depth review of the publication process. Further to the publication process, two separate break-ins occurred at the Society Office earlier this summer and the Editor's computer and printer were taken. Aside from the consequent necessity of installing a new electronic security system and repairing/securing doors and windows, the break-in has disrupted electronic copy-editing and other office operations. Due to the efforts by the Treasurer, Headquarters and Finance Committees, the damage to the building was quickly repaired and the lost equipment quickly replaced so that office operations are functioning normally again. The Publications Committee has completed work on copyrights to the Society journals. The copyright registration is currently being implemented.

Dr. V.N. Fursov, Secretary of the Ukrainian Entomological Society (UES) has contacted Joe Shemanchuk requesting increased contact with ESC, including exchange of literature, collaborative research, and support for conferences. UES is especially interested in receiving recent ESC publications (*The Canadian Entomologist, Memoirs, Bulletin*). ESC Members interested in establishing contact with the UES or exchanging/donating publications can contact Dr. Fursov at the following address: Dr. V.N. Fursov, Kiev-34, Vladimirskaya Street, House 51/53, Apt. 73 , 252034 UKRAINE

Preparations for the joint Annual Meeting of ESC and ESBC are progressing well. Terry Shore, Bernie Roitberg, Hannah Nadel and their committees put together a technical program featuring a variety of topics that should be of interest to a wide cross section of membership. Hope to see you all in Victoria.

Corrections for the ESC Common Names Disk

Please make the following corrections to your disk. If you registered it you will already have received some of these changes. (Press G on the menu to get the User Registration Form. Ignore serial number).

Acknowledgements -
Replace "B.C. Provincial Museum" with "Royal British Columbia Museum".

Names -
Allegheny spruce beetle - Add footnote - called boreal spruce beetle on ESA list
cat follicle mite - author has e with acute accent (alt 130)
chrysanthemum leafminer = *Chromatomyia syngenesiae* Hdy. (not *Phytomyza*)*
clover seed chalcid = *B. platypterus* (not *platyptera*)
death watch beetle - join deathwatch
fourhumped stink bug - Add footnote - called rough stink bug on ESA list
German yellow jacket - join yellowjacket
mockorange leafminer = *Agromyza* (not *Liriomyza*)*
pine spittlebug - delete footnote 62 (it has been changed to *A. cribrata* on ESA list)
spotted pine sawyer = *M. mutator* LeC. (not *M. maculosus* Hald.)*
Correct footnote 75 to - also applied to *M. clamator* LeC.
spruce spittlebug - delete footnote 78
straw itch mite = *Pyemotes tritici* (L.-F. & M.) (not *P. ventricosus* (Newp.))
sweetclover aphid - author has o umlaut (alt148)
tomato russet mite = *Aculops lycopersici* (Massee) (not *Aculus*)*
west Virginia white = West Virginia white
western rust mite - Delete from list (*A. malivagrans* is a synonym of *A. schlechtendali* and apple rust mite is the approved common name.)

Correct Family names: -
to "Blattellidae" for brownbanded cockroach, German cockroach and Pennsylvania wood cockroach;
to "Diaspididae" for European fruit scale and walnut scale;
to "Lygaeidae" for chinch bug, hairy chinch bug and western chinch bug;
to "Papilionidae" for black swallowtail, celeryworm, parsleyworm and pipevine swallowtail;
to "Scarabaeidae" for bumble flower beetle, carrot beetle, European chafer, goldsmith beetle, Japanese beetle, rose chafer and tenlined June beetle;
to "Sesiidae" for ash borer and lilac borer;
to "Tenthredinidae" for pearslug;
to "Tettigoniidae" for forktailed bush katydid.

(Make the above changes where appropriate in NAMES.TXT, SCI2.TXT, FRENCH.TXT and FTNOTE.TEXT. * - move entry to alphabetical order in SCI2.TXT)

Insect Common Names and Cultures Committee
E.M.Belton, Director-At-Large, ESC (24 July 1995)

The deadline for submissions to be included in the next issue (Vol. **27(4)**) is **November 1, 1995**

La date limite pour recevoir vos contributions pour le prochain numéro (Vol. **27(4)**) est le **1 novembre 1995**

Call for Nominations
Achievement Awards Committee

Gold Medal for Outstanding Achievement in Canadian Entomology
and
The C. Gordon Hewitt Award

Members of the Society are invited to nominate individuals whom they regard as eligible for these awards (for the year **1996**). Nominations should be sent in an envelope marked "Confidential" to the following address:

Achievement Awards Committee
Entomological Society of Canada
393 Winston Avenue
Ottawa, Ontario
K2A 1Y8

and should comprise: (1) the name and address of the nominee(s); (2) a statement of relevant achievements; and (3) the name of the nominator and at least one seconder. To be considered by the Achievement Awards Committee, nominations must bear a postmark no later than **December 31 1995.**

The following conditions govern these awards:

1. Outstanding contributions should be judged on the basis of

(a) superior research accomplishment either as a single contribution or as a series of associated endeavours and which may be either in entomology or a related field where the results obtained are of great consequence;

or

(b) dedicated and fruitful service in the fields of Society affairs, research, administration or education.

2. No more than one of each award shall be granted per year but, where circumstances warrant, more than one individual may be mentioned in a single award.

3. Recipients need not be members of the Society providing their contribution is judged to have a major impact on entomology in Canada.

4. The award may be granted on different occasions to the same recipient but for different contributions to entomology in Canada.

5. Nominees for the C. Gordon Hewitt Award must be less than 40 years of age throughout the calendar year in which the award is both announced and awarded.

Comité des décorations

Médaille d'Or pour Contributions Exceptionnelles à l'Entomologie Canadienne et Prix C. Gordon Hewitt

La Société invite les membres à lui faire parvenir les noms des personnes qu'ils considèrent éligibles à ces deux prix. Veuillez envoyer vos nominations (pour l'année **1996**) au:

Comité des décorations
La Société d'entomologie du Canada
393 Winston Avenue
Ottawa, Ontario
K2A 1Y8

dans une enveloppe portant la mention "Confidentiel". La nomination doit contenir: (1) le nom ainsi que l'adresse du (ou des) candidat(s) désigné(s); (2) un compte rendu des réalisations pertinentes; et (3) le nom du parrain et celui d'au moins une deuxième personne appuyant la mise en nomination. Pour être acceptées par le Comité, les nominations devront porter un sceau postal d'au plus tard le **31 décembre 1995**.

Les conditions suivantes régissent le choix des récipiendaires de ces prix:

1. Les contributions exceptionelles devraient être jugées dans le contexte

(a) d'un accomplissement hors pair en recherche, soit comme résultat d'une seule contribution ou d'une série d'efforts reliés et ayant abouti à des résultats de grande valeur. Cette recherche aura été réalisér en entomologie ou tout autre domaine connexe.

ou

(b) de service dévoué et fructueux au profit de la Société, de l'administration de recherche, ou de l'éducation.

2. Chaque prix ne sera décerné qu'une seule fois par année. Cependent, lorsque les circonstances le justifient, plusieurs personnes peuvent collectivement devenir récipiendaires d'un prix.

3. Les récipiendaires ne doivent pas nécessairement être membres de la Société pour autant que l'on juge que leur contribution a eu un impact majeur sur l'entomologie au Canada.

4. Chaque prix peut être décerné plus d'une fois au même récipiendaire mais pour différentes contributions à l'entomologie au Canada.

5. Le candidat désigné pour le prix C. Gordon Hewitt doit être âgé de moins de 40 ans pour toute la durée de l'année au cours de laquelle le prix est annoncé et décerné.

ARTICLES

Risk Assessment of Biological Control (predators and parasitoids)

R. S. Bourchier[1] and L. S. McCarty[2]

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[2] L.S. McCarty Scientific Research And Consulting, 280 Glen Oak Drive, Oakville ON L6K 2J2

Introduction

This paper is a report on the results of a workshop entitled "Risk Assessment of Biocontrol" that was held as part of the Canadian Forum for Biocontrol Meeting in Winnipeg, Canada, 16 October 1994. The specific objectives of the workshop were :

1. to gain an understanding of risk assessment and how it can be applied to biocontrol,
2. to review the state of the knowledge about the unique risk assessment issues associated with biocontrol,
3. to develop a list of the communication requirements relating to biocontrol policy.

Definition of Scope

In the context of the workshop and this report, the term biological control refers to "..the applied control strategy that involves the manipulation of living natural enemies for purpose of the regulating the abundance of pest populations" (Kelleher and Hulme 1984). Some definitions of biological control are much broader, covering both the use of live organisms and the use of natural products derived from these organisms. Thus the use of products such as pheromones, hormones, and natural toxins are sometimes considered to be methods of biological control. This paper however, is limited to a discussion of biocontrol using macro-invertebrates. There are two basic strategies of using macro-invertebrates for the control of insect pests or noxious weeds:

Classical biological control: the suppression of a pest population by the importation of natural enemies that are non-indigenous to the territory where the target species is a pest (Nordlund, 1984, Wallace 1995). These releases are termed inoculative (Nordlund 1984); small numbers of a natural enemy are released to re-establish a host-natural enemy relationship that exists in the country of origin or to establish a new host-natural enemy association. Once released the parasitoid or predator is expected to multiply naturally and move with the host throughout its range.

Inundative release: the liberation of large numbers of a parasitoid or predators for short term protection of limited areas from a host insect (Nordlund 1984, Wallace and Smith 1995). Releases generally are repeated as required. The released natural enemies are usually already present in the release environment.

Basic Principals of Risk Assessment

Environmental risk assessment has been defined as the use of toxicological and ecological data to estimate the probability that some undesired environmental event will occur (Wilson and Crouch 1987). Risk assessment is really the scientific portion of a larger process referred to as risk management. The Canadian Standards Association has proposed a general framework for risk management, that provides a means of addressing risks involved in the use of virtually any product or process (Canadian Standards Association, 1991). The CSA framework is only one of a number of models for risk management; others such as the US Environmental Protection Agency model (1992) may have an alternative emphasis or terminology due to differing objectives. The thing most risk management models have in common is a scientific portion that involves risk assessment and a policy portion (risk control) that involves decision making (see Figure 1). Combining the scientific knowledge of risk with the policy decisions to address risks is required for effective risk management.

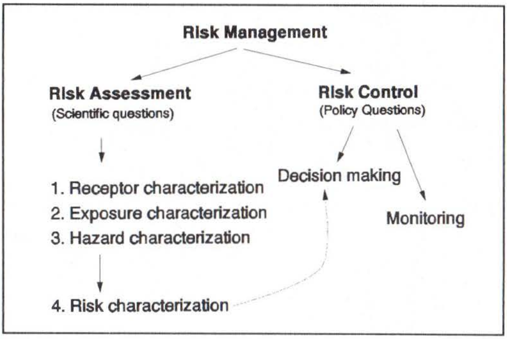

Figure 1. General risk-management framework

The overall objective in risk management is to reduce the risk of a particular activity, not to eliminate it; there is no such thing as zero risk in any activity. Even if the particular activity is eliminated, risk does not necessarily go to zero because there is the phenomenon of risk transference. For example, if a absolute cure for cancer was found, the risk of dying is not eliminated. In fact, the risk of dying from causes other than cancer will increase.

Risk assessment is only a tool for evaluating scientific data used in the process of risk management. Prior to conducting a risk assessment the risk control or policy objectives must be defined. The evaluation of risk must examine several options including at least the status quo and one proposed action. For a proposed parasitoid introduction for classical biocontrol, options may include: 1) to introduce the parasitoid and potentially control a pest or 2) to not introduce the parasitoid and deal with the potential impacts of the pest.

At the workshop we first considered the four basic steps used for an ecological risk assessment (Gaudet *et al.* 1994, Figure 1). After defining the steps in general, we looked specifically how these steps related to biological control. The four basic stages are:

1. **Receptor characterization (WHO is going to be affected?)**

Identification of all organisms potentially affected by the activity being evaluated. This includes the development of a list of the expected effects and how these effects can be measured . A key question is to think about is how many different 'receptors' at differing trophic levels are likely to be exposed to the agent.

2. **Exposure characterization. (HOW does the exposure takes place?)**

The process of determining how the agent gets into the environment, where it goes and how long it persists. What are the ecological pathways for exposure? What are levels of exposure, the frequency and duration of exposures for the various receptors identified in step 1?

3. **Hazard/effects characterization (WHAT is the nature of the impact ?)**

The process of identifying the range of effects that have been reported for the various receptors; specifically, what effects have been quantified in model systems and/or field experiments. This data is used to establish an acceptable biological exposure limit that will not cause adverse effects, or at least should avoid producing effects that can be identified with the current state of the art.

4. **Risk characterization/analysis (DECISION)**

The final stage in which the acceptable exposure level is compared with the anticipated exposure level to calculate an exposure ratio (ER). A decision to proceed is dependent on the nature of the exposure ratio. In general, an exposure ratio of less than 0.1 is of little concern. An ER ratio of 1 is of potential concern, and an ER of greater than 10 usually represents a definite problem.

The development of the accepted level of exposure can be based on scientific data or on a policy decision. A key objective of this exercise is for people to recognize that both science or policy are driving the final decision and their relative influence is rarely equal. Exposure ratios are semi-quantitative in nature, many researchers are now moving to the use of probabilistic methods for risk assessment. In this approach the probability distributions of the receptor exposures and receptor responses are considered, rather than just the single-point estimates that are used for calculation of an exposure ratio. Incorporation of variable responses requires more effort in data collection, but provides increased confidence in the final decision.

Application of ecological risk assessment to biological control

Formal risk-assessment protocols or measurements of exposure ratios for live biological-control organisms are generally not available. Efforts to administer the proposed new biocontrol regulations in both Canada and the United States will be based on as yet undeveloped protocols. At the workshop we focused on the first 2 stages of the risk assessment process and how these stages were unique when considering a biocontrol program.

1. As part of the **receptor characterization** we examined the nature of the target/non-target effects of biological-control organisms. Receptors are simply organisms that are affected, they can be at different trophic levels or be either pests or beneficials. The three basic ways receptors can be affected are *directly, indirectly, or non-directly* (Munkittrick and McCarty 1995). *Direct effects:* examples include, a reduction in the density of the target species or displacement of a native species by the released species. *Indirect effects:* examples include increases or decreases via predation, parasitism, disease or nutrition in the density of a non-target species that are caused by the released organism, that may also affect the original target species. *Nondirect* or *induced* effects are those produced by changes to the habitat related to the presence of the pest and/or the release of the biocontrol organisms. For example, large-scale defoliation of habitats by gypsy moth may ultimately affect both the pest and the community in which it lives. The major difference between indirect and nondirect effects is that the latter are not linked quantitatively to dose-dependent direct effects.

2. As part of **exposure characterization** we examined the determination of the fate of released organisms. Specifically novel data requirements are to address questions about natural enemy mortality, reproduction, phenotypic variability, adaptation to habitat and target species and the potential for genetic change.

Because of the distinctive requirements for biocontrol agents, we chose these two areas to be addressed by working groups. Each group was given a series of questions to answer with the aid of a facilitator. Questions were intended to help focus the discussion and identify areas were we have information and areas that require further work. These working groups were dealing with the scientific aspects of the risk management problem. A third working group addressed the policy issues related to risk management of biocontrol. The following three sections are summaries of the points raised in each discussion group, in response to questions (in italics) posed by the facilitator.

Discussion Group 1: Risk Assessment of Biocontrol
THE NATURE OF THE TARGET/NON-TARGET EFFECTS

What are general principles that must be observed to effectively assess the nature of the effects of a biocontrol release?

Must distinguish between classical and inundative type of biological control in developing risk assessment.

In classical biocontrol situation:

- dealing with a remediative approach, attempting to restore some " natural balance" with an intervention. It is sometimes difficult to know what is "natural" since the pest itself may be an introduced one and nature is never static.
- risks will have to be assessed in the long term. Once an introduction is made effects are self-sustaining if establishment is achieved.
- because of the long term nature of effects, prediction and quantification of potential effects prior to a release is vital.
- there is no concept of dose in a classical introduction of a natural enemy, excepting the required "dose" to get successful establishment of the agent. The majority of introductions, accidental and planned fail. Waage and Mills (1992) estimated that 25% of the species released in biocontrol projects have become established. For biocontrol of the gypsy moth in North America, there have been 90 different species of parasitoid introduced (Montgomery and Wallner 1988) with the successful establishment of only 11 species (Schaffer *et al* 1989).
- no direct human health risks are known

In inundative situation:

- intervention usually does not involve introduction of a new species, and acts as a one time only pulse to the system. Thus, it is more similar to the application of a chemical in terms of exposure and persistence.
- species used for inundative release may already be present in the release habitat. The release represents a shift in the relative densities of the host and natural enemy in the environment.
- concept of dose applies because release rates and efficacy are assessed for the period of natural enemy activity.
- potential for direct human health risk are low but are possible.
- potential transfer of genetic information to natural strains of the natural enemy is more likely to occur in inundative situation.

The biocontrol paradigm, especially for classical introductions, is one of remediation of a "natural" situation, putting a system back into what is judged to be balance. This is done by either introducing a natural enemy that is present in the native environment of the target, or for inundative release adjusting the density of a natural enemy that is already present in the habitat

The level of acceptable risk should be associated with the severity of the problem and the impact on potential non-target receptors.

How do biocontrol agents differ from chemicals with respect to the nature of target/non-target effects?

There is a need to focus on the interaction of the introduced species in the release environment since indirect and/or nondirect effects are most likely to be the cause of undesirable ecological/human effects. In the case of chemical contamination direct effects are more common. In biocontrol, direct effects are likely to be focused on the target pest species, although direct effects on non-target species are possible as some control agents may attack new or previously known substitute hosts.

- the risk of extinction due to a biocontrol agent is likely lower than for chemical control agents.
- the released biocontrol agent can move by itself. It does not require facilitation of transport by physical-chemical dispersal mechanisms present in the environment for effects to occur.
- there is no bioaccumulation with a biocontrol organism whereas there can be bioaccumulation for a chemical.

List the specific exposure pathways by which impacts of a biocontrol release could occur.

The discussion of effects was started from the immediate direct effects on the other species of putting biocontrol agents into a system and the different ways in which that might happen desirable, undesirable, intended, and unintended. We then worked outwards in circles to try identify the more remote and indirect kind of consequences there might be. The group did not get all the way out to the most indirect consequence possible.

For classical introductions :

Direct effects

- the reduction in the target pest population to the desired level,
- nothing happens to the target population because released agent fails to become established,
- attacks on alternative/non-target hosts, either of economic or ecological importance, could be other biocontrol agents, endangered species or other pests .

Indirect effects

- if host density is reduced by the biocontrol agent there will be fewer hosts available for target pest's native predators/parasites,
- effects on native parasites that have a potential new host to exploit.

For inundative release program

All listed effects for classical biocontrol programs were considered possible for inundative programs but as indicated under general principles, there is a shorter time frame for impact. Points specific to inundative releases were:

- there is potential for hybridization between the released natural enemies and those already present in the environment
- potential for health effects is higher than for classical because of the volume of material involved,
- applications can be more obtrusive for public because of the scale of the operation being more similar to chemicals.

Proposed exposure pathways can arise from:

- inadequate testing of specificity of the released organism could result in target host switching,
- contamination with other species,
- misidentification of the release species or biotypes,
- clandestine use of biocontrol agents, more of a concern for inundative programs, leading to "accidental" introductions of exotics,
- evolutionary change in agent or pest.

Make as comprehensive a list as possible of specific methods that could be used to assess the direct, indirect and non-direct (induced) effects of a biocontrol release.

Divide methods into pre/post release phases?

Which of these methods are practical and/or feasible enough that they could be included as part of an enabling regulations?

The development of standard methods for assessing the effects of a biocontrol release was considered by group 1 to be impractical. The important interactions that would have to be considered in a given release are case-specific, and require the development of appropriate methods specific to the case. General methods of what should be considered were discussed in group 2.

What is your desired endpoint for each effect ?

There was confusion with this question because of the differing definitions of end-points for ecologists and risk- assessment specialists. For risk assessment, an endpoint is a response that you measure in the environment; whereas, for ecologists there is the added concept of tolerance of a particular impact, up to an action threshold. Thus, the question should have been phrased what are you going to measure to assess each of the above potential effects? Suggestions from this group included the need for:

- biodiversity data of the potential non-target species in the release area
- for the non-target species of interest, data requirements include:
    - basic biology of the non-target, host plants, location, phenology
    - rates of parasitism by biocontrol agent, in lab and in the field
    - other potential mortality factors of the non-target species

Endpoints as defined for risk management were also addressed within group 2.

Discussion Group 2: Risk Assessment of Biocontrol
FATE OF A RELEASED BIOCONTROL AGENT

What are general principles that must be observed to effectively assess the fate of a released biocontrol agent ?

In a biocontrol release are dealing with a complex ecosystem.

- must be familiar enough with the target ecosystem to define important interactions and potential impacts,

- must have baseline data for population dynamics of the target organism,

- long term follow-up and evaluation of release is required.

How do biocontrol agents differ from chemicals in respect their fate ?
Are these differences organism-specific, if so how?

- biocontrol agents evolve whereas chemicals degrade, natural enemies may co-evolve with target hosts, so host resistance is less likely to occur than for a host resistance to a chemical that cannot evolve,

- biocontrol agents will both actively and passively disperse , whereas chemicals are passively dispersed after being applied in a controlled dispersive manner,

- chemicals do not increase or reproduce,

- the release of a biocontrol agent does not guarantee exposure, and by the same token, exposure to a biocontrol agent does not guarantee effect. The proper application of a chemical, i.e., getting it to the site is as good as guaranteeing exposure and some effect,

- there are a variety of fates of biocontrol agents i.e., reproduction, dispersal, establishment, die off immediately, die off after multiple generations whereas once applied chemicals will only degrade. For some chemicals worldwide dispersal has been observed and in some cases the degradation products may be more problematic that the parent chemical,

- biocontrols may be more sensitive to combinations of environmental conditions than chemicals.

For each heading below :
1. give a brief list of key points that we need to know in the development of a biocontrol program and,

2. Make as comprehensive a list as possible of specific methods that could be used to assess the factor under consideration.

Mobility

Key considerations

- variety of dispersal strategies divided into active or passive. e.g., wind, water , phoresy, hitchhiking (on host), walking flying,
- rates of movement or dispersal are critical, but generally little is known for natural enemies,
- movement varies with insect life stage, dispersive stages are more difficult to sample but are the most important phase to consider,
- density of target host where release occurs will affect movement and dispersal of the natural enemy,
- evaluation of release impacts may have to be longer term if movement of released organisms is a significant aspect of its biology,
- potential to disperse will be limited by suitable habitat. e.g. natural enemy released in moist coastal rainforests will not threaten desert areas of Southwest.

Methods to measure movement

- focus on the dispersive stage, using appropriate trapping,
- sampling objective to assess presence or absence of organism,
- determine conditions that prevent dispersal, and determine survival under various environmental conditions, link to suitable habitat types and develop estimate for potential establishment in N.A.
- assess the effects of host density on movement,

Reproduction

Need to know :

- potential fecundity of the released organism under optimal conditions,
- number of generations per year,
- type of reproduction, sexual versus asexual,

Factors that will affect the realized fecundity of a released organism:

- environmental requirements for successful mating,
- effects of host quality on natural enemy fitness,
- host suitability for successful development of natural enemy,
- potential alternate hosts,
- effects of host density on realized fecundity.

Evolution (co-evolution)

Need to know :

- potential for co-evolution of the released organism, mechanisms include :
- a switch that occurs due the removal of a mass-rearing bottleneck, could require changes in the rearing or release strategy to avoid the bottleneck,
- there is a need for tracking genetic attributes of commercial strains to allow for identification of released material,
- need to assess the usually limited potential for phytophagous species to switch to new hosts.

A major problem is that it is not always practical or even possible to assess these genetic shifts in a relevant time frame. It is possible to shift numerous population characteristics in the lab but difficult to assess the importance of these shifts in the field

Phenotypic response to environmental challenges

Phenotypic variation is inseparable from genotypic variation; therefore, the basic biology of the release organism relating temperature tolerance and diapause conditions to the climatic conditions in potential release sites must be known.

Must examine how the biology of the released agent changes in response to shifting environmental factors (temperature, RH, day length), host phenology, development and survival.

Persistence

For the individual there is need to know the lifespan. For a population, where establishment of the biocontrol agent is vital, there must be a focus on reproductive issues (see above points).

Interactions with other organisms

Key issue: does displacement of other species occur either directly or indirectly via food chain.

There must be the general requirement of understanding the ecosystem function prior to action.

Empty niches are not empty for long and the removal or significant reductions in the density of one species may only result in switching of pest problems.

- must define species for which have concern for displacement
- conduct interspecific competition studies
- as with co-evolution question above, long time scale may apply to adequately assess effects

Discussion Group 3: Risk Management of Biocontrol. COMMUNICATION OF RISK ISSUES RELATED TO BIOCONTROL

What do we need to communicate to the public about the science of biocontrol

Need to define :

- invertebrate biological control agents,
- classical biocontrol programs,
- inundative release programs,
- target audiences for communication, e.g., general public, regulators, user groups, media.

Need to explain :

- concept of risk management, ie that there are risks with both action and no action. Include biocontrol track record.

Each biocontrol case is considered and tested on an individual basis, requirements may be case specific.

The regulatory system and the testing and data requirements for registration.

Communication must be transparent and open to public questions and comment. Science must be understandable

What are the benefits that need to be communicated ?

Major reasons for conducting biocontrol programs are the perceived economic and environmental benefits compared to current pest control methods.

Environmental benefits are associated with a reduced impact on biodiversity and the use of biocontrol is not as likely to compromise ecosystem integrity.

Biocontrol is an alternative approach with generally lower human health concerns.

Biocontrol is not necessarily less risky, there is still a requirement for appropriate risk assessments, many errors have occurred from faulty assumptions.

If a classical program is successful the economic benefits are usually greater than the costs.

An inundative release program is a short-term perturbation to the ecosystem. Often the release agent does not persist (e.g., cannot overwinter)

For inundative programs the immediate objective is to reduce the density of a target host. Most inundative release agents have a built-in feedback loop; they are selected to be effective at high host densities and as the density of the host declines after the release, the ability of the natural enemy to remove hosts also declines.

What are the risks associated with biocontrol that need to be communicated to the public?

Main concern is potential negative impact on biodiversity for insect biocontrol programs whereas for weed biocontrol programs the main concern is host switching. Weed bio-control is perceived to be more risky because of we can place a value of potential non-targets (e.g., agricultural crops) whereas we have not placed value on a species of butterfly that might be an affected non-target species in an insect program. The effects on non-targets for weed programs are easier to test than with non-targets for insects because rearing methods for the non-target plants are available.

For communication of risks we must identify the key difference between classical biological control and inundative programs. Classical programs once initiated cannot be reversed, whereas inundative programs are a short-term increase in the density of a natural enemy that will decline. This basic difference results in differing regulatory criteria for inundative and classical biocontrol programs.

For both techniques there is the potential that they will not work (i.e., cause decline in target population) because release agents may not become established. There is a need to communicate that we are dealing with a live biological organism for which there is more variation in response than a chemical.

Both types of biocontrol programs involve screening for:

- potential of release agent to switch to non-targets,
- potential displacement of local species by release agent,
- potential dispersal capability of release agent.

Summary

For the risk assessment of any pest-control problem, there are a number of choices to be compared. These options include: development of a cropping system that prevents the pest problem, use of some form of biological control, use cultural, physical or mechanical control, application of a chemical pesticide, or to not intervene at all. There is a continuum of risk associated with these options. The information generated in the discussion groups was focused on the assessment of risks associated with the use of biological-control agents only. For the risk management process involving both policy and science, the risks associated with biological control must be placed in the context of the risks associated with the other options. When placed in this context the risks of biological control may be more or less serious, than when they are viewed strictly in isolation, as was done by the discussion groups.

The information developed in the discussion groups can be used to develop a checklist of what should be considered from a "good science" point of view in carrying out any biocontrol program. It is a synthesis developed by researchers working to implement biocontrol as a tool for pest management in a variety of situations. The drafting of regulations will affect the direction of research by creating specific requirements for registration of biocontrol products. Ideally the requirements for registration should match the requirements for good science that already exist in most biocontrol programs.

A fundamental point about most agents being considered for biocontrol programs is the absence or very limited nature of known human health risks. Thus the principal receptor of concern in most risk assessments of chemicals, humans, is not a priority for the a risk assessment of biocontrol releases. What is required, in each proposed biocontrol release, is to identify the organisms of concern and focus on them for risk assessment purposes. This decision of what is an "important" organism comes from the risk control side of the process, and is a policy decision as well as a scientific one.

Risk assessment as a framework for decision making can be applied to biocontrol. The workshop groups only considered the first 2 stages for a risk assessment. An attempt was made at the workshop to divide the discussion into 2 groups of receptor characterization and exposure characterization, but as one participant pointed out there was significant overlap in the points presented in group summaries indicating, that for biocontrol agents, this may be a somewhat artificial division.

What my be more useful is to use the checklist data, routinely generated in most biocontrol programs, to assess the probabilities of particular events occurring. Comparison of probabilities will enable informed decision making.

An example: to assess the impact of a parasitoid release on a species of bird in the release habitat; the impact would be indirect via modification of food availability. Data requirements are the same as required to assess the non-target effects of *Bacillus thuringiensis*, acting via the removal of food sources of birds. Examples of probabilities that should be compared in this case are:

1. what are the probabilities of local extinction of a bird species if one food supply, (2, 3 food supplies, etc) decline due to an additional mortality factor such as a parasitoid;

2. what is the probability of local extinction of a bird species if no parasitoid release is conducted and all trees in the habitat are defoliated for 1, 2, 3 etc years, trees die.

By dividing the question into a choice between probabilities, it becomes possible to design specific experiments to collect the required data. Experiments will be required for every potential organism of concern and thus it is critical to first define what organisms are of concern or chose potential indicator species. (Receptor characterization, in risk assessment terms).

For chemicals the common methods of determining acceptable exposure limit is the calculation of an LD50, LC50, or EC50. The applied dose or exposure concentration of a particular chemical that will cause 50% of the test population to die (LD50, LC50) or exhibit a given biological response (EC50). As indicated in the discussion groups there is no concept of dose for classical biological control; an introduced natural enemy either becomes established or it does not. To assess risks prior to introduction, potential impacts could be tested by screening non-target insects (similar to the protocols for biocontrol of weeds). For this to work however, we must first identify insect species that we are concerned about or potential indicator species that could be used in pre-screening programs. Potential indirect effects could be estimated by choosing indicator species based on the niche they occupy in the environment and assessing the consequences of a potential population reductions of any species in that niche.

For an inundative release program dose is often expressed as the number of parasitoids or predators released per hectare. Using this definition there is the potential to design a standard lab assay to calculate what density of a natural enemy, that for a fixed density of hosts, causes 50 % mortality. Ecologists have attempted to do this for years, with some success, when they have examined functional responses of predators to prey items. The key factors that would have to be considered in the calculation of a functional response-50 (FR-50) are those that also have to be considered in planning an inundative release with a natural enemies; ie the data that researchers already collect to measure the quality attributes of natural enemies and predict field efficacy (host acceptance rates, searching rates, realized fecundity, host suitability, and response to host density).

It is important to recognize that there are significant problems in the transfer of a lab calculated LD50/LC50 or EC50's for "biological" insecticides such as *Bacillus thuringiensis* to field results. The calculation of an FR-50 for a parasitoids would be at least as complicated as the calculations required for Bt. An advantage for the development of a parasitoid index is that the proposed FR-50 is based on lab data which has already been shown to relate to field efficacy. The principal benefit of developing this index is that it places many systems on a comparative scale using ecologically meaningful data, and it enables the calculation of the probabilities of events.

There is a potential to use risk assessment to facilitate decisions about biological-control programmes. The science discussion groups identified many of the basic data requirements for any biocontrol project. These data can also be used for risk assessment. Future work for classical biocontrol programmes for insects should be focused on developing a list of indicator non-targets to screen potential effects of a natural enemy release (i.e., the receptor characterization portion of risk assessment). For inundative programs, future work should address how to use the data generated from biological-control programmes to calculate a functional response-50 (FR50) for natural enemies or to calculate the probabilities of events such as local extinction. This information will greatly facilitate the communication of biocontrol benefits and risks to the public, because pest management policy can be based on experimental results rather than educated guesswork.

Acknowledgements

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NEWS OF ORGANIZATIONS

International Commission on Zoological Nomenclature

The following applications were published on 30 June 1995 in Vol. 52, Part 2 of the *Bulletin of Zoological Nomenclature*. Comment or advice on these applications is invited for publication in the *Bulletin of Zoological Nomenclature* and should be sent to the Executive Secretary, I.C.Z.N., c/o The Natural History Museum, Cromwell Road, London SW7 5BD.

Case 2884 ***Xerammobates* Popov, 1951 (Insecta, Hymenoptera): proposed designation of *Ammobates (Xerammobates) oxianus* Popov, 1951 as the type species**

Donald B. Baker
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Abstract. The purpose of this application is to conserve the current (and original) understanding of the name *Xerammobates* Popov, 1951 for a subgenus of ammobatine parasitic bees. The synonym *Micropasites* Warncke, 1983 is a junior homonym. The present type species of *Xerammobates*, i.e., *Ammobates biastoides* Frieses, 1895, belongs to *Ammobates* sensu stricto and was misidentified by Popov. It is proposed that *Ammobates (Xerammobates) oxianus* Popov, 1951 be designated as the type species.

Case 2945 ***Melissodes desponsa* Smith, 1854 and *M. agilis* Cresson, 1878 (Insecta, Hymenoptera): proposed conservation of the specific names**

Wallace E. LaBerge
Center for Biodiversity, Illinois Natural History Survey, Champaign, Illinois 61820, U.S.A.

Abstract. The purpose of this application is to conserve the specific names of *Melissodes desponsa* Smith, 1854 and *M. agilis* Cresson, 1878 which are in universal usage for two of the most common North American species of long-tongued, solitary bees (family APIDAE). The names are threatened by the virtually unused senior subjective synonyms *Macrocerca americana, M. pensylvanica* and *M. philadelphica,* all of Lepeletier (1841).

The following Opinions were published on 30 June 1995 in Vol. 52, Part 2 of the *Bulletin of Zoological Nomenclature*. Copies of these Opinions can be obtained free of charge from the Executive Secretary, I.C.Z.N., c/o The Natural History Museum, Cromwell Road, London SW7 5BD.

OPINION 1808. *Mastotermes darwiniensis* Froggatt, 1897, and *Termes meridionalis* Froggatt, 1898 (currently *Amitermes meridionalis*) (Insecta, Isoptera): neotypes retained following rediscovery of syntypes.

OPINION 1809. *Bruchus* Linnaeus, 1767, *Ptinus* Linnaeus, 1767 and *Mylabris* Fabricius, 1775 (Insecta, Coleoptera): conserved.

OPINION 1810. *Cryptophagus* Herbst, 1792, *Dorcatoma* Herbst, 1792, *Rhizophagus* Herbst, 1793 and *Colon* Herbst, 1797 (Insecta, Coleoptera): conserved as the correct original spellings, and *Lyctus bipustulatus* Fabricius, 1792 ruled to be the type species of *Rhizophagus*.

OPINION 1811. COLYDIIDAE Erichson, 1842 (Insecta, Coleoptera): given precedence over CERYLONIDAE Billberg, 1820 and ORTHOCERINI Blanchard, 1845 (1820); and *Cerylon* Latreille, 1802: *Lyctus histeroides* Fabricius, 1792 designated as the type species.

OPINION 1812. ELMIDAE Curtis, 1830 (Insecta, Coleoptera): conserved as the correct original spelling, and the gender of *Elmis* Latreille, 1802 ruled to be feminine.

Biological Survey of Canada (Terrestrial Arthropods) Survey Report

The Scientific Committee met in Ottawa on April 20 and 21 1995.

Scientific projects

1. Arthropod fauna of the Yukon

Additional progress with the book on arthropods of the Yukon was reported, especially with introductory sections and taxonomic chapters. Specific consideration of publication processes will start during the summer.

2. Arthropods of Canadian grasslands

Accounts of three ongoing projects in grasslands have been drafted. It is hoped to develop an outline for cooperative work to allow comparison. Following discussions about proposals for a major project, it was agreed that a paper outlining the advantages of using arthropods for biodiversity monitoring and ecosystem management would be prepared.

3. Arctic invertebrate biology

Another issue of *Arctic Insect News* was produced late in 1994, including submissions from British and Russian as well as Canadian scientists. Cooperative work has been initiated on herbivores and pollinators under the Canadian component of the International Tundra Experiment.

Other scientific priorities

1. Old-growth forests

A table giving details of old-growth forest projects has been expanded, and is being verified with respondents prior to dissemination, probably in the *BSC Newsletter*, in order to help link the many existing projects. Various current projects in old-growth forests were reported on.

2. Invasions and reductions

The great public as well as scientific interest in invading species was noted. Possible ways to consolidate the project on invasions and reductions in the fauna will be considered at the next meeting.

3. Arthropod fauna of soils

Dr. V.M. Behan-Pelletier noted that recent international meetings have helped to establish that taxonomists and ecologists have not always communicated effectively, hindering the study of soil arthropods.

4. Infrastructure support for collections

The Committee discussed the draft of a brief urging infrastructure support for collections which provide the major long-term database for the study of biodiversity. The brief will be revised for submission to the Natural Sciences and Engineering Research Council and a version will also be prepared for submission to the Canadian Biodiversity Convention office.

5. Endangered species

The ESC resolutions endorsed by the Committee at its October 1994 meeting had been widely circulated and an annotated summary of relevant legislation published in the Survey Newsletter. (see also under Liaison, CWS, below)

6. Workshop on Coleoptera

Arrangements for this workshop in Ottawa had been completed, and it took place on May 22-28 after the Survey meetings.

7. Analysis of gaps in taxonomic knowledge

A draft analysis of gaps in taxonomic knowledge and expertise was discussed. Detailed protocols for entries in a table will be prepared, and the table completed with the assistance of individual experts.

8. Damaged ecosystems

Dr. J.D. Shorthouse reported that as a result of his discussions with companies in Sudbury, a proposal for work on the beetles of revegetated tailings has been initiated.

Secretariat Activities

During the 1994 round of visits on behalf of the Survey to entomological centres in Canada, Dr. H.V. Danks discussed the Survey and its projects informally with entomologists, other biologists and officials. Various seminars or lectures on the Survey and on aspects of the insect fauna were also presented.

Liaison and exchange of information with other organizations

1. Canadian Museum of Nature

Dr. P. Colgan, Executive Vice-President, CMN, reported that the CMN is experiencing a budget cut of 19% over 3 years. For the decade beginning in 1989, Museum appropriations will have fallen from $21 million to $13 million (in shrunken Canadian dollars).The Museum plans to respond by increasing revenues from non-governmental sources, involving considerable transformations. Research is being focussed through three Centres of Knowledge, dealing with Natural Diversity, Contemporary Change and Planetary Evolution, to ensure that the work going on is both scientifically and societally important. Various projects in research and collections address both internal policies and external leadership and coordination. The Federal Biosystematics Group (CMN, Agr. Can and CFS) has produced a position paper on Systematics: an impending crisis, intended to alert decision makers and stakeholders about the importance of systematics.

2. Biological Resources Division, CLBRR

Dr. Jacques Surprenant, Executive Deputy Director, BRD, reported that Agriculture Canada has a 19.5% budget cutback over the next three years. The Central Experimental Farm received about a 60% decrease in staff over that period. BRD will experience a 10% cut. All BRD research activities are now being re-evaluated to ensure that they are addressing concerns of the main stakeholders, Agriculture and Forestry, which put money into BRD. By the end of the summer, all research activities should be realigned to answer the needs of those providing the resources. Dr. Surprenant confirmed that fees for services are to be applied to everyone who is not putting in money, although collaborative research (e.g. between BRD and university personnel) would not be in this category. The national collection will be protected, being rationalized on the basis of the support it provides to work required to obtain information of value to Agriculture Canada. The Committee noted the value of the BRD handbooks. Dr. Surprenant reported that the handbooks will still be produced but by a different publishing avenue.

3. Entomological Society of Canada

Dr. L. Safranyik, President, ESC, reminded the Committee about the current operational concerns of the Society, and pointed out that an ad hoc committee is conducting an in-depth review of both the structure and the function of the Society. He reviewed sales of the book on Diseases and Pests of Vegetable Crops in Canada, and other activities of the Society, including planning for future Annual Meetings.

4. Parasitology (Canadian Society of Zoologists)

Dr. D. Marcogliese, Chair, Parasitology Module, CSZ, reported on the module's ongoing projects on parasites of yellow perch, a parasitological directory, and a gap analysis for parasites. He also provided other news and publications of interest to the Committee. Fisheries and Oceans Canada is closing down the centre of disciplinary expertise in Mont-Joli within two years, comprising 50% of the parasitologists in Atlantic Canada.

5. Canadian Forest Service

Dr. J. Huber, CFS, reported that the Canadian Forest Service was severely cut in the February budget. The Forest Insect and Disease Survey no longer exists as an entity, and its staff has been reduced. The number of regional centres has been reduced by amalgamation and closure, and a major reorganization of programmes has started and is still underway. Nevertheless most entomologists at scientific and technical levels have been reassigned to different programmes, not laid off. Following the reorganization, entomology staff will be in the forest centres in Ste.-Foy, Sault Ste. Marie, Victoria, Edmonton and Fredericton, a satellite laboratory in Newfoundland, and in BRD.

6. Ecological Monitoring and Assessment Network, Environment Canada

Ms. P. Roberts-Pichette, Senior Scientific Advisor, EMAN, introduced the concept of the Ecological Science Cooperatives (ESC), which cooperatively carry out fundamental work focussed on biodiversity and indicators of change in a given ecological zone, and of the Ecological Monitoring and Assessment Network (EMAN), providing a framework for developing and coordinating ecological monitoring, research and integration, and connecting the ESCs into a national network. Ms. Roberts-Pichette pointed out that one of the overall topics for the ESCs to look at is biodiversity(a high priority item on the federal agenda),and that the ESCs provide a valuable opportunity for work because the sites already have climatic or other long-term records, and others have long-term research information. She discussed with the Committee how standard protocols for the work of monitoring can be established.

7. Canadian Wildlife Service

Mr. S. Nadeau, Endangered Species Division, reported on the impact of the recent federal budget on Environment Canada. For the Canadian Wildlife Service, the cuts amount to 46% over that period, though final expenses for the Green Plan program are included in those cuts. Nevertheless, the budget increased for endangered species, clearly a priority of the department. However, fewer specific departmental actions and more provincial involvement are expected. For example, more public decision making is called for, and some endangered species studies and most enforcement (including enforcement of federal legislation) will be left to the provinces. Discussion on this national approach to endangered species is continuing, to derive relevant legislation.

8. Natural Sciences and Engineering Research Council

A letter in support of individual operating grants had been sent to NSERC, and a positive reply received.

Other items

1. Regional developments

Members of the Committee summarized information from different regions of the country including studies in faunistic and systematic entomology at different institutions. Ongoing initiatives in B.C. include the Protected Areas Strategy (attempting, fairly quickly, to put aside 12% of representative ecosystems throughout the province), and Forest Renewal British Columbia. These initiatives are supporting work on invertebrates. Recommendations for inventory priorities and other items have been published. Two positions are available at the assistant professor level in the Biology Department of the University of Victoria, with major emphasis in ecology. A book on Alberta butterflies is to be published in May. Work on grasslands in Alberta can be developed into a broader proposal. A potential article from the 1994 ESC symposium on biodiversity definitions and measurements is nearly complete. In Ontario, the Vineland collection has been transferred to the University of Guelph collection. There have been no cuts in staff at the Royal Ontario Museum, and the museum is being grouped into various centres of excellence; a centre of biodiversity has been approved. In Quebec, a systematist has now been hired at Macdonald College, and an associated graduate scholarship is being put into place. The insect collection of Dr. D.J. Larson is being partly dispersed to different locations in Newfoundland as insurance against possible fire. Concern was expressed about the Forestry collection in Newfoundland, because no curatorial staff are now designated, although an intention to maintain the collection has been declared by the CFS. With respect to studies in the Arctic, full cost recovery will be implemented by the Polar Continental Shelf Project over the next two years. Most arctic researchers will be unable to meet these costs, forcing most people to abandon their research in the arctic. Moreover, additional hindrances exist, for example with respect to dealing with multiple jurisdictions and other problems with research permits. Therefore, decreasing funds are being committed to Canadian arctic research.

2. Other matters

The Committee also discussed a variety of other matters, including the Biological Survey Foundation, the 1995 Annual Report to the Museum, general operations of the Survey Secretariat, and some developments in the United States.

H.V. Danks
Ottawa, Ontario

PUBLICATIONS
BOOK REVIEWS

Gullan, P.J. and P.S. Cranston. 1994. *The INSECTS: An Outline of Entomology*. Chapman and Hall. 15 Chapters, 419 pp.

The INSECTS: An Outline of Entomology was, to me, an immediate enigma. Was this an alternative to *Outlines of Entomology* (7th ed., R.G. Davies, 1988) by the same publishers? Was it an up-date of *O. of E.*? Or was it in competition with *O. of E.*? Reading the introduction, the acknowledgements and text did not resolve my questions. Having wiped my mind clean of these assumptions, I settled down to reading the text and comparing it to other, similar contributions at this level. I was, therefore, absorbed in an interesting journey. Having grown up with Imms as the "ultimate text", and having taught entomology at various levels in Canadian universities for almost 30 years, I feel I am in a good position to evaluate this book. For many years in North America, we (I?) have used Borror and DeLong (and its offspring) as the standard text in introductory entomology, at least until Gillott ("Entomology") came along in 1980.

This is an extremely well written and beautifully illustrated textbook. The systems approach is greatly appreciated, but the lack of emphasis in systematics is, sadly, lacking, especially at a time when "biodiversity" has such a high profile in public and professional minds. After all, insects do make up much of the world's diversity. The authors acknowledge this need in the first paragraph of the Preface, but, unfortunately, reduce it to its inclusion in other, more ecological sections of the book. This is surprising considering that both authors are insect systematists.

There is an impressive range in topics from the importance and diversity of insects (Chapter 1), insect structure and function (5 chapters), systematics and evolution (Chapter 7), to special themes such as soil insects, aquatics, insects and plants, insect societies, predation and parasitism, insect defence, medical and veterinary entomology (including forensic entomology) and insect pest management. Some of my own favourite topics, such a marine/intertidal insects, biocontrol, diapause, photoperiodism and the endocrine system are well treated and up-to-date. Most of the references come from the 1980s and 1990s. My pet peeve, however, is that there is no inclusion of polar or alpine insects and their unique adaptations to cold.

The construction of the book is excellent. The use of BOXES, as developed in many modern textbooks in Biology, is both pertinent and informative. A list of the boxes in the Table of Contents, however, would have been very useful to the reader. The use of double columns allows good use of space to information ratio, and the font size makes the book easy to read. The inclusion of the glossary is an excellent idea and the index is impeccable. How many entomologists know what polydnaviruses and uricotelism are? Most of the illustrations in this book are taken from other sources, but those in the boxes (as well as some other sections) are superb. My congratulations to the illustrator(s)!

This is a comprehensive text and one that should be in the library of every entomologist. I have already consulted the book on many occasions for my courses in Introductory Entomology and Economic Entomology, and realize that it also supplies up-to-date information on many other subject areas in biology and entomology, such as general aspects of ecology, ethology, invertebrate biology and integrated pest management. If it were economically feasible to recommend two texts for introductory entomology courses then, in addition to Borror et al. (1989) or Gillott (1980), this would be it. There is something in this text for everyone, including topics which should catch the interest of even the most specialized entomologist.

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Norton, G.A. and J. D. Mumford. (eds.) 1993. *Decision Tools for Pest Management.* CAB International, Wallingford, Oxon, 0X10 8DE, UK. Hard cover. 288 pp. US71.25.

Practical implementation of pest management has been difficult to achieve, in spite of its social and political acceptance. Too often, researchers fail to develop a programs that meet farmers' needs. *Decision Tools for Pest Management* makes an excellent attempt at identifying reasons for lack of adoption of IPM research and provides a series of tools and techniques to overcome these problems. The editors suggest that faults in research design and problems of delivery are the main reasons why research in pest management has not always led to improved practices. Reasons given for this are that pest problems are complex, institution barriers exist which prevent delivery of improved systems, and researchers often do not appreciate the farmers' point of view. The authors outline a decision tools approach as a means for overcoming these problems as decision tools allow rigorous definition of pest management problems and assembling, analyzing and interpreting and extending research findings.

The book consists of 17 chapters which are grouped into 4 sections. The first chapter is an overview of the decision tools approach. The authors carefully outline the underlying concepts behind the decision tools approach, including a general decision model, information gaps, development pathways, locking-in, and identification of key components and processes. Various types of decision tools are discussed.

Chapters 2 through 5 provide a description of various types of decision tools. Chapter 2 outlines descriptive techniques used for system and problem definition. Techniques such as flow charts, time profiles and matrices are covered. Chapter 3 outlines methods for analyzing the decision problems associated with a pest system in terms of diagnosing the problem, considering the options, assessing the outcomes of a decision. General approaches are described for each of these. Chapter 4 describes workshop techniques which can be used to develop the information required for material covered in the preceding two chapters. Suggested outlines for workshops are given, as are pre-workshop activities. An example of workshop recommendations are given. Chapter 5 outlines the purposes behind grower surveys, their use, and various survey methods. The steps used in and rationale for conducting surveys is discussed in detail.

Chapters 6 through 15 describe computer tools used in pest management research and development. This section begins with an excellent introduction to pest models in Chapter 6. The purpose behind modelling, types of models, design and testing of models are covered. Further chapters provide more detailed explanations of analytical, simulation and rule-based models. Use of proprietary software for modelling is covered in a chapter on spreadsheet modelling. More specific examples of computer applications in pest management are covered. These include expert systems, pest management games, and geographic information systems. An important chapter covers information retrieval for pest management, and provides examples, benefits and cost of on-line searches and use of CD-ROM technology.

The last two chapters provide concrete examples of how decision tools can be used for implementation of pest management. Using decision tools in conservation, augmentations and importation of natural enemies is discussed in light of the varying needs and requirements of each approach. Finally, the book ends with a discussion of the roles and objectives of extension and the use of decision tools in extension. Unsuccessful case studies are reviewed and individual, group and mass methods are presented. The chapter concludes with a five-step program for extension activities.

This book is well-organized and written. The information presented is timely, interesting and useful, and will be useful to anyone conducting research or extension activities in pest management.

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Hawkins, B.A. and Sheehan, W. (eds) 1994. *Parasitoid Community Ecology.* Oxford University Press, Oxford, New York and Tokyo. x+516 pp. Hardcover (Can) $137.50. ISBN 0 19 854058 2.

This book represents the first serious attempt to bring together the literature on the diversity of host-parasitoid associations and on the factors that might determine community structure; it is based, in part, on papers presented at a symposium at the Entomological Society of America annual meeting in Baltimore, MD in December 1992.

The book is organized in seven parts comprising a total of 25 chapters. In the first chapter, the editors introduce the topic of community ecology, linking studies of individual species to those of communities and biological control. The importance of 'bottom up' effects of hosts on parasitoids is noted as a recurrent theme of the book.

Part 1 (Community size and structure) provides examples of parasitoid communities. Y. Hirose (chapter 2) examines the host ranges of egg parasitoids in the genera *Trichogramma, Telenomus, Ooencyrtus* and *Anastatus* that are associated with Lepidoptera in Japan. He shows that parasitoid diversity correlates with egg volume, suggesting that host choice is constrained by host size and habitat specificity. In chapter 3, N.J. Mills defines a parasitoid community as a component community within a hierarchical classification of communities sensu Root (1973; *Ecol. Monogr.* **43**: 95-124). Parasitoids associated with tortricids and weevils are classified into guilds according to the larval feeding niche, which is the host stage (from egg to adult) attacked. Although weevils have fewer known parasitoids than tortricid larvae, there is no evidence that host feeding in a concealed site functions as a partial refuge. T.S. Hoffmeister & S. Vidal, in chapter 4, use a similar approach to analyzing the diversity of tephritid parasitoids. From a rigorous statistical analysis of literature data for 195 parasitoid species, they conclude that the host's feeding site, stage attacked, and taxonomy do not influence the total species richness of parasitoid complexes, but that they do influence species richness within each guild of idiobiont and koinobiont larval and puparium parasitoids. Hosts that share ecological characteristics, or are related to each other, often have similar sets of parasitoids. In chapter 5, H.V. Cornell & B.A. Hawkins examine patterns of parasitoid accumulation on introduced herbivores. If the herbivorous hosts are the same in both native and foreign locations, similar constraints should operate on the size of parasitoid assemblages. W. Sheehan (chapter 6) evaluates data from a massive rearing program of parasitoids of Lepidoptera in the north-eastern USA, undertaken between 1915 and 1933. He notes that host abundance and the season of larval feeding are the chief factors determining, respectively, species richness and host-range composition of hymenopteran and tachinid parasitoids.

Part 2 addresses various aspects of host range. In chapter 7, M.R. Shaw presents a lucid overview of the current understanding of host choice and specificity, pointing out difficulties resulting from non-quantitative data collection and analysis. Using the host associations of British species of Pimplinae (Ichneumonidae) and of genus *Aleiodes* (Braconidae), he contrasts 'specialist' koinobiont with 'generalist' idiobiont life histories. Chapter 8, by R. Belshaw, reviews the life history characteristics of Tachinidae, with emphasis on polyphagy. The focus of chapter 9, by J.B. Whitfield, is on host immune reactions to parasitism and the possible role of polydnaviruses in the evolution of parasitoid host ranges. In chapter 10, R.R. Askew shows that the host ranges of parasitoids of leaf-mining Lepidoptera are strongly influenced by the growth form and apparency of their host plants.

Tritrophic-level interactions are the subject of Part 3. T.P. Craig (chapter 11) examines the influence of intraspecific plant variation on the structure of the parasitoid community attacking the gall-forming sawfly *Euura lasiolepis*; and P. Stiling & A.M. Rossi (chapter 12) use parasitoids of a gall midge, *Asphondylia borrichiae*, as a model system that includes two facultative hyperparasitoid species. In chapter 13, S.H. Faeth explores interactions between different trophic levels from the perspective of the host plant, with emphasis on possible fitness returns from enhanced natural enemy attacks on herbivores. D.R. Strong & S. Larsson (chapter 14) conclude from a study of the parasitoid community associated with *Dasyneura marginemtorquens* on basket willow in Sweden that parasitoids may, in fact, prevent the evolution of plant resistance to this gall midge.

Part 4 (Tropical communities) is comprised of four chapters that do not hang well together thematically. I.D. Gauld & K.J. Gaston (chapter 15) examine the effects of plant allelochemicals on parasitoid fitness, drawing examples mainly from tropical communities including 'nasty hosts'. In chapter 16, J. Memmott & H.C.J. Godfray discuss several methods of analysis of a parasitoid web, which they define as a subset of a community food web that includes parasitoids and hosts; they note that parasitoid communities are more complex than the simple assemblages assumed by most students of population dynamics and that new theory is needed to generate predictions about community structure. J.-Y. Rasplus (chapter 17) uses a statistical approach to measuring host range, abundance, and niche overlap of parasitoids associated with seed-feeding beetles in the tropics. The last chapter (18) in this section deals with parasitoid communities that are associated with African fig wasps; S.G. Compton, J.-Y. Rasplus & A.B. Ware point out that parasitoid/host ratios are relatively low, and more typical of early successional communities than of those associated with galling or mining phytophages.

Part 5 (Dynamics) includes a single chapter (19) by T.H. Jones, M.P. Hassell & R.M. May. The authors conclude that classical population dynamics models of host-parasitoid-hyperparasitoid interactions can usefully contribute to the understanding of parasitoid community structure; they give little guidance on how this might be done, however.

Part 6 is concerned with biological control. N.J. Mills (chapter 20) discusses the restructuring of parasitoid communities that may result from the introduction of natural enemies, with regard to both native and exotic pests; and L.E. Ehler (chapter 21) examines different introduction strategies and their underlying assumptions. In chapter 22, M. Tagaki & Y. Hirose provide an example of the complementary role of two parasitoid species in the successful control of arrowhead scale, *Unaspis yanonensis*, in Japan.

Part 7 (Overview) includes contributions by M.E. Hochberg & B.A. Hawkins (chapter 23) on the implications of population dynamics theory to parasitoid diversity and biological control; P.W. Price (chapter 24) on the evolution of parasitoid communities; and J.H. Lawton (chapter 25) on parasitoids as model communities in ecological theory.

In general, the book contains much useful information on parasitoid ecology. Although many chapters are based on the authors' own studies, they are all supported by extensive and up-to-date citations to the relevant literature. My main criticism is that there appears to be no clear organization among the various parts and that, as a result, the book lacks focus. For example, the first attempt to define a parasitoid community (and hence the book's scope) is made by N.J. Mills, in chapter 3. The distinction between tritrophic interactions in temperate (Part 4) and tropical communities (Part 5), and why the discussion of web analysis (chapter 16) is included with the latter, is not obvious. Chapter 19 on population dynamics theory is poorly integrated with other sections and, perhaps more important, separated from chapter 23, which explains the implications of such theories to the understanding of parasitoid diversity and biological control. Coverage of different systematic groups of parasitoids is very uneven. Whereas parasitoids associated with gall-forming insects are the focus of several chapters, the economically important and well-studied parasitoids of aphids are hardly mentioned. Also, as noted by J.H. Lawton in the last chapter, physiological and developmental correlates, including the effects of body size, are largely ignored as factors that may shape parasitoid host ranges and species richness, in spite of much recent research in these areas. Nevertheless, I enjoyed reading the various contributions, and recommend the book to researchers interested in parasitoid ecology.

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British Columbia

POSITIONS AVAILABLE

M.Sc. Research Assistantship.

The Department of Entomology & Nematology of the University of Florida has a M.Sc. research assistantship available in January, 1996. The project involves the search for and use of resistant plant varieties and biological control for management of whiteflies and silverleaf, an associated plant phytotoxic disorder, in squash. The prospective candidate should be interested in field and laboratory research in integrated pest management, biological control or host plant resistance. An annual stipend of $10,500 US and a tuition waiver are offered. For more information, contact: Heather McAuslane, Dept. of Entomology & Nematology, University of Florida, P.O. Box 110620, Gainesville, FL 32611-0620; tel 904-392-1901 ext. 129; fax 904-392-0190; e-mail hjm@gnv.ifas.ufl.edu. (Posted Jul 14, 1995).

Possible Post-doctoral Position.

If there are any European researchers with an interest in insect feeding stimulants who are looking for a post-doctoral position, get in touch with me as soon as possible, as there is a possibility of getting some money for up to 3 years research in this area. Ideally you should have experience in electrophysiology, insect-plant interactions and insect behaviour. Note that this is not a definite position— I need candidates to put forward for the grant. Contact: Dr. Andy Evans, SAC, West Mains Road, Edinburgh EH9 3JG, Scotland, UK; tel 44-131-535-4093; fax 44-131-667-2601; e-mail esa041@ed.sac.ac.uk. (Posted Jul 28, 1995).

Postgraduate Research Assistant Position.

A Research Assistant is required to work on a new project financed by the Biotechnology and Biological Sciences Research Council. The work will involve the analysis of predator gut samples (mainly carabid beetles) using a range of species-specific monoclonal antibodies against slug and aphid proteins. He/she will also assist with the development of new monoclonal and recombinant antibodies. Some experience of molecular biology and/or immunoassay techniques is required, plus a degree in a relevant subject. The post will be for 18 month in the first instance, with a probable renewal for a further 18 months. The chosen candidate would also have the opportunity to register for a Ph.D. Starting salary 13,941 pounds. Application forms can be obtained from the Personnel Department, University of Wales, 50 Park Place, Cardiff CF1 3AT; tel 01222-874017; fax 01222-874788. (Posted Jul 31, 1995).

MISCELLANEOUS

Request for Scientific Literature

The lack of access to international scientific literature is one of the main problems Latin American scientists and students have to face. If you are willing to help with subscriptions and/or donations of journal collections on biology (e.g. *The Canadian Entomologist*) to Latin American universities and research institutions, please contact Dr. Isabel Bellocq, Faculty of Forestry, University of Toronto, 33 Willcocks St., Toronto, Ontario, Canada M5S 3B3, (416)978-5482, Fax: (416)978-3834, e-mail: bellocq@larva.forestry.utoronto.ca.

SCHOLARSHIPS AND GRANTS

Entomological Society of Canada Graduate Research-Travel Grants Invitation for Applications

Preamble

To foster graduate education in entomology, the Entomological Society of Canada will offer two research-travel grants, awarded annually on a competitive basis. The intent of these grants is to help students increase the scope of the graduate training. These grants, up to a maximum of $2,000, will provide an opportunity for students to undertake a research project or to do course work pertinent to their thesis subject that could not be carried out at their own institution.

Eligibility

To be eligible, a student must:

1) be enrolled as a full-time graduate student
2) be an active member of the Entomological Society of Canada

Format of the Application Form

The application form will be in the format of a grant proposal, where the applicant will provide the following information: 1) the subject of the thesis; 2) a pertinent review of the literature in the field; 3) a concise presentation of the status of the ongoing thesis research; 4) a description of the research or course work to be undertaken, clearly indicating a) the relevance to the overall goal of the thesis, b) an explanation of why such work cannot be carried out at the student's own university and c) the justification of the site where the research/course work will be carried out; 5) a budget for the proposed project; 6) anticipated dates of travel and date on which grant money is needed.

The application form should also be accompanied by: 1) an up-to-date C.V.; 2) a supporting letter from the senior advisor; 3) When appropriate, a support letter from the scientist or Department Head at the institution where the applicant wishes to go.

Evaluation Procedure

The scientific merit of each application will be evaluated by a committee that has the option of sending specific projects out for external review by experts in the field. A constructive written report, underlining the positive and negative aspects of the proposal, will be returned to the applicant.

Timetable and Application Procedure

Application forms, which may be obtained from the Secretary of the Society, must be completed and returned to the Secretary of the Society by **15 January 1996**. The committee will evaluate all applications by 30 April 1996 and determine if, and to whom, grants will be awarded. The successful applicants will be informed immediately, thereby providing sufficient time for students wishing to start in the fall to make necessary arrangements. Grants must be used in the 12 months following the award.

Recipients must provide a short final report, as well as a detailed list of expenses, in the three months that follow the trip. Any money not spent must be returned to the Society.

La Société d'entomologie du Canada Allocations de Voyage pour Étudiants Gradués

Appels pour Allocations

Préambule

Afin the promouvoir les études graduées en entomologie, la Société d'Entomologie du Canada offrira deux bourses de voyage associées à la recherche. Celles-ci seront décernées annuellement sur une base compétitive. Le but de ces bourses est de permettre aux étudiants gradués d'élargir les horizons de leur formation. Les bourses, d'une valeur maximale de $2,000 permettront à des étudiants de réaliser un projet de recherche, ou de suivre des cours pertinents à leur sujet de thèse qui ne peuvent être entrepris dans leur propre institution.

Éligibilité

Afin d'être éligible, l'étudiant doit:

1) être inscrit à temps plein comme étudiant gradué
2) être un membre actif de la Société d'Entomologie du Canada

Format du Formulaire de Demande

Le formulaire de demande sera dans le style d'une demande d'octroi et l'étudiant devra fournir les renseignements suivants: 1) le sujet de la thèse; 2) une présentation de la littérature pertinente au domaine d'étude; 3) une présentation concise du statut du projet de recherche en cours; 4) une description de la recherche ou des cours qui seront entrepris, indiquant clairement a) la pertinence des objectifs généraux de la thèse, b) les raisons pour lesquelles ce travail ne peut être entrepris à l'université où l'étudiant est inscrit, et c) une justification concernant le choix de l'endroit où la recherche/les cours seront entrepris; 5) un budget pour le projet proposé; 6) dates prévues pour le voyage et date pour laquelle la bourse sera requise.

La demande devra aussi être accompagnée: 1) d'un C.V. complet mis-à-jour; 2) d'une lettre de recommendation du directeur de thèse; et 3) lorsque convenable, une lettre d'appui d'un administrateur de l'institution que le candidat désire fréquenter.

Évaluation

La valeur scientifique de chaque demande sera évaluée par un comité qui aura l'option d'envoyer des demandes spécifiques pour évaluation par un lecteur externe, expert dans le domaine. Un rapport écrit, contenant une critique constructive, faisant ressortir les aspects positifs et négatifs de la demande, sera retourné à chaque candidat.

Échéances et Procédures

Les formulaires de demande, qui peuvent être obtenus du Secrétaire de la Société, doivent être remplis et retournés pour **le 15 janvier 1996** au Secrétaire de la Société. Le comité évaluera toutes les demandes pour le 30 avril 1996 et déterminera si, et à qui, les bourses seront décernées. Les candidats choisis seront contactés immédiatement, cela afin d'allouer suffisamment de temps pour les préparatifs nécessaires à un départ possible à l'automne. La bourse doit être utilisée dans les 12 mois suivant l'octroi.

Les récipiendaires devront préparer un court rapport final, en plus d'une liste détaillée de leurs dépenses, dans les trois mois suivant le voyage. Tout argent non dépensé devra être remis à la Société.

UPCOMING MEETINGS / RÉUNIONS À VENIR

Colloque International sur la prévision et la dépistage des ennemis des cultures
10-12 octobre 1995, Québec, Canada
Cet événement aura lieu dans le cadre des activités du Symposium de la FAO, marquant le 50^{e} anniversaire de fondation de cet organisme à Québec en 1945.
PERSONNE-RESSOURCE: M.Michel Letendre, Réseau d'avertisements phytosanitaires, Services de phytotechnie de Québec, MAPAQ, Complexe scientifique (D.1.300.10), 2700, rue Einstein, Sainte-Foy (Québec) CANADA G1P 3W8; Téléphone 418-644-4689; Télécopieur 418-646-0832.

Agrobiotec Conference and Exhibition
October 19-22, 1995, Ferrara, Italy
Sessions include: "Biodiversity for the Progress of Biotechnology and Biotechnology for the Conservation of Biodiversity", "Transgenic Solanaceae: Research and Applications", "Regulation, Protection and Acceptance of Research, Results and Products", "Advanced techniques in fruit tree breeding".
CONTACT: BOLOGNAFIERE, Via Bologna, 534, 44040 Chiesuol del Fosso, Ferrara, Italy.

43rd Annual Meeting of the Entomological Society of Alberta
November 2-4, 1995, Holiday Inn, 4235 Calgary Trail N., Edmonton, Alberta.
Registration: $40.00 regular member, $30.00 student/spouse; registration includes banquet and mixer.
CONTACT: Holiday Inn (1-800-565-1222) for special meeting accommodation rates, and Lloyd Dosdall (Alberta Environmental Centre, P.O. Bag 4000, Vegreville, AB T9C 1T4; Fax: 403-632-8379) for paper submissions and details on the scientific program.

7th International Symposium on Pollination
June 24-28, 1996, Lethbridge, Alberta, Canada
Pollination: from theory to practise. General topics will include: Implications of evolutionary theory to applied pollination ecology; Modelling pollination; Pollination techniques/methods/standardization; Pollinator foraging behaviour; Commercial bumble bee management for pollination; Native bee management for pollination; Role of pollinators in species preservation, conservation, ecosystem stability and genetic diversity
CONTACT: Dr. Ken Richards, Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, Alberta, Canada T1J 4B1. Tel. (403) 327-4561; Fax. (403) 382-3156; Email: Richards@abrsle.agr.ca.

48th International Symposium on Crop Protection
May 7, 1996, University of Gent, Belgium
English summaries of all papers will be made available to participants. Topics to be treated include: Insecticides, Nematology, Applied Soil Zoology, Semio-chemicals; Fungicides, Phytopathology, Phytovirology, Phytobacteriology; Herbicides, Herbology, PLant Growth Regulators; Biological and Integrated Control; Residues, Toxicology, Formulations, Application Techniques. The proceedings will be published in the "Mededelingen Faculteit Landbouwkundige en Toegepaste Biologische Wetenschappen, Universiteit Gent".
CONTACT: Dr. ir. L. Tirry, Faculty of Agricultural and Applied Biological Sciences, Coupure links 653, B-9000 Gent (Belgium). Tel. 32 (0)9 264 61 52; Fax. 32 (0)9 264 62 39 or 264 62 49.

XX International Congress of Entomology
August 25-31, 1996, Palazzo dei Congressi, Florence, Italy
CONTACT: Organizing Secretariat, OIC, Via A. La Marmora, 24, 50121 Florence, Italy
Fax. ++39-55-5001912

ENTOMOLOGICAL SOCIETY OF CANADA
LA SOCIÉTÉ D'ENTOMOLOGIE DU CANADA
393 Winston Ave., Ottawa, Ontario K2A 1Y8
Application for membership - (new members only)
Demande d'adhésion (nouveaux membres seulement)

Name and Address (please print):
Nom et Adresse (lettres moulées):

telephone (bus.) / téléphone (au travail):

Fax:

Electronic mail address / Adresse electronique:

Key words describing interests (up to six):
Décrivez vos intérêts en utilisant jusqu'à six mots clés:

MEMBERSHIP DUES / COTISATION

Regular member [1] / Membre actif [1] .... $80.00 *
US & Other .... $74.00 US

Student member [1] / Membre étudiant [1] .... $40.00 *
US & Other .... $36.00 US

Student member - *Bulletin* only / Membre étudiant - *Bulletin* seulement .... $20.00 *
US & Other .... $18.00 US

[1] includes *The Canadian Entomologist* and *Bulletin*
[1] incluant l'abonnement au *The Canadian Entomologist* et au *Bulletin*

Endorsement / Signature du professeur________________

Students - ask your professor to endorse form/demandez l'appui de votre professeur

MEMOIRS (including discount for members) .... $20.00 *
MÉMOIRES (incluant l'escompte pour les membres) US & Other .... $18.00 US

* Canadian members, add 7% GST .... $_____
* membres canadiens, ajouter 7% TPS

Total .... $_____

If you need an official receipt please check:
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