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Conflict of Interest in CIBC Biological Control of Weeds Programs

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Abstract

CIBC undertakes investigations on biological control of weeds under contract with several countries. Where possible conflict of interest is likely to arise, attempts are made to resolve the issue before a project commences, by ensuring that adequate tests are undertaken, and/or by convincing the authorities concerned that the benefits greatly outweigh any potential detriments. Nevertheless, final authority for introduction of exotic agents rests with the importing country and not CIBC.

Conflits d'Intérêts dans le Cadre du Programme de Lutte Biologique Contre les Plantes Nuisibles de l'Institut du Commonwealth pour la Lutte Biologique

L'Institut du Commonwealth pour la lutte biologique entreprend des recherches en matière de lutte biologique contre les plantes nuisibles pour le compte de plusieurs pays. Lorsque des conflits d'intérêts risquent de surgir, l'Institut tente de résoudre les problèmes avant de mettre en ouevre le projet, en effectuant des essais appropriés ou en persuadant les autorités concernées que les avantages dépassent de loin tous les inconvénients prévus. Néanmoins, la décision finale relative à l'introduction d'agents exotiques relève du pays importateur et non pas de l'Institut.

Introduction

Andres (1981) states that conflicts arise when we are faced with choices or differing points of view. Differing points of view may relate to concern that introductions for weed control may irrevokably reduce plant populations to the extent that the target or its relatives cannot be grown as a crop if a use for it is discovered or, in instances where uses are known, circumstances alter so that it would be profitable or otherwise useful to grow the plant, or that they will destroy allied endemic plants. Other differences or points of view may be based on a general ignorance of the principles and practice of biological control. The case where individuals with a vested interest in current control methods oppose biological control reflects a type of conflict of interest which can impede introductions of agents even after all other indications indicate that the proposed introduction is safe, free from risk, and offers a good possibility of an economic solution to a particular weed problem.

Additional to its activities on biological control of weeds, CIBC also works on biological control of invertebrate crop pests. Conflict of interest of another type can arise if an introduced parasitoid or predator is likely to turn its attention to native or introduced weed control agents. In addition to examples of conflict of interest relating to biological control of weeds and invertebrate pests, I will refer to another CIBC endeavour, the introduction of oil palm pollinators from West Africa into Malaysia, as some of the obstacles faced are relevant.

Conflicts of Interest Within Biological Control of Weeds Programs

CIBC, as a contracting agency, undertakes investigations on biological control of weeds when authorized to do so by a country experiencing a weed problem, or by a funding agency acting in the best interests of a country or group of countries, which cannot or will not fund the relatively high costs of exploration and host range testing of natural enemies. In either instance, CIBC cannot undertake introductions and releases of exotic weed control agents without the consent of the appropriate national agency responsible for authorizing such introductions.

CIBC has undertaken exploration and host range testing on two weeds — *Eichhornia crassipes* (Mart.) Solms Laubach (Pontederiaceae) (Bennet and Zwölfer 1969) and *Mikania micrantha* H.B.K. (Compositae) (Cock 1982) — where funding was supplied by the UK Overseas Development Agency (ODA). These weeds have a comparatively wide distribution in several developing countries, but individually, the countries could not support the research required to ensure the safety of candidate control organisms. In both instances, in contrast to projects contracted by the country where control for the target weed was required, host range testing was hampered by the absence of definitive guidelines from the country or countries where control was required until late in the program, at which time additional costs could be incurred to test plants which were not included in the initial tests. Also, it was not possible to approach all authorities in advance to ascertain whether the question of conflict of interest arose.

Water Hyacinth

After undertaking exploration and limited host-specificity testing of several natural enemies of water hyachinth under a program financed by ODA, agreement was reached to do further testing under quarantine at the CIBC Bangalore laboratory prior to release in India. While these tests were in progress, the regulatory authorities in India, when advised that water hyacinth might have potential for a wide range of uses and products, e.g. animal food, biogas, mulch, paper, etc., decreed that testing of the control agents be terminated. Subsequently, investigations on utilization in India, and elsewhere, suggested that there is at least a limited practical use for this plant and despite frequent inquiries and requests from farmers, etc., for a viable control option in areas where water bodies were completely choked by the weed, the authorities continued to ban further biological control work for several years. Gradually, it became accepted in India, that although there was potential for the use of water hyacinth, it is unlikely that utilization would be feasible in many remote areas or that in other areas the level of utilization would keep the plant in check. A workshop was held in Bangalore in 1982 to resolve this impasse. It was agreed that biological control and utilization were not mutually exclusive options (see Bennett 1982); permission to release *Neochetina eichhorniae* Warner (Coleoptera: Curculionidae) and to proceed with further testing of other candidate agents was granted.

When I was invited to visit the Sudan in 1976 to assist in drawing up proposals for a program for biological control of water hyacinth, ODA (which had indicated interest in funding such a program and gave financial support for the visit) stipulated as one of the terms of reference of the visit that I should ascertain from spokesmen from various organizations working on other approaches to the control and utilization in the Sudan, whether there was adequate potential for utilization in the foreseeable future. ODA wished to make it quite clear that it did not wish to fund a biological control operation which might adversely affect the economy or ecology of the Nile. It was the concensus that although utilization might develop, it would be negligible in the foreseeable future and in view of the enormity of the problem and the high costs of controlling water hyacinth either manually or with herbicides, any form of biological control which offered a glimmer of hope should be vigorously pursued (Bennett 1976). On this basis, a program was instituted. *N. eichhorniae*, *N. bruchi* Hustache, and *Sameodes albiguttalis* (Warren) (Lepidoptera: Pyralidae) were introduced and subjected to further testing under quarantine. Before the first releases were made, permits were obtained from the Plant Protection Department and the Regional Ministry of Agriculture, Animal Resources, Forestry and Irrigation. Also the personnel of the Sudanese German Water Hyacinth Control Project agreed to cooperate and share facilities at El Tawila, north of Kosti, where experiments on biogas production and other utilization aspects were in progress. This program has lead to a drastic reduction of the problem (Beshir and Bennett 1985).

In both of these instances, CIBC considered that introductions did not not present any risk, and recommended biological control programs. However, the final decision of whether to make releases or not, rested with the country concerned.

Parthenium hysterophorus *L. (Compositae)*

This Neotropical composit, because of its rapid growth and its allergenic properties, has become an agricultural weed and a medical hazard. When CIBC was commissioned by the Queensland Department of Lands to undertake investigations of natural enemies in Mexico, the impact that these might have on guayule (*Parthenium argentatum* A. Gray), which has potential as a source of latex, had to be considered. Although this plant had been grown experimentally as a source of latex in Australia, it proved to be an uneconomic crop at the time the trials were undertaken. Nevertheless, the possibility that recent increased costs of synthetic rubber might alter the economics of the situation had to be taken into consideration. Batra (1981), pointing to the potential risks of attempting biological control of a weed congeneric with a crop, cited these *Parthenium* spp. as an example where conflict of interest is involved. However, despite floral similarities, there are major differences in vegetative structure: *P. hysterophorus* is an annual with a non-woody stem, whereas *P. argentatum* is a woody perennial shrub with a tough foliage adapted to xerophytic conditions. Hence, whereas phytophages attacking the stems and foliage of *P. hysterophorus* would be less unlikely to attack *P. argentatum*, those attacking flowers and seeds might. As seed and flower feeding organisms were short listed as candidate species, it was evident that if they did attack *P. argentatum*, latex yields would not be seriously affected. If guayule in the future became a major crop in Australia, and if insects introduced for control of *P. hysterophorus* did restrict seed production, it would be possible by judicious use of chemical pesticides to grow ample seed to plant guayule on a large scale.

In India, a different type of conflict of interest was apparent. Although many farmers have suffered severely from allergies and although CIBC outlined repeatedly the possibilities of biological control, adequate funding to permit introductions of control agents was not forthcoming. On the other hand, numerous 'eradication' campaigns organized by local or regional government authorities have been conducted at a much greater cost in terms of man-power and chemicals than the costs of a full-fledged biological control program. It was apparent that there was more political advantage and immediate short-term impact by uprooting the weed than investing in biological control. The view was also expressed that uses would be found for *P. hysterophorus* and therefore the introduction of weed control agents might be detrimental in the long run. However, because of the seriousness of the problem, and after efforts by CIBC to allay fears of adverse effects of introductions (backed by data on host range tests undertaken in Mexico and by the Queensland Department of Lands in Australia), permission to make introductions under quarantine and to make releases, after evaluation of results of supplementary tests, has been granted.

Papaver sommiferum *L. (Papaveraceae) and* Cannabis sativa *L. (Cannabaceae)*

During the early 1970s, CIBC (funded by the United Nations Fund for Drug Abuse Control), investigated the natural enemies of opium poppy, *P. sommiferum*, and marijuana, *C. sativia*, to ascertain whether species might have potential as biocontrol agents of illicit production of these narcotic plants. Although promising agents were found and host-specificity tests conducted (Buckingham *et al.* 1983), no introduction has been made. Proposed introductions could raise another type of conflict of interest. Illicit producers would certainly protest, possibly in violent fashion, if releases were to be made in or near their 'cultivations'!

Conflict of Interest Arising from Biological Control of Arthropod Programs

CIBC also undertakes projects on biological control of arthropod pests. Questions of safety of organisms proposed for introduction are frequently raised. Will they turn their attention to endemic species related to the target pest, or will they adversely affect organisms introduced for biological control of weeds? It can be very difficult or impossible to predict this, and laboratory trials do not always provide satisfactory answers.

Effects of Introduced Parasites and Predators on Introduced Biological Control Agents

Trichogramma spp. (Hymenoptera: Trichogrammatidae) are routinely introduced from continent to continent against sugarcane borers and other lepidopterous pests. They are frequently mass produced in the laboratory on stored-products pests such as *Sitotroga cerealella* (Olivier) (Lepidoptera: Gelechiidae), *Corcyra cephalonica* (Staint.) (Lepidoptera: Pyralidae), etc., and in the laboratory will attack a much broader range of lepidopterous eggs than indicated by field collections. The action of *Trichogramma minutum* Riley imported for the control of agricultural pests in Hawaii, is cited as the main reason for the failure of *Bactra truculenta* Meyrick (Lepidoptera: Tortricidae) imported to control nut grass (Clausen 1978). (Other groups of parasites will also attack a broader range of hosts in the laboratory, for example, *Lixophaga diatraeae* Townsend [Diptera: Tachinidae], a parasite of *Diatraea saccharalis* [Fabricius] [Lepidoptera: Pyralidae], can be readily bred on the moth *Galleria mellonella* [L.] [Lepidoptera: Pyralidae], the cassia pod borer *Trachylepida fructicassiella* Rag. [Lepidoptera: Pyralidae], etc.)

Responses to the cues which lead most parasitoids to their host in the field are inherent, and for this reason many species which act as suitable laboratory hosts are not at risk from the same organisms in the field. Nevertheless, in Hawaii the gall fly *Procecidochares utilis* Stone (Diptera: Tephritidae), introduced for the control of *Eupatorium adenophorum* Sprengel (Compositae) is attacked by one or more of the parasites introduced for the control of fruit flies.

There are other examples where species introduced for control of an arthropod pest have included in their diets phytophagous species previously introduced for weed control. *Cryptolaemus montrouzieri* Mulsant (Coleoptera: Coccinellidae), introduced into South Africa on several occasions to control various mealybug pests, attacked

Dactylopius spp. (Homoptera: Dactylopiidae) previously introduced for control of the cactus *Opuntia megacantha* Salm-Dyck (Cactaceae). This host may in fact have aided in its successful establishment leading to the control of the citrus mealybug *Planococcus citri* (Risso) (Homoptera: Pseudococcidae) (Greathead 1971). By the application of selective pesticides, Annecke *et al.* (1969) were able to demonstrate that *C. montrouzieri* and other coccinellids reduce the effectiveness of control of cactus exerted by *Dactylopius* spp. In Maritius, although *C. montrouzieri* failed to establish on the target mealybug, *Dysmicoccus brevipes* (Cockerell) (Homoptera: Pseudococcidae), it established on *Dactylopius* and was suspected to be the cause of an increase in abundance of *Opuntia* spp.

Following successful introduction of *Metrogaleruca obscura* DeGeer (Coleoptera: Chrysomelidae) leading to successful control of the weed *Cordia curassavica* (Jacq.) R&S (Boraginaceae) in Mauritius, plans to introduce a reduviid predator for the control of *Heliothis armiger* (Hubner) (Lepidoptera: Noctuidae) were dropped through concern that it might reduce the effectiveness of *M. obsucra* (Greathead 1971).

Protection of Arthropods Considered to be Natural Resources

Some of the butterflies most prized by lepidopterists occur in Papua New Guinea (PNG). To make material available to the rest of the world, butterfly farming has been encouraged; therefore, to protect this natural resource, legislation governing the collection of butterflies and other wildlife has been passed and is strictly enforced (National Research Council 1983). Hence, any proposed biological control project involving a weed allied to the food plants of a protected butterfly would receive very close scrutiny. Although this type of conflict has not arisen, CIBC has been required to undertake tests with exotic parasites selected for the control of sugarcane borers, *Chilo* spp. (Lepidoptera: Pyralidae) to ensure that they would not develop on butterfly caterpillars. On the basis of laboratory tests, the parasite under consideration, *Apanteles flavipes* (Cameron) (Hymenoptera: Braconidae) was readily cleared and releases were approved.

Similarly, the Institute of Virology, Oxford (IVO) had to satisfy the regulatory authorities that there was no risk before undertaking trials with a nuclear polyhedral virus to control cabbage pests in PNG. When IVO wished to undertake tests in collaboration with CIBC in Trinidad, assurance was sought by the Ministry of Agriculture that the virus would not affect non-target organisms. On the basis that experimental use of the virus had been approved in PNG, tests were permitted in Trinidad.

Oil Palm Pollinators

The African oil palm *Elaeis guineensos* Jacq., when introduced from West Africa into south-east Asia, required assisted pollination to ensure fruitset. Although long considered to be wind-pollinated, CIBC studies conclusively proved that the weevils *Elaeidobius* spp. are the main pollinators in West Africa. As these weevils breed in the spent male florescence (as opposed to the closely allied *Prosoestus* which breed in female flowers), the procedures utilized for screening candidate organisms for weed control were followed. When I approached the Malaysia quarantine authorities for a list of plants to be included in screening tests, I was advised that it would be pointless to send a list because importation of the weevils into Malaysia would not be permitted. This viewpoint conflicted with that of oil palm producers who constitute a very powerful lobby in Malaysia. They sponsored a visit to West Africa and the UK, enabling the quarantine authorities to satisfy themselves that the introduction would not have any serious adverse side effects.

PNG had also expressed interest and was prepared to consider introductions of *Elaeidobius* spp. largely on the basis of CIBC tests. This willingness to proceed also assisted in overcoming the reluctance of the Malaysian authorities, particularly when it was pointed out that each year that introductions were delayed could cost the industry several million dollars, and that officials 'obstructing' the introductions might have cause for later regret!

Subsequently, permission was granted and *E. kamerunicus* (Faust) was released in Malaysia in February 1981. Establishment and rapid buildup followed and within a year hand-pollination was discontinued. Oil palm yields increased by 20% as a result of more efficient pollination. Benefits resulting from the savings on hand-pollination and increased yields have been calculated to be some US$115 million/yr (Greathead 1983).

Discussion

Each proposal for biological control of weeds where conflict of interest may arise will have to be considered separately, and the advantages and disadvantages of biological control compared; alternative control procedures and economics must also be taken into account. When conflict of interest rules against classical biological control, consideration should be given to locally-occurring agents. Recent advances in the development of mycoherbicides indicate that there are viable options to chemical herbicides for the control of certain native and introduced weeds.

It is certain that investigators working on classical biological control of invertebrate pests will have to pay increasing attention to the possibility that introduced parasitoids and predators might adversely affect weed control agents. This is particularly so in those countries where one of the conditions to seek introductions of a control agent is the submission of a statement on the possible adverse environmental impact which could result from the proposed introduction. As an example of an unanticipated impact, the introduction of *Pediobius foveolatus* (Crawford) (Hymenoptera: Eulophidae), which seasonally reduces populations of an important agricultural pest (the Mexican bean beetle, *Epilachna varivestis* Mulsant; Coleoptera: Coccinellidae) to virtual extinction in Florida, may have resulted in an increase of certain weeds which serve as alternative hosts for this beetle (R. Sailor, pers. comm.). In this instance, the economic benefits resulting from a reduction of damage to crops far overweigh any detrimental impact caused by resurgence of the weeds. It is of interest to note that this is one instance where the process could be reversed if desired. *P. foveolatus* does not overwinter in the USA, and if annual releases were terminated, *E. varvivestis* would return to former population levels.

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