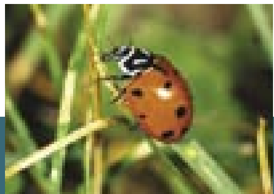
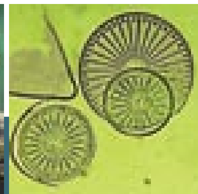
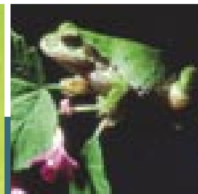
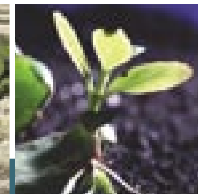
Biocontrol Files

Canada's Bulletin on Ecological Pest Management

Issue #1, December 2004
www.biocontrol.ca
Disponible en Français





Yet to be realized: biological control technologies constructed on a 'chemical paradigm' do not approach the potential seen for biological control by early scientists and ecologists.

Biological Control: Realizing the Promise

Towards the end of the 19th century, scientists began to experiment with the production and release of natural enemies for insect control. In 1878, Metchnikoff produced and released the green muscardine fungus *Metarhizium* he had seen killing beetles in cereals. Interest grew in the 20th century, for instance with studies on the production and release of predators and parasitoids, such as the moth egg parasite, *Trichogramma* species.

Not surprisingly, however, the use of natural enemies as biological control agents was set back by the growing use of synthetic organic chemical pesticides in the 1950s. A few decades later, biological control re-emerged, driven by the need to find replacements for chemical pesticides in integrated pest management (IPM) systems.

Priority was given to biological agents such as *Bacillus thuringensis* (Bt) that could be produced and used like chemicals. While Bt is a living organism, which can reproduce in insects, its development as a product has focused on its toxic protein crystal, which acts much like a pesticide. Biological control technologies constructed on such a 'chemical paradigm', while promising, do not approach the potential seen for biological control by early scientists and ecologists.

The effectiveness of a bioinsecticide depends on two factors: its capacity to kill pests and its capacity to reproduce on pests and therefore continue to compound its killing action. To date, bioinsecticide development has tended to concentrate only on the direct killing action of insect pathogens. Increasingly, however, it is realizing the value of a pathogen's power of reproduction. This involves a shift from regular application of the biopesticide to strategic application early in the crop season. These early applications establish populations that recycle over the whole season and check the growth of invading pest populations. This strategy greatly extends the utility of biopesticides and can be much cheaper for farmers.

Biopesticides in IPM

The development of biopesticides and mass released predators and parasites has meant a lot to Integrated Pest Management (IPM), which is based on the principle that pests should only be controlled when they threaten harm, using the least environmentally damaging approach. The growth of interest in IPM is creating a demand for biological control technologies worldwide. Not only have these agents done the job of controlling pest populations, but unlike many insecticides, they have allowed local natural enemy populations to recover and to have an impact as well. In fact, in many instances where biological agents have been mass-produced and released, it is not clear which of these two factors has had the greater benefit.

Some years ago, an expectant world looked to the agrochemical industry to develop these technologies for mass distribution. Multinational corporations made substantial exploratory investments in bacteria, fungi, viruses, nematodes, parasites and predators, but in the past few years these have largely been abandoned. Reasons include poor competition with chemical products; small, difficult markets; and the lure of biotechnology, such as genetic modification, as an alternative investment.

How to realize the promise

To move forward, we will need to make use of the biological agents that are available, such as Bt. But we will also need to look towards future biological control technologies which do not model products on chemical pesticides but exploit that feature of biological agents that makes them inherently superior to chemicals: their capacity to reproduce and spread themselves. Some systems already do this. Examples include parasites and predatory mites released in Europe and North America to build up in glasshouses over a season; viruses in Brazil which can control several pest generations; and a fungal product in Africa which may cycle on its target locust and grasshopper populations. It is not only new products which are required. We also need new approaches to use, registration, marketing, end-user training and distribution to create a dependable supply of high quality biological control technologies as components of sustainable IPM. The promise of biological control discovered early in the 20th century is still there to be realized ■

Based on Jeff Waage's article 'Biological control - The struggle for sustainable options', published in Pesticide News, #45, September 2000

Biocontrol Files: Canada's Bulletin on Ecological Pest Management is a quarterly publication which reports on tools and developments in ecological pest management. The co-publishers World Wildlife Fund Canada, the Biocontrol Network and Agriculture and Agri-Food Canada welcome additional partners and sponsors committed to advancing knowledge and adoption of ecological pest management.

Letters to the editor are welcomed. Please send to: biocontrol-network@umontreal.ca

If you want to receive this publication directly, also please contact us at: biocontrol-network@umontreal.ca

Managing editor: Vijay Cuddeford for WWF-Canada

Editorial Committee: Julia Langer, Colleen Hyslop, Leslie Cass, Alan Tomlin, Jean-Louis Schwartz, Mark Goettel

Additional writing: Wayne Campbell, Vijay Cuddeford

Scientific review committee: Mark Goettel, Dave Gillespie, Richard Bélanger, Jacques Brodeur

Guest columnists: Judy Myers, Rob Bourchier

Designed and produced by: Design HQ

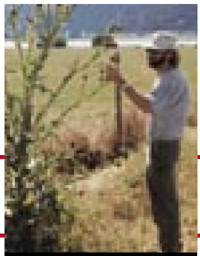
French translation by: Alain Cavenne

Website production: Biocontrol Network

Appreciation is owed to the Joyce Foundation (Chicago) and the Laidlaw Foundation (Toronto) for generously supporting WWF-Canada's work on pesticide reduction and alternatives, including this bulletin, as is NSERC's support to the Biocontrol Network, including for public awareness regarding bio-pesticides and other pest management bio-alternatives.

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Guest Author Rob Bourchier



Rob Bourchier

Invasive alien species are a serious threat to global ecosystem integrity.

In Canada, most rangeland weeds are introduced invasive species that threaten the ecological integrity of native grasslands, the economics of grazing, and species biodiversity in a variety of habitats. Invasive weeds such as knapweed and leafy spurge have infested thousands of hectares in western North America, and hundreds of millions of dollars are spent annually to control them.

Biocontrol for invasive weeds – how and why

When an invasive species becomes widely established, biological control is often the long-term control strategy of choice. In their new habitat, invasive species are not controlled by the herbivores which keep their populations in check in their places of origin. Biological control seeks to restore the ecological balance between the invasive species and its herbivores by re-uniting them in the new habitat. The goal is not to eradicate the invasive species, but to reduce its density to the point where it no longer dominates and alters ecosystems by out-competing desired species. Biocontrol is an attractive option because it is self-sustaining, economical for large areas requiring treatment and has a relatively low environmental impact.

Weed biocontrol in Canada

Weed biocontrol in Canada began in 1951 with the release of two species of leaf beetles to control St John's Wort. Management of this weed and suppression of nodding thistle by an introduced seed weevil are two early success stories. Control of both weeds is now possible without wide-scale applications of chemical herbicides. More recent successes include control of Dalmatian toadflax, houndstongue, purple loosestrife, and leafy spurge in some habitats.

***Chrysolina hyperici*, released in 1951 for control of St. John's Wort.**

Host range of weed biocontrol agents

The most common question from the public about insects used for weed biocontrol is: will they feed on other plants? Any biocontrol agent being considered for release in North America undergoes extensive host-range testing to ensure the safety of native species. Screening prospective biocontrol agents begins by compiling a list of test-plants of concern, based on the taxonomic similarity of the test species to the target weed.

Today's increased interest in protecting biodiversity has changed the content of these lists considerably from early weed biocontrol programs. In these early programs, the focus was on economically important plant species located in the native range of the biocontrol agent. Today test-plant lists include taxonomically related species of both ecological and economic importance, and species which come from both the native and introduced range of the target plant.

Once a test-plant list is determined, each species on the list is exposed to the prospective biocontrol agent to test host acceptance. Such tests are conducted in containment when required and include: 1) no-choice tests in which the insect is provided with only the test plant for feeding; 2) choice tests in which the insect is offered multiple species and its preferences assessed, and 3) field studies conducted in the country of origin. Field studies assess host choice as well as the direct impact of the biocontrol agents on target and non-target species under natural conditions. Once host-range screening is complete and an agent is determined to be host-specific on the target weed, a petition for the agent's release is submitted to regulatory agencies in Canada and the US. These petitions must address both the potential direct and indirect ecological impacts of the proposed release.

Biological control is not totally risk-free with regard to its effects on non-target species. But not controlling an invasive species carries risks to a different suite of non-target species. The challenge for researchers is to define the risks of potential biocontrol agents and to document the potential for significant impact on the target pest. The challenge for policy makers is to choose and implement the management strategy for invasive species that maximizes the conservation of native ecosystems ■

Rob Bourchier is a research scientist in insect ecology and biological control with Agriculture and Agrifood Canada.

An Exercise in Bio-Chontrol

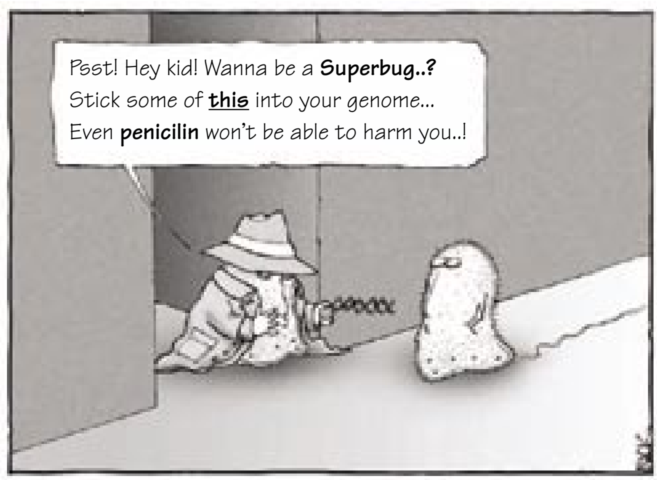
Next summer, if all goes according to plan, Victoria-based MycoLogic Ltd will market its first biological control agent, Chontrol™. The product is an ecologically friendly alternative to the chemicals currently used to control fast-growing deciduous plants in conifer reforestation areas and electrical transmission line corridors. The commercial launch will cap the company's 10 years of lab and field trial work, aimed at characterizing the agent (*Chondrostereum purpureum*, a fungus), optimizing its efficacy, determining its environmental fate, working out scale-up procedures, and completing other tasks required for registration. With a $5M Canadian and $35M American market, plus the prospects of significant European interest, the bioherbicide's economic promise augurs well for the University of Victoria spin-off company.

According to company co-founder and University of Victoria plant geneticist Dr Will Hintz, *C. purpureum*'s story actually began much earlier than MycoLogic with the work of plant pathologist Dr Ron Wall at the Canadian Forestry Service. Wall was interested in the fungus because it appeared to kill deciduous trees, and such trees hindered efforts to re-forest British Columbia's clear-cut areas with conifer seedlings. "Deciduous plants grow faster than conifers," explains Dr Hintz. "They steal the sunshine from the slower conifers, stunting their growth." While forest managers achieve a certain level of control by lopping off their tops, deciduous species form several new sprouts, and after a few cutting cycles they can flourish to form an impenetrable brush. To control sprouting, chemical herbicides are combined with cutting, halting spread and lengthening the time between cuttings, thereby saving money.

A similar problem exists on transmission line corridors. Says Dr. Hintz: "BC Hydro uses the same *cut and treat* model to control deciduous plants, but the lines cross many water ways and dry creek beds where chemicals cannot be used, and this requires more frequent, expensive cutting."

These problems, combined with increasing public opposition to chemical applications, led Hintz to form MycoLogic with a view to commercializing Wall's work. "As a university spin-off, we had access to industrial matching funds from government," says Hintz. "We were able to use this plus cash kicked in by BC Hydro as leverage to raise about $1.2 M additional funding for the company." One of the first things the U. Vic geneticist did was discover a genetic 'fingerprint' for the fungal strain. Using this fingerprint in field trials confirmed that *C. purpureum* was indeed the pathogen responsible for killing the deciduous trees. The next step was to research the pathogen's efficacy, environmental fate, scale-up procedures, and potential formulations, including a spray and topical application as a paste. MycoLogic now has a temporary joint license in Canada and the U.S. (one bit of information is still missing) and expects to use Chontrol™ in the late summer of 2005 when BC Hydro begins cleaning its corridors.

Dr Hintz is quick to point to the NSERC-sponsored Biocontrol Network, headquartered at the Université de Montréal, as an invaluable resource in advancing MycoLogic's first product to registration. "Biocontrol is a forum for sharing ideas, knowledge, and experience, especially regarding the restraints you encounter in registering biological agents." By bringing the research community together with industry and end-users, the Network creates valued synergisms, building profile for companies and a sense of community among the participants ■



It was on a short-cut through the hospital kitchens that Albert was first approached by a member of the Antibiotic Resistance.

Biological Control of Tansy Ragwort

Tansy ragwort is problematic chiefly because it contains chemical compounds that can accumulate and cause liver failure in domestic animals.

Prior to the successful use of biological control, tansy ragwort (*Senecio jacobaea*), a native of Europe and Asia, infested large tracts of rangeland in the Northwest United States and southwestern British Columbia. Recently, the weed has re-emerged as a problem in the Okanagan Valley, where it is increasing on sites burned by the major forest fires of 2003. Other Canadian infestations occur in the Maritimes, with sporadic occurrences in Quebec and Ontario. A highly opportunistic weed, tansy ragwort is commonly found on newly logged forest lands, rangeland, managed pastures, waste or fallow sites, perennial seed fields, and occasionally in stands of alfalfa. Populations can range from isolated plants to linear colonies along roadways to dense infestations in pastures and clear cuts. The plant is rarely found in annually tilled fields.

Tansy ragwort is problematic chiefly because it contains chemical compounds that can accumulate and cause liver failure in domestic animals. Acutely fatal doses for cattle and horses, though relatively rare, range from 3 to 7% of body weight and cause death within a few days, with younger animals being particularly sensitive. Chronic exposure causes gradual loss of liver function, eventually leading to death. While cattle normally avoid eating tansy ragwort, this is difficult when rosettes are intermingled with grass. In the early 1980s, almost 30% of pastureland in Prince Edward Island was infested with tansy ragwort, a third of it severely, with up to 64 rosettes per square metre in grazed pasture. Prior to biocontrol of the weed, cattle losses of 5-10% occurred annually in coastal Oregon. It is believed that Canadian losses were similar. Animals can also be poisoned by contaminated hay or silage. In silage, the chemicals diffuse out of the plant and into the surrounding material.

Control methods inadequate

Mechanical controls (e.g., mowing, pulling, tilling) have proven inadequate for the most part. While defoliation is achieved with herbicides (e.g., 2, 4-D), the roots often regenerate, and herbicide treatment can increase both the palatability and the toxicity of the plant. Grazing on treated stands is not safe for at least 4 to 6 weeks after spraying. While sheep and goats are sometimes used to graze tansy ragwort, animal weight gain can be depressed.

Successful biological control

The overseas search for candidate biological control agents for tansy ragwort began as early as 1927 in Britain, initiated by New Zealand. The release of tested European insects against tansy ragwort began in the 1970-80s in Canada, USA, New Zealand and Australia. The outcome of these programs has been variable.

The most spectacular successes occurred in Oregon and California, where the release of biocontrol beetles reduced tansy ragwort densities on coastal pastures by over 90% within 5-6 years. Annual benefits from reduced livestock losses, increased pasture production and decreased herbicide use amounted to US $5 million. Estimated benefit-to-cost ratios varied from 13:1 to 15:1. Non-monetary benefits included reductions in herbicide use and recovery of native plants previously crowded out by tansy ragwort.

The biocontrol agent chiefly responsible for these successes was the tansy ragwort flea beetle (*Longitarsus jacobaeae*), which was introduced from Italy. The larvae of this beetle burrow into and feed on roots, causing host plant injury or death. In late spring, they leave the roots and pupate in the soil. Emerging adults feed on the leaves of tansy ragwort for several weeks, then enter a 3- to 5-month resting stage. In the fall adults once again become active and feed, mate, and deposit eggs.

Although fall adult emergence and egg laying is suitable for the mild coastal climates typical of BC and the US, the insect has not been as successful in colder climates. For these areas, a Swiss biotype is being tested. This import lays its eggs in mid-summer, prior to the killing frosts, and its eggs lay dormant until the following spring. The biotype was released in Montana in 2002, and is being monitored for establishment. Agriculture and Agri-Food Canada is now advising stakeholders in BC interested in having the Swiss strain of *L. jacobaeae* introduced in the Okanagan Valley, and the Swiss import is undergoing host-specificity testing ■

Control for Crown Gall Disease

Crown gall is a major disease which affects over 600 woody and herbaceous plants, particularly roses and other members of rose family, which includes apples, raspberries, peaches,and many other species. Field-grown nursery stock such as grapes, willow, and chrysanthemum are also susceptible. The disease is triggered by virulent strains of the bacteria *Agrobacterium tumefaciens* and *A. rhizogenes*, which infect plants via wounds in roots and stems. Symptoms are swellings or growths at the crown and on roots, stems and shoots.

The economic consequences of crown gall are of worldwide significance. Infected nursery stock cannot be sold. Orchard trees have reduced life spans while infected grape vines seldom survive. Losses of 13-17% in peach nursery stock and 32% in "vinifera" grapes were recorded in Ontario prior to successful biological control. Individual nursery growers are at greatest risk; they must destroy infected plants and are obliged to conduct stringent sanitary control measures.

Biological control

The discovery of Agrobacterium radiobacter strain 84 by Dr. Alan Kerr in Australia in the early 70's and its subsequent commercialization marks a watershed in the treatment of crown gall. *A. radiobacter* products are now available in many countries, including DyGall, registered in Canada in 1989. Dygall is manufactured by AgBioResearch, a New Zealand company, and distributed in Canada by Mori Nurseries Ltd. of Ontario.There are no effective registered alternatives for the control of crown gall disease.

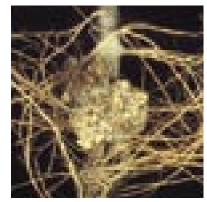
A. radiobacter K84 is extremely specific, producing an antibiotic which is active only against certain types of *Agrobacterium*. A new, genetically engineered strain of the bacterium (K1026) was registered in the U.S. in 1998. It is not registered at this time in Canada. The new strain has been altered to eliminate the possibility of genetic exchange between the biological control agent and the disease-causing bacteria in soil, thus minimizing the buildup of immunity in the pathogen. K1026 was the first genetically engineered microbe to be available as a commercial product.

How does it work and how is it used?

The product is successful against crown gall for two reasons. Firstly, it produces an antibiotic which is toxic to the infecting organism. Secondly, it outcompetes the infecting organism for space on the host root. It is vital that the product be applied before infection; it will not eliminate disease in infected stock. The products are applied as dip solutions for roots, stems and germinating seeds in greenhouses and nurseries.

It should be understood, however, that neither K84 nor K1026 is an effective treatment for all plants. Some bacteria are resistant to the antibiotic produced by *A. radiobacter*. For example, efficacy is poor with apples and grapes.

Prior to the introduction of biological control, crown gall resulted in annual losses of about 10% in Canadian nursery stock. Use of *A. radiobacter* reduces infection levels to about 1% or 2%, which benefits both producers and the overall industry ■



A nasty infection: Crown gall affects over 600 woody and herbaceous plants, infecting plants via wounds in roots and stems.

Sporodex: The Little Yeast That Could

Powdery mildew: causing major losses to ornamentals, food crops and cereals and is one of the most economically important plant diseases in the world.

As all good bar room bouncers know, sometimes it's the little guys who are really dangerous. A case in point in the world of pest control is *Pseudozyma flocculosa*, a retiring yeast-like epiphyte that has been re-fitted by research to vanquish 'powdery mildew', a heavyweight plant disease and runner-up to rice blast as the most economically important plant disease in the world.

Laval University plant pathologist Richard Bélanger, in collaboration with James Traquair and William Jarvis of Agriculture and Agri-Food Canada, has worked on *P. flocculosa* as a biocontrol agent since the early 1990s, and has spent the last three years tangling with legal issues and regulatory agencies. According to Professor Bélanger, "the research was the fun part."

Sporodex (*P. flocculosa*'s product name) has already been registered in Canada and the U.S. by the Ontario-based horticultural company Plant Products Co. Ltd. for use against powdery mildew in greenhouses, where the disease causes major losses to ornamentals (especially roses) and food crops (cucumbers, tomatoes). Outside, it is a major disease of cereals. Although registered in Canada and the US for use against powdery mildew on greenhouse cucumbers and roses, due to some additional requirements, it is not yet available in the market. The company is now confronting the complexities of getting registration in the European Union. "Acceptance in Europe increases the market size significantly," explains Bélanger. "The company needs this to ensure the product's economic viability." Although he hopes that Plant Products will obtain registration of Sporodex in Europe, dealing with the political vagaries of 25 disparate countries is costly and time-consuming.

P. flocculosa is easy to overlook. Its numbers are normally vanishingly small and it inhabits recessed niches on leaf surfaces. What Dr. Bélanger discovered, however, was that it produces a powerful, protective surfactant (a glycolipid) capable of eliminating other fungi which invade its limited space, including economically important fungi like powdery mildew. Supported by Plant Products, the Laval scientist spent the 1990s researching *P. flocculosa* and the mode of action of its glycolipid, conducting greenhouse efficacy trials in important market areas (Canada, the U.S., Holland, Columbia), developing methods for mass production, and working on formulations.

Trials comparing Sporodex with the chemical of choice for control of powdery mildew (a sterol biosynthesis inhibitor or SBI) showed that it is equally effective, actually increases crop yield in some instances, and is user friendly. Says Bélanger: "Workers in our Netherlands efficacy trials vied for the biocontrol agent. It has no odour and doesn't leave residues." In addition to environmental concerns, SBIs are expensive and continued use is leading to resistance in the targeted pest.

The Columbia efficacy trial underscores the fact that this country, along with neighboring Ecuador, is a major producer of roses directed at the U.S. market. American registration of Sporodex is an important sales pitch here, since the U.S. will block the entry of ornamentals sprayed with agents that do not have American registration.

Professor Bélanger cites the value of the Université de Montréal based Biocontrol Network as a powerful ally in the lobbying required to move biocontrol products forward towards registration. "What they throw at you is a big brick of a book on product requirements" comments Bélanger. "And here, the Network, through its web of collaborators and experts, can offer valuable assistance".

In the future, the company may opt to use Sporodex outside the greenhouse. Powdery mildew is especially hard on grapes, and California alone has upwards of 400,000 hectares under cultivation. This would mean new formulations according to Dr Bélanger, since environmental conditions are an important determinant of efficacy ■

Information derived from an interview with Dr. Bélanger

Bti: Control of Mosquitoes and Black Flies

The kids are all right, but those adults!

Mosquito larvae live in water and consume bacteria and other living things. If they didn't grow up, we'd consider them beneficial. On the other hand, *adult* mosquitoes fly, bite and are a formidable nuisance in many parts of the world. In some parts of the tropics, four hundred bites a night is not unusual! While only professional pest managers pay much attention to mosquito larvae, millions of us spend fortunes trying to kill the adults with aerosol sprays, residual wall sprays, smoking spirals, and mosquito repellents, not to mention applications from trucks, planes and helicopters. Unfortunately, the net effect of all these efforts is generally as short-lived as the passage of clouds; the adult population is replaced from breeding sites within a few days.

So why not treat the breeding sites? There are two basic reasons: (1) it is ecologically disastrous, and, (2) we have Bti, *Bacillus thuringiensis israelensis*, a perfect biological control agent.

Bacillus thuringiensis (Bt) is a common, soil dwelling and spore forming, aerobic bacteria. The Bti variant makes a crystal toxin which, when ingested by a mosquito, kills it by causing the gut cells to rupture. One of the strengths of Bti is that its crystal toxin contains a variety of different proteins, making it very difficult for mosquitoes to develop resistance to the treatment. Also, the toxin is very specific, affecting only mosquito and blackfly larvae and some closely related species, and consequently causes minimal impact to non-target organisms within the ecosystem. *There are three commercial Bti products currently available in Canada for control of black flies and mosquitoes: Aquabac, manufactured by Montreal-based AFA Environment Inc.; Vectobac, manufactured by Valent Biosciences; and Teknar, also manufactured by Valent.*

KABS

The German Mosquito Control Association (KABS) manages the oldest and largest campaign which uses Bti to control mosquito larvae. During springtime and occasionally in the summer, the Rhine and Neckar rivers flood the surrounding lowlands. When the rivers retreat, millions of mosquito eggs are left behind in ponds and puddles. Within a few weeks, adult mosquitoes are ready to fly to the nearest village in search of people to bite. If you stroll along the Rhine in this season, your unprotected arms will become *grey* in minutes, then *red* as the mosquitoes suck your blood (*see photo*).

German villages pay KABS to survey the flooded areas by foot and via satellite photography, then apply Bti at the right time and in the right places. KABS has developed an ingenious formulation for the insecticide: ice-granules. These are ice pellets of diluted, flowable Bti, effective and cheaper than powders. The heaviness of the ice granules ensures that they land on target when dropped from planes.

Similar large-scale Bti operations are carried out in the U.S., Italy, Spain, Greece and France. In the last few years, the International Centre of Insect Physiology and Ecology has conducted mosquito control programs using Bti in several African countries, including Eritrea and Kenya. While European and North American programs focus on control of mosquitoes as a vector of West Nile virus or as nuisance pests, a major focus in Africa is prevention of malaria.

West African Onchocerciasis Control Program

In the mid-1980s, the World Health Organization's (WHO) Onchocerciasis Control Program (OCP) in West Africa was in trouble. The larvae of the black flies which spread the disease (also called river blindness) were developing resistance to the widespread, intense treatments of organophosphorous insecticides. At the time, river blindness affected more than 20 million people worldwide. Besides causing blindness, onchocerciasis results in severe skin disease, and is probably also responsible for epilepsy and growth retardation. In addition, many of West Africa's fertile river valleys – with great potential for food production – were deserted, due to the presence of black flies and the disease they carried.

WHO learned about the use of Bti for black fly control from Canadian and American programs, and arranged for a trial. Bti is used in the dry season, and six other synthetic insecticides are rotated during the rainy season, with Bti comprising about half of all applications. The use of Bti saved the program. By the end of the 1990s, OCP had eliminated onchocerciasis in seven of eleven countries affected. There were virtually no new infections and 1.25 million people had lost their infection. Repopulation of previously deserted river valleys has been initiated, allowing cultivation and food production ■

Adapted from material received from Ole Skovmand, Intelligent Insect Control, Montpellier, France

If you stroll along the Rhine in this season, your unprotected arms will become *grey* in minutes, then *red* as the mosquitoes suck your blood.

Issues Column: Judith Myers

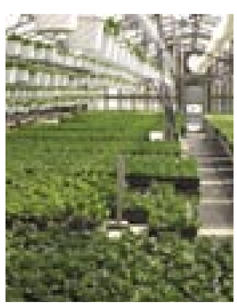
Biological pest control is increasingly the solution of choice for a variety of farming systems. Organically grown crops demand a high price and depend on biological control of pests. New introductions of exotic insects and weeds are rampant, and the only long-term solution is classical biological control. Many of the more toxic chemicals formerly approved for use as insecticides have failed stringent re-evaluations and are no longer produced, or pests have become resistant to them. In short, alternatives must be found and biopesticides and biocontrol provide the greatest potential. This article considers some of the challenges to providing successful biological control.

Biological Pest Management: potential and challenges

Biological pest management utilizes micro-organisms as well as insect predators and parasitoids that are reared or produced then packaged as commercial alternatives to chemical pesticides. Although they represent only 1% of the global market for crop protection, biopesticides and biological control agents have particular value in situations in which other pesticides cannot be used. To be effective, this “augmentative” biological control requires that organisms can be cheaply and efficiently produced, and that a resilient life stage exists during which the agents can be shipped and released. While products are very effective, their margin of profit is usually low. Increased costs or fluctuating demand can cause small production companies to fail, jeopardizing carefully balanced biological control programs.

Far and away the most successful biopesticide is the bacterium, *Bacillus thuringiensis* (*Bt*). But more microbial agents are required in the arsenal. Insect viruses such as the nucleopolyhedrovirus (NPV) of Lepidoptera have great potential because they are host specific and thus do not cause non-target effects. Their downside is their small market and limited profitability. They must also be grown on live hosts, which places limits on the scale of production. On the other hand, fungi that kill insects can be cultured in large quantities and easily applied, giving them considerable potential as bioinsecticides. However, efficacy and registration remain problems for fungi.

New introductions of exotic insects and weeds are rampant, and the only long-term solution is classical biological control.



Classical biological control

Biological control involves the use of predators, parasitoids and diseases against specific pests. “Classical” biological control targets introduced species, the most destructive of pests. To reduce the aggressiveness of exotic insects and weeds, natural enemies are transferred from the native habitat to the exotic habitat. Brilliant in concept but complex in operation. What makes a good biological control agent? Each insect or plant species has a variety of natural enemies. From this array, agents must be selected that are safe, specific, and effective.

While testing of host specificity has long been a part of weed control, some releases of generalist predators and non-specific parasitoids have led to well-publicized failures, and have tarnished the reputation of insect biological control. Recognition that non-target organisms can be impacted has led to more careful scrutiny, which in turn has spawned a lengthy and bureaucratic international process. Within this process, greater emphasis must be placed on efficacy as well as reducing the potential for indirect effects of biological agents. The days of dumping in more and more exotics to control one pest are gone.

Regulatory challenges

Registration of microbial agents can be prohibitively expensive. Streamlining of procedures is required. Relevant issues may include: Is it necessary to use local biotypes of the disease agent? Is checking for residues on crops necessary? Do the same vertebrate toxicity tests need to be repeated for each additional agent? What should be done with agents that have been genetically modified to kill faster or to have a wider host range? While optimistic geneticists see a myriad of ways to improve biocontrol agents, will these ever be commercialized?

The future

Biological control is the future for insect, weed and plant disease management. But manifesting this future requires an important transition. The ecological complexity of both natural and agricultural systems must be considered in the development of sound and environmentally safe biological control programs. Biological control is neither as easy nor as profitable as the “one chemical kills all” approach. However, the long-term payoffs - reduced chemical contamination and improved food and environmental quality - will be realized by all ■

Judith Myers is an agroecologist at the University of British Columbia and the Leader of the Greenhouse Theme of the NSERC Biocontrol Network. She studies the role of disease in insect ecology and the biological control of plants and insects.

Websites

• Biological Control: A Guide to Natural Enemies in North America http://www.nysaes.cornell.edu/ent/biocontrol

This site provides photographs and descriptions of biological control agents of insect, disease and weed pests in North America. It offers a tutorial on the concept and practice of biological control and integrated pest management (IPM).

• Biocontrol Network bilingual website http://www.biocontrol.ca

Provides in the ‘Documents and publications’ section a full listing of microbial and pheromone pest management products registered in Canada

• U.S. Environmental Protection Agency Biopesticide website http://www.epa.gov/pesticides/biopesticides

Features on this site include: Regulating Biopesticides, What is a biopesticide?, and information on each biopesticide registered in the U.S.

• Natural Insect Control http://www.natural-insect-control.com

A commercial site offering lots of information on products containing biological control organisms. Oriented mostly to domestic lawn and garden products.

The Bio-Integral Resource Centre is a non-profit organization whose website at http://www.birc.org has lots of information on “non-toxic and least-toxic, integrated pest management (IPM) solutions to urban and agricultural pest problems”.

Books

J. C. Van Lenteren (Ed.) (2003) Quality Control and Production of Biological Control Agents: Theory and Testing Procedures CABI Publishing, Wallingford, Oxon, UK, 327 pp.

This book is about arthropod natural enemies reared for use in augmentative and inundative biocontrol programs in a variety of production systems, but primarily in greenhouse horticulture. The chapters cover a variety of topics, ranging from the theory and analysis of quality standards for biological control agents currently in use, through to the definition and measurement of quality in arthropod natural enemies. The work is an excellent foundation for the definition and study of quality in augmentative and inundative biological control agents and should be on every biocontrol researcher’s bookshelf.

Conferences

International Symposium: Ecology and Management of Lygus Plant Bugs. January 30 to February 3, 2005. Ottawa, Canada. Contact Peter Mason at: MasonP@agr.gc.ca

Joint meeting of the International Organisation for Biological and Integrated Control of Noxious Animals and Plants, Nearctic Region (IOBC-NRS) and the Biocontrol Network, Le Chéribourg Hotel, Magog-Orford, QC, May 8-11, 2005. See the “What’s new” section of http://www.biocontrol.ca or contact L. Lévesque at: biocontrol-network@umontreal.ca