Because land doesn't come with a manual. . .

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Biocontrol: Toward Safer, Sustainable Pest Management

From The President

• Chris O'Brien

Advancing the mission of ELA requires the concerted, coordinated efforts of many dedicated people. At the Annual Membership Meeting in July, four new members were elected to the Board of Directors. Joanna Campe (the 'e' in Joanna's last name should be accented), Karen Dominguez-Brann, John Larsen, and Sandy Vorce bring a variety of expertise and fresh perspectives to the ELA Board of Directors. Welcome.

The organization already has begun to tap the reservoir of knowledge and experience that these four individuals add to ELA. But it takes more than a small board of directors to make the association successful. Dedicated members are essential – particularly members who can make their time available periodically to help out with a particular project.

ELA is launching several new initiatives in the year ahead! These include the relocation of the well-attended Winter Conference and Eco-Marketplace to Springfield, Massachusetts. We will also expand our public relations and outreach efforts to further spread the word about the ELA mission. As we add members around the nation, the association is examining how to structure local groups within ELA. Successful completion of these objectives requires the execution of many smaller tasks and projects. This is where the help of volunteer members is critical. The individuals among our diverse membership have many skills and resources that are much needed to support ELA. On some occasions we simply need alert individuals to help us staff a table at a conference. The Winter Conference, for instance, operates through the efforts of dozens of volunteers.

If you have time or skills that you can offer to ELA, please email Penny Lewis at ELA.info@comcast.net or call (617) 436-5838 to be added to ELA's volunteer database. Our volunteer coordinator can match you up with a project that corresponds to your interests and abilities. We understand that your time often is constrained and will honor those limits. Your participation is integral to the future of ELA.

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Biocontrol & IPM: The industry in 2006

• Mike Cherim

New pests enter our work life all the time and a continual effort is made to seek safer, more environmentally-friendly solutions. This is true of not only the biocontrol and IPM industry, but the pesticide industry as well. To the credit of chemical makers, great strides are being made to develop chemicals and compounds which mitigate pests without doing so at the expense of natural enemies. The challenges continue, though. Years of overuse and irresponsible practices have increased levels of resistance to pesticides which is why formulating new products is essential. Moreover,

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The ELA board meets throughout the year in various locations in eastern Massachusetts. All members are welcome. Contact us for specific dates and locations.

as the world becomes more unified and boundaries become blurred, we share a greater number of pest problems.

There are heavy costs in terms of environmental degradation, human health issues, and resources, and there are monetary costs that affect all of us. As fuel prices climb, petrochemical prices increase, heating costs rise, and transportation costs explode. Getting bugs from producer to grower must be done by an expedited means to ensure vitality and freshness; biocontrol agents are living organisms and have a very finite shelf-life. An expedited means translates to increased shipping costs. Often transportation costs exceed that of product costs. For producers, this means that order consolidation, pre-planning and market-preparedness play a larger role in successful IPM implementation today than ever before. This increases pressure on the industry, which will have to adapt to survive.

To ensure safe use and implementation, oversight is needed. This unfortunately adds to costs and limits the practical aspects. Inspections can cause delays, exacerbating the need for expedited transportation. If that alone isn't enough of a challenge to the biocontrol industry, international conflict adds risk and regulation.

Pollution and an ever expanding world population are taking a serious toll on the planet earth. Mother Nature isn't taking it in stride. More erratic weather patterns are developing. The destabilized weather effects are far-reaching and challenge everyone who has to work with anything related to nature. This means biocontrol producers and those who serve them must become even more creative and resilient in order to prosper.

Consumers, like everything else, place demands on the biocontrol industry on many levels. Consumers want better bugs, cheaper bugs, cheaper freight, faster delivery, more convenience, better information, better service, and more. As an increasing sector of consumers embrace ecological landscaping, the biocontrol and IPM industry continues to grow and experience issues typical of nascent markets. Open dialogue benefits all parties.

A solution to many of these issues is technology. There are technological solutions to many problems, and the industry must embrace and implement them, not only in production methods and transport methods. The web, for example, has amazing benefits – such as meeting many consumer needs – but its difficulties must be realized and understood.

While spelling out the challenges isn't always easy and may seem negative, knowledge benefits both producers and consumers of biological controls. Knowing is all part of development, like watching the weatherman on television and carrying an umbrella if rain is called for. If the challenges are understood, we can better know what the following year may bring to decide if we need to carry that umbrella.

Mike Cherim is the director of The Green Spot, Ltd., Nottingham, NH. The Green Spot, Ltd. was founded in 1992 as a distributor of biological controls and IPM supplies, and encourages education through informative dialogue. To learn more, call 603-942-8925 to request their Green Methods Catalog or visit them at www.greenmethods.com.

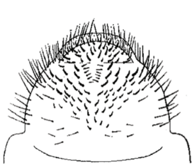
White Grub Control Without Chemicals

• Bruce Wenning

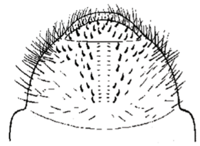
White grubs are insect pests of home lawns, athletic fields, parks, gardens, and anywhere their preferred hosts grow. White grubs live in soil, are C-shaped, have six legs, chewing mouthparts, and feed on turfgrass roots and the roots of other plants. Lawns that are attacked by these pests show poor vigor, thin turf, smaller (or no) roots, and bare spots susceptible to weed colonization. The four grub species of concern in our area are introduced pests and are very problematic on home lawns. They are the Japanese beetle (JB, *Popillia japonica*), Oriental beetle (OB, *Anomala orientalis*), European chafer (EC, *Rhizotrogus majalis*), and Asiatic garden beetle (AGB, *Maladera castanea*).

The life cycle for all four species is very similar: there is one generation per year; adult beetles are active during the summer; the grub (larval stage) actively feeds on turf grass roots in the fall (August through October), and again in the spring (April through May). The misuse and overuse of insecticides for the control of all white grub species has the public concerned with health and environmental issues. In addition, many home owners and landscapers battle white grubs without much success because they assume that all white grubs are the insecticide-susceptible Japanese beetles. They are not!

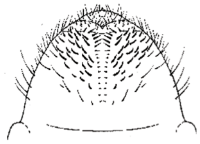
First, I want to give the reader a quick review on some of the biological adaptations exhibited by three of the four grub species enabling them to escape (at times) chemical control. As you will see, proper white grub identification (using a 10x hand lens) is very important for selecting least toxic and non-toxic control options. Most homeowners and landscape company personnel do not identify grubs to their species. Doing so would provide better information for choosing a non-toxic solution over of an insecticide in most situations.



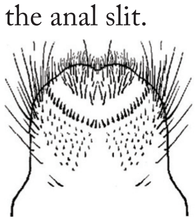
Japanese beetle: Adults feed on nearly 300 species of plants, including trees, shrubs, and vines. The grub has a small distinctive V-shaped rastral (spine) pattern and a transverse anal slit on the 10th abdominal segment that distinguishes this species from the other three. JB grubs are widely distributed in southern New England and are the most susceptible to chemical and non-chemical controls of these species.



Oriental beetle: This grub has a transverse anal slit like the JB but exhibits a distinct straight and parallel rastral pattern unique to this species. OB grubs are less susceptible to many of the commonly used insecticides and are quick to move down in the soil profile during hot weather. Since they have the ability to detect and avoid hot, dry conditions they become more difficult to control when insecticides are applied at this time. If you did not ID this species properly, and assumed it to be JB, your chemical option could be ineffective for good control.



European chafer: This white grub is the most damaging to home lawns and other turf grass areas causing turf to become easily dislodged from the soil. It is commonly referred to as an "eating machine on lawn roots." European chafer is the only grub that can feed during cold weather, causing root damage in the early spring and well into the fall, when the other grub species are inactive. EC grubs have been detected feeding on lawn roots under snow in February. EC grubs are hard to control using labeled insecticides because they are larger in size than the other three species. They also have genetic characteristics allowing them to avoid and/or metabolize insecticides to escape being killed. To ID this species, look for a rastral pattern that is somewhat Y-shaped; rows of rastral spines look like an opening zipper near the anal slit.



Asiatic garden beetle: Chemical control for this grub has been inconsistent. Imidacloprid (trade name, Merit) has not demonstrated effective control for this species in all situations. Some suspect that the spread of AGB is attributable to imidacloprid overuse; killing the other grub species and allowing the expansion of this one. To ID this grub, look for a rastral pattern in the shape of a reduced semi-circle.

Not all landscape pests can be controlled using bio-control agents. The nematode, *Steinernema carpocapsae* is available commercially but does not work on white grub control. However, the commercially available nematode, *Heterorhabditis bacteriophora* (HB) is an effective bio-control agent against Japanese beetle grubs. Dr. Albrecht Koppenhofer (Rutgers University) has shown that *H. bacteriophora* only works on JB grubs, and not effectively enough on the other white grub species for satisfactory control. Late summer field trials (limited in scope) by Dr. Patricia Vittum, University of Massachusetts, showed in this case control for all four species of white grubs using the HB nematode. However, she prefers to defer to Dr. Koppenhofer's research findings.

IPM Labs Entomologist, Carol Glenister states that the "HB nematodes are most able to do their job against grubs in late summer (mid-August to early September) when soils are warm and the grubs have increased in size. Earlier than that, it doesn't make much sense to apply the nematodes." Ms. Glenister adds, "In July, the pests are in the egg stage and in June they are mostly adults. Although we do have some grubs in May, the soil is a little too cool for the HB nematodes to function well." She then asks, "Which grub species will they attack? With the proper environmental conditions they'll reduce all the species to varying degrees, but Dr. Koppenhofer's research indicates that they work best on Japanese beetle grubs."

Protective equipment for applying nematodes is not needed. The E.P.A. exempts nematodes from the registration required for chemicals. The HB nematode seeks out grubs for food and reproduction. When this nematode enters a white grub through a natural body opening, it feeds on the grubs' internal organs releasing a bacterium while it feeds. The bacterium eventually kills the grub. The nematodes move through the soil to seek out more grubs. Nematodes that are commercially available are specific to pests stated on the label. For best results, read and follow all labeled instructions and be certain that the beneficial nematode matches the biology of the pest in question.

To find out how and when to purchase this nematode for white grub control, and handling procedures for lawn application, contact: IPM LABS, Locke, N.Y. (315) 497-2063. Website: http://www.ipmlabs.com.

Information presented in this article derives from the ELA Winter Conference, March 5, 2005 lecture by Dr. Patricia Vittum, U. Mass Amherst, Stockbridge Turf Program, and from an interview with Carol Glenister, Entomologist, IPM Laboratories, April 13, 2005. This article previously appeared in the Newton TAB.

Drawings by Dr. David Shetlar, Ohio State Univ. Extension.From the Rutgers Cooperative Research and Extension Fact Sheet 1009.

Bruce Wenning is Horticulturist and Grounds Manager, Massachusetts Audubon Society, Habitat Wildlife Sanctuary, www.massaudubon.org; garden columnist, Newton TAB *for Green Decade Coalition / Newton, www.greendecade.org; and serves on the Board of Directors for the Ecological Landscaping Association, www.ecolandscaping.org*

Is Classical Biological Control The Answer?

• Richard Casagrande

Over the past several years I've addressed many audiences on issues and opportunities in biological control with mixed results. Many in the audiences are vigorous supporters or at least cautiously optimistic about biological control in general, but others have serious reservations.

No one objects to enhancing existing biological controls in the landscape. This can be accomplished by judicious use of pesticides, providing food for natural enemies, and utilizing good horticultural practices. It is generally understood that indiscriminate use of insecticides kills natural enemies that would otherwise control pests. This results in secondary pest outbreaks that are not only common in agriculture, but also known to occur in home landscapes such as when sod webworms or chinch bugs follow white grub treatments or mite outbreaks follow imidacloprid use against hemlock woolly adelgid.

Gardeners generally don't need encouragement to plant flowers, but few realize that the parasitic wasps and predatory insects in our landscapes need the nectar and pollen that these plants provide. For instance, the hover flies visiting our alyssum or sedum flowers produce the maggots that eat the aphids off our broccoli.

And how many times have you heard "right plant, right place", "don't plant too deep", and "avoid volcano mulching"? Landscaping mistakes induce insect pest problems. Predatory mites can generally keep spider mites in check on Alberta Spruces planted in the landscape, but against a house? It's a disaster. Similarly azaleas, rhododendrons, and andromedas seldom experience serious lace bug problems in our area – unless planted in full sun where they don't belong. Insect natural enemies work in concert with natural plant defenses to keep pests in check and they often can't do the job alone if the plant is under stress from horticultural mistakes. While not universally understood (or practiced), these concepts meet little conceptual opposition.

It is Classical Biological Control that generates the discussion. Through this approach, exotic natural enemies are introduced to control non-native pests – both plant and insect. There are several issues that contribute to apprehension. First is the sheer number of introduced pests. The questioning often goes along the lines of "how could you consider introducing additional species when we already have so many problems with exotics?" It is important not to confuse the problem with the solution. Many of our exotic species have become pests here because they left their native enemies back in Europe or Asia. No one will argue that we need more exotic pests, but introduction of another non-native may be exactly what we need if that exotic is a *Galerucella* beetle and your problem is purple loosestrife.

I can always identify those who have been to Hawaii by the question: "What about the mongoose that was introduced against the (exotic) rats, but decimated the (native) birds". (If you haven't been on that tour, the explanation is that "the mongoose works the day shift, but the rats work the night shift".) Use of exotic vertebrates for biological control has, in fact, been a series of disasters and I doubt that we'll see any such introductions in the future – certainly not with authorization.

There have been also some purposeful insect biological programs with unfortunate side effects. Many New Englanders are aware of the decline in *Saturniid* moths (*Cecropia, Luna, Polyphemus*) that resulted from the 1906 introduction of a tachinid fly (*Compsilura concinnata*) against the gypsy moth and brown-tail moth. Even though this introduction solved the brown-tail moth problem (which was more severe than the gypsy moth at that time), we would not introduce such a generalist parasitoid today because of predictable adverse side effects. I also expect (and certainly hope) that we have seen the last introduction of generalist predators such as ladybird beetles which, although effective in reducing some pest problems, tend to displace our native species and sometimes cause problems of their own (e.g. Halloween ladybug). Then there is the problem of an exotic weevil adversely impacting native thistles out west and the cactus moth that is spreading through the southeastern states on native cacti. These introductions occurred 30-50 years ago when there was less concern about indirect effects of all types of pest control actions.

Current biological practitioners are keenly aware of all these issues. No scientist or agency wants to be credited with introducing the next gypsy moth, starling, or cactus moth. Thus there is great emphasis on studying the biology and host specificity of potential biological control agents before considering them for introduction into North America. This process is carefully regulated by the USDA for biological control of weeds. Here it is necessary to test insect performance on 50-100 potential alternate hosts including closely related species, crop species, and plants that share a habitat with the target pest. The successful control of purple loosestrife is an excellent example of current weed biocontrol. Through careful field and laboratory testing, a list of 120 European loosestrife insect herbivores was narrowed down to the 4 host-specific species that were released. These species have successfully established throughout our region and are substantially reducing loosestrife population without adverse impact on non-target plants.

USDA testing requirements are somewhat less stringent for biological control of insect pests, but researchers do evaluate host specificity. For instance, we found six natural enemies parasitizing lily leaf beetles in Europe. From the literature we determined that two of them were not host-specific. We then spent three years in our quarantine laboratory evaluating the host range of the other four species and determined that three would attack no other North American hosts. With USDA permits we have released and established two of these parasitoids in four New England states where they are already reducing pest densities and spreading. These insects will not change their host preferences as lily leaf beetle populations decline.

Classical Biological Control has served us well for over a century and I'm confident that it will continue to play a large role in pest control with today's increased awareness of ecological effects. There are several ongoing efforts of particular consequence in ornamental horticulture. Among the most important is the parasitoid release work of Joe Elkinton and University of Massachusetts colleagues against the winter moth (see previous issue, Vol. 12, No.5, for more information). This relatively new arrival in New England has been controlled in Nova Scotia and in the Pacific Maritimes by releasing European parasitoids – most importantly a tachinid fly. This fly was released in Massachusetts two summers ago and I fully expect that through this and subsequent releases, this pest will come under control over the next decade.

I wish I could be so optimistic about the hemlock woolly adelgid. A predatory beetle from Japan was released against this pest several years ago, but without apparent effect. Other natural enemies from China and from the Pacific Northwest are under evaluation. These may provide good control on the adelgid-resistant oriental and western hemlocks, but it is not clear to me whether they will be adequate on our susceptible Canadian and Carolina hemlocks.

The birch leaf miner, on the other hand, is proving to be a good example. This European insect was first found in Connecticut in 1923 and has been a major pest of ornamental and roadside birches since that time.

However, USDA scientists working with European colleagues identified and introduced key parasitoids, which University of Rhode Island and University of Massachusetts entomologists released in New England. It took about 14 years for these parasitoids to spread and build up throughout our region, but it appears that this pest is now under good biological control. We haven't seen any damage in three years and this year we could not find any leaf miners in either Rhode Island or Massachusetts.

On the plant front, the purple loosestrife success spawned a similar program on common reed (*Phragmites australis*). Although there are isolated pockets of native phragmites, virtually all the problems with this plant are due to the invasive European biotype. We are working closely with Bernd Blossey of Cornell and colleagues at CABI Bioscience in Europe to evaluate European natural enemies of this plant. We'll be moving promising agents into our quarantine laboratory this winter to begin host range testing of agents that may provide biotype-specific control of the invasive plants. Aaron Weed, a doctoral student researcher, is in Europe this season to discover and evaluate natural enemies of swallow-worts for a potential control program against these emerging weed-pests of northeastern landscapes. This work is looking quite promising and several species will be returned to our quarantine laboratory for evaluation. There are many other programs underway at other institutions to look for biocontrols of garlic mustard, Japanese knotweed, and others.

With all this progress in Classical Biological Control, it is worth taking another look at the constraints. In my mind the first constraint is that biological control should be practiced only against exotic pests. No matter how much we don't like white pine weevils or poison ivy, I don't believe we should undertake permanent control of these native organisms. Secondly, host specificity is key to biocontrol success and environmental acceptability. Pests that do not have close native relatives are generally better candidates for biological control. The permanence that makes biological control so attractive also makes possible a permanent mistake. Once introduced, an exotic natural enemy is probably here to stay. It must be expected to spread throughout its favorable range, which might include much of North America. Thus we must thoroughly examine and debate the risks and benefits of a particular biological control agent before its release. Finally, it takes time (5-7 years minimum) and funding on the order of millions of dollars to complete Classical Biological Control programs. It is becoming increasingly difficult to secure this funding from granting agencies that are primarily funding high tech approaches. Despite these limitations, I am confident that we will continue to make significant progress on key pest problems, but don't be surprised if you're asked to help foot the bill.

Our best option is to keep exotic invasive species out of North America, but we have a large backlog of existing problems and accidental introductions continue, apparently at an accelerating rate. With continued vigilance, Classical Biological Control will provide an effective approach to managing these invasive species.

Galerucella calmariensis *beetles produced on tomatoes for release against Purple Loosestrife in Illinois. Photo credit: Michael Jeffords (Illinois Natural History Survey)*

Richard A. Casagrande is Professor of Entomology, University of Rhode Island in Kingston, RI. Dr. Casagrande researches and lectures on biocontrol issues, and is the author and co-author of many articles from research on this subject.

Biological Controls – Interview with Richard Ward, and Industry Leader

Editor: Over the past ten years, what would you say are the greatest changes that have occurred in the use of biocontrols in landscape management?

I would say that the Landscape industry has become very much more aware of the benefits of biological control. This is because of two main reasons. Firstly, that companies dealing in biological control have been expanding their markets from the traditional vegetable market into the ornamental and landscaping industries. Second is the fact that many of the traditional chemicals used in the landscape industry are now not available, or on the list to be phased out.

• Over the coming ten years, what would you expect to be the most significant developments in biocontrols in landscape management?

I think the industry will continue to expand its use of biological control, especially in the areas of soil borne insects and grubs. Bio-control companies are also looking at this side of the industry as one with great potential, so working together, I think that both industries can and will benefit from the development of new products for this sector. Interiorscapes is also a market that is growing rapidly as the use of chemicals is now forbidden in most of these areas that may be visited by the public.

• Landscape professionals are generally more aware of arthropod biological controls than others. What other vectors of biological control are having significant impact and how are they used?

What do you see on the horizon in the way of new biocontrol products/vectors? Nematodes are being used more and more in the landscape and golfing industry for the control of soil borne insects. There are a number of nematodes on the market now that have had good success in this area. Education is very important in that it is crucial that these products be applied correctly if they are to work and produce the results expected. Detailed instructions are normally given to new users and most bio-control companies have technical staff to help with any questions that customers may have.

• Some concern has arisen in certain cases among landscape professionals and cooperative extensions regarding availability of certain biocontrol products. How is the biocontrol industry addressing this concern?

As you know, we are dealing with live products in this industry and as such all have a specified shelf life or use by date for best results. As we develop this side of the industry more, we as producers will get a better feel for the market, its potential usage and time frame. I think one of the reasons some companies have experienced shortfalls in supply is because this is still a developing side of the industry and none of us (producers or consumers) at this point have any idea what the yearly usage will be. Hence I refer back to the fact that we are dealing with live product, which can't be put on a shelf and inventoried for months so as to be assured of having product when demand suddenly increases. The other problem we face is the change in demand from one year to the next. For example, white grubs may be a huge problem this year and a very minor one next year. It is very difficult to plan for this when producing live product.

Improvements in larval identification and sorting by producers of green lacewings (Chrysopa *spp.*) *have increased survival in shipping, as reported by* Midwest Biocontrol News. *Photo by Roland Smith, Auburn University.*

• Another concern is quality control. How do you feel the creation of an inspection/quality assurance program would affect producers and consumers of biocontrol products?

This is a subject of great concern to our industry and most of the producers are painfully aware of the costs and ramifications if product does not arrive at the consumer in good condition. Our producer association, the ANBP (Association of Natural Bio-Control Producers) works very closely with ASTM and IOBC to develop standards for use by producers. We also work closely with independent researchers to develop testing methods that are quick, easy and accurate for the consumer to do upon receipt of the product/s they ordered. There are some products that are "not good shippers" as we refer to them in the industry, but it is up to the individual companies selling these products to advise their customers of the possibilities of damage or cannibalism during shipment. For the most part, I think most companies are doing this well and most will over pack these products to compensate for this possibility.

• How do you think the use of biological controls has improved the landscape professions as well as the experience of the clientele?

Bio-control has improved the vegetable, ornamental and landscape industry by drastically reducing the dependence on harmful chemicals. This is especially true in the landscape industry as many soil insecticides were being used that would eventually find their way into our underground water supply or our streams, rivers and lakes. The use of biological control has severely reduced the use of these chemicals in the landscape industry and in so doing, has eased the impact of harsh chemicals on our environment in a small, but still significant way. The reduction/de-registration of chemical treatments has also made landscape, city, and PCA personnel more vigilant to possible insect problems and hence they can be treated biologically before they become too large a problem.

Richard Ward is Managing Director of Biobest Canada Ltd. and Biobest USA, Inc., Leamington, Ontario and President of the Association of Natural Bio-control Producers.

HABITAT POTS AS A SOURCE OF BENEFICIAL INSECTS

• Carol Glenister

In August 2005, Baker's Acres and IPM Laboratories successfully completed a joint research project to test habitat for beneficial insects that control pests. Beneficial insects tend to abandon environments that lack supportive habitat. During periods when pest insect numbers are low or their life cycle keeps them dormant, providing habitat (especially nectar for parasitic wasps and flies) is essential to keep your pest management efforts on track. This summer's project was designed to support the establishment and reproduction of beneficial insects by supplying pollen and nectar in Habitat Pots of blooming plants. Baker's Acres placed one large hanging basket with habitat plants over each herb bench in the herb greenhouse.

As hoped, the project demonstrated establishment of all the released beneficials plus several more local wild species that came in naturally on their own. These plants are so attractive, that hover flies found them within 5 minutes at a children's camp where some Habitat Pots were taken for a demonstration. Hover fly larvae are very important predators of aphids. Kevin Zippel of IPM Lab's checked the plants every week for presence of beneficial insects. The *Orius* bug maintained a constant population on the habitat pots through the project's completion in August. The barley with grain aphids supported a constant supply of aphid parasites to patrol the greenhouse. *Encarsia*, a tiny insect that kills whitefly, maintained a presence from the time of its first release through the final observations in August.

This project indicates the great potential for increased establishment and effectiveness in insect biological control of other insect pests through the use of habitat plantings. Creative applications, such as hanging baskets, offer more avenues of use and aesthetic potential while also increasing effectiveness.

Carol Glenister is President and Entomologist at IPM Laboratories, Inc. in Locke, New York, serving IPM since 1981. Find out more at ipmlabs.com or call 315-497-2063. She researches, writes and gives regular talks about IPM practices and developments. This project was supported with funds from the USDA Northeast Sustainable Agriculture Research and Education Grant.

Habitat Pot Plants – Start in April

- 3 marigolds
- 1 lantana
- 3 sweet alyssum
- 1 fennel
- barley with grain aphids

Beneficials introduced in April
Aphidius colemani - Aphid parasite
Encarsia formosa - whitefly parasite

Wild volunteer beneficials:
lady beetles – aphid predators
lacewings – aphid predators
hover flies – aphid predators

Microbial Agents for Insect Pest Control

• **Martin Erlandson and Mark Goettel**

A large variety of entomopathogenic viruses representing at least 13 virus families have been reported from insects in addition to numerous as yet unclassified viruses (Hunter-Fujita et al., 1998). Two of the most commonly observed groups are Cypovirus (CPV) in the *Reoviridae* family and the baculoviruses in the *Baculoviridae* family. Most research and development of viruses as microbial control agents has been devoted to this latter group which infects over 600 insect species. With a few exceptions, most baculoviruses are quite specific, infecting a single species of insect or a few species within the same genus (Cory, 2003). Baculoviruses are a rather unique group of rod-shaped, double stranded DNA viruses that have two forms in the replication cycle: occlusion of mature virus particles in large protein crystals (called occlusion bodies) in the nucleus of infected insect cells, which are responsible for insect to insect transmission of the virus. A non-occluded, budded form of the virus spreads the infection from tissue to tissue within a host insect. The baculoviruses are currently classified into two genera Nucleopolyhedrovirus (NPV) and Granulovirus (GV).

Baculoviruses are responsible for spectacular natural epizootics resulting in crashes of insect populations, particularly in some lepidopteran and sawfly pest species in forest ecosystems. Commercial products have been registered, including Lymantria dispar NPV for control of gypsy moth and Neodiprion lecontei NPV for management of the redheaded pine sawfly. This has been a successful strategy. Baculovirus attributes suggest that their potential as microbial insecticides has yet to be fully exploited. Narrow host ranges indicate they will have few non-target impacts, and occlusion bodies give the infectious virus particles stability in the environment, also making the virus easy to formulate and apply using conventional technology. There is considerable potential for secondary biological amplification of the agents in the pest population once it is applied, leading to enhanced activity. These viruses also can be fast-acting, producing mortality in four to six days post-infection. The relatively long history of use of these viruses in forest systems has generated a substantial body of evidence indicating that these are safe agents from the perspective of vertebrate safety as well as showing minimal environmental impact. Possibly the biggest roadblock to the development of baculoviruses is the cost of production of these agents.

Baculoviruses are responsible for spectacular natural epizootics resulting in crashes of insect populations . . .

Although fungi have great potential for development as microbial control agents, only a few have been used on an operational scale. Modern exploitation of fungi as inundative insecticides began in the 1960s and several products based on *Beauveria bassiana* were used for control of numerous pests in the People's Republic of China (Feng et al., 1994) and the Colorado potato beetle in the former USSR (Ferron et al., 1991). *Metarhizium anisopliae* has potential against several pest species and is being used commercially in Brazil for control of spittle bugs in sugarcane (Wraight and Roberts, 1987). *Paecilomyces fumosoroseus* and *Verticillium lecanii* are commercially produced and used for control of whiteflies and aphids in greenhouses in Europe and the USA (Copping, 2001). *Metarhizium anisopliae* has recently received registration in the United States for control of various ticks, beetles, flies, gnats, thrips and termites.

Unfortunately, until recently, it was generally believed that all that was needed was to apply an adequate amount of viable inoculum to the host. As more and more researchers move from the laboratory to the field, we are finding out that this is not necessarily so. Successful use of entomopathogenic fungi as microbial control agents will ultimately depend on the use of the right propagule, formulated in an optimum fashion and applied at the right time to a susceptible host.

Protozoa are a diverse and heterogenous group of organisms associated with insects in relationships ranging from commensal to pathogenic (Tanada and Kaya, 1993). There are numerous species of Protozoa pathogenic to insects but in general they are quite host specific and slow acting, most often producing chronic infections leading to a general debilitation of the host and characterized by slowed rates of growth and reduced feeding, fecundity and longevity. Spores must be eaten in sufficient quantity by the host to initiate disease. Thus only a few are presently being considered as potential microbial control agents. Only one, *Nosema locustae*, has been registered (USA) and is commercially available for use against grasshoppers. With elucidation of sometimes very complex life cycles and a better understanding of protozoan epizootiology, mass production techniques, virulence optimization, persistence, environmental hazards and constraints, the potential for use of Protozoa in insect pest management should increase. However most protozoa, like viruses, are obligate parasites that need to be produced in live insects and so current costs and methods of production limit the availability of commercially produced agents.

Microorganisms can and have been used in the four types of biological control strategies; classical biological control, inoculative, inundative and conservation strategies. Classical biological control entails the introduction of the biological control agent into a new ecosystem with the intent of having it establish and provide long term suppression of a pest. It is most commonly used for suppression of non-indigenous pests, i.e., those that have been introduced without their natural enemies. A good Canadian example is the European Spruce Sawfly, *Gilpinia hercyniae*, a major forest pest in eastern Canada in the 1930s through early 1940s, but which was reduced below an economically significant population level after the introduction (accidental or otherwise) of a highly specific and efficacious NPV in 1945 (Magasi and Syme, 1984). Another example is the decimation of the gypsy moth, (Lymantria dispar), a lepidopterous pest of hardwood forests that was accidentally introduced into North America, through the introduction of its (fungal) pathogen, *Entomophaga maimaiga*, from Japan (Pell et al., 2001). Classical biological control must be practiced with caution, as introduced agents can provide widespread control and do not respect political boundaries. Classical control programs are consequently practiced by governmental agencies as "public good" programs.

A second strategy has been termed "inoculative release" in which an agent is applied or released in an insect pest population at the early stage of an outbreak and gives season long or multi-year control. This approach is often used in forest systems, for example, the use of the baculovirus product TM Biocontrol-1 (OpMNPV) for control of Douglas-fir tussock moth. For this and the classical approach the agent needs to have a mechanism to efficiently spread and cycle through the host population.

The third strategy, referred to as "inundative" is similar to the conventional use of chemical insecticides where the microbial agent or "biopesticide" is applied to a pest insect population that has exceeded its economic threshold. This strategy requires a relatively fast acting agent, a requirement not always achieved by many pathogens. This approach has been used most typically on greenhouse and horticultural crops as, for example, the use of codling moth GV in orchards and the *Spodoptera exigua* NPV (SPOD-X) for control of beet webworm in greenhouse crops in Europe. The most successful examples of the use of biopesticide as "inundative" control agents in large scale applications are use of Bt for control of forest lepidopterous pests and the use of *Anticarsia gemmatalis* NPV for control of the velvet bean caterpillar on approximately 2 million hectares of soybeans annually in Brazil. In this NPV case the virus agent has been produced at a lower cost than chemical insecticides and gives comparable control efficiency (Moscardi, 1999).

The fourth strategy, "conservation" is still in its early stages of implementation. This strategy aims to conserve the natural enemies already present. A recent example is the conservation of the entomopathogenic fungus *Neozygites fresenii* in cotton aphids in the USA. The fungus often causes epizootics in cotton aphids in midsouthern USA; however chemical insecticide intervention usually occurred before the epizootic could establish. Through careful diagnoses of pre-epizootic aphids, epizootics can be predicted, thereby alleviating the need for application of chemical insecticides and assisting in the preservation of the fungus and other aphid natural enemies (Pell et al., 2001).

There are a number of characteristics of microbial agents, including issues of environmental stability, time-to-effect and target specificity that may require different strategies for implementation than are currently used for chemical pesticides. The target specificity of many of these agents will undoubtedly allow for more integration with other biological control strategies. The use of microbial insecticides may require better monitoring of both pest and beneficial species as optimizing timing of agent introduction will be more critical than with chemical pesticides. In addition novel strategies for application or introduction of agents may be needed to utilize these agents to their full potential.

At present, the prominent goal is to develop microbial pathogens as biopesticides for use in the inundative fashion. However, as pest management concepts evolve, there may be a move from the purely "insecticidal" approaches to those for longer term pest management using augmentative and conservation approaches where there may be an increased role for pathogens not necessarily amenable to mass production, such as many protozoans, especially as classical biological control agents.

Excerpted from "Microbial Agents for Insect Pest Control", PBI Bulletin, National Research Council Canada. Dr. Martin Erlandson is at the Saskatoon Research Centre, Agriculture & Agri-Food Canada Saskatoon, SK. Dr. Mark Goettel is at the Lethbridge Research Centre, Agriculture & Agri-Food Canada Lethbridge, AB.

ELA events

ELA Roundtables and Co-Sponsored Events

The 2006-2007 Roundtable Series starts on October 25, 2006 ~ 3:00-5:00pm. Roundtable: 'Greenscapes': A Campaign for 'River-Friendly' Landscape Techniques. Co-presenters: *Wendy Garpow & Samantha Woods*. Co-sponsored by: Massachusetts Social marketing Association & ELA. To take place in the Saltonstall State Building, Conf. Room B - second floor at 100 Cambridge St. Boston. The cost is $7.

Co-presenters Wendy Garpow, Massachusetts Bay Program, and Samantha Woods, North and South Rivers Watershed Association, will share their experiences on developing a multi-faceted education and outreach program called Greenscapes. The Greenscapes program was implemented on the South Shore of Massachusetts over the last three years and endeavors to educate homeowners and landscape professionals on landscaping techniques that reduce the need for water and unnecessary chemicals. They will present the elements and results from the program to date.

Reserve your space by responding to your "e-vite" or leave name, phone number, and number of guests on the ELA phone line (617) 436-5838.

November 3, 2006 ~ 9:00am-4:00pm Roundtable/Workshop: Harnessing Microclimates in the Landscape. *Ben Falk, Landscape Designer, Whole Systems Design.* Offered in collaboration with Arnold Arboretum of Harvard University. For a complete description visit the www.ecolandscaping.org or read in the forthcoming post card. Where: Hunnewell Building, Arnold Arboretum, Jamaica Plain, MA. Fee $75 member, $90 nonmember.
Bring a lunch and wear clothes suitable for walking outdoors. Registration: Send check payable to Ecological Landscaping Association, 60 Thoreau Street, #252, Concord, MA 01742-2456 or call in your registration at (617) 436-5838 by leaving name, address, phone number, and number of guests. Payment is due at the door, cash or check only.

December and January Roundtables – TBA. Please visit www.ecolandscaping.org or call (617)436-5838 for recorded information in November.

2006 Annual Appeal

With your generous support of the 2006 Appeal, ELA will build on its record of promoting ecological landscaping through networking, events and publications. Your tax-deductible contribution to ELA is **ESSENTIAL**. *Thank you!*

Ecological Landscaping Association
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other events

November 3, 2006, "Turning a New Leaf" a conference and eco-marketplace on sustainable landscaping. Held at Unitarian Universalist Church in Bethesda, Maryland (located near Routes 495 and 270).

The full day's agenda and registration information is available at www.chesapeak-elandscape.org For additional information: Carol Jelich (410) 634-2847 x 40 or Sylvan Kaufman, (410) 634-2847 x 24.

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announcements

ELA MEMBERSHIP RENEWALS

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gleanings

IN THE NEWS: BLOWERS LOSE
– Reprinted from Landscape Online Weekly
Tree-filled Palo Alto, Calif. has banned gas-powered leaf blowers in the town's residential neighborhoods. Landscapers and the Outdoor Power Equipment Institute (OPEI) aren't happy with the decision. The trade group lobbied the city extensively and has loudly complained that the ban excludes newer blower models that are much cleaner and quieter.

Palo Alto is often looked at as a model for legislation – particularly on environmental issues, said Bill Guerry, an attorney who fought the ban. "The difference is that Palo Alto made requests of the gardeners … to buy the cleanest and quietest blowers, and participate in training programs, then challenged the manufacturers to build cleaner and quieter products, at a cost of literally tens of millions of dollars, and then they changed their mind," he told the San Francisco Chronicle.

The OPEI was stung by the outcome, and is warning landscapers in other municipalities to avoid antagonizing local government officials. "In most cases, city and government officials, when presented with accurate information, (will) work with us on legislation." OPEI president Bill Harley wrote. "Therefore, OPEI calls on all landscape professionals to work with community residents and officials to prevent adversarial conditions."

More than 1,600 landscape workers were burned, the OPEI says, when they were certified by the city to use quieter gas-powered blowers, and bought new $500 machines believing officials would reverse the ban. The Bay Area Gardeners Association, representing close to 1,600 gardeners who serve Palo Alto, doesn't think so. It estimates that its members have lost roughly $1 million in profits since the ban took effect.

The association and the gardeners also have the support of two companies, Stihl Inc. and Shindaiwa Inc., which manufacture outdoor power equipment. In letters sent this summer to the Palo Alto City Council, both companies say they specifically poured money into engineering quieter machines for the city of Palo Alto.

Sources: San Francisco Chronicle, Outdoor Power Equipment Institute (OPEI).

NATIVE NATURAL ENEMIES

The most important native natural enemy of gypsy moth is the white-footed mouse or deer mouse. This cute rodent relishes gypsy moth pupae and will also attack the large caterpillars, skinning and gutting them before feasting. Deer mice can have a dramatic effect on the growth of gypsy moth populations. Evidence of their effectiveness can be seen by comparing defoliation of oak trees growing in lawns to those growing in a woodland setting with shrubbery, logs and other cover for mice. Mice avoid crossing exposed areas such as lawns, so caterpillars on those trees are protected and their population soars.

Birds will also feed on gypsy moth. Chickadees and nuthatches will peck at egg masses in winter to extract eggs. Few birds will prey on the caterpillars as the long hairs irritate the thin skin around their eyes. However, some species with longer beaks do feed on the caterpillars. Cuckoos (black and yellow-billed) will congregate where hairy caterpillars such as the gypsy moth are abundant, but they can't eat enough to bring an outbreak under control.

Beetles and other invertebrates can be important predators on the gypsy moth. The big, fast ground beetles kill many caterpillars that they find in the tree tops, on the trunks, or on the ground. Stinkbugs inject a digestive fluid into the caterpillars that turns their tissues into a soup which the stinkbug then sucks up. And though they appear frail, daddy long-legs are predators with a poisonous bite and kill many pupae (they pose no threat to humans).

Excerpted from Wisconsin Dept. of Natural Resources, UW Extension, "Introduction and Spread of Natural Enemies."

Registrations Still Being Taken for UMass Extension Green School: Location: Radisson Hotel, Milford, MA

Classes start October 31st!

Green School is a comprehensive certificate training program for Green Industry professionals taught by UMass Extension Educators and Faculty. This course is designed for landscape, turf, and other horticultural practitioners wishing to gain an understanding of horticulture fundamentals and strategies and their relation to environmental quality. Green School attendees learn about sustainable approaches to turf and landscape management in managed environments. Green School's curriculum is based on research and emphasizes environmental stewardship and integrated pest management (IPM). Participants will develop an understanding of how proper management practices impact natural resources such as soil and water. Participants learn how to make environmentally appropriate decisions related to turf and plant selection, plant maintenance, and pest & nutrient management.

Choose 1 of 2 sections: Landscape Management or Turf Management. Green School begins on October 31, 2006 and runs for 12 sessions until December 12th. Classes will be held at the Radisson Hotel in Milford, MA (exit 19 off Rt. 495). Each day runs from 9:00 am to 3:30 pm.

For more information and a registration form, go to: http://www.umassgreeninfo.org/programs/green_school.html

Alternatively, call UMass Extension's Landscape, Nursery, and Urban Forestry Program at (413) 545-0895 or e-mail greenschool@umassgreeninfo.org.

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