Biological Control of Insects
Michigan State University Extension Service
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Insects represent approximately 80 percent of all animal species. Even greater than their abundance is their potential to reproduce. A single pair of houseflies could produce an estimated 400 million tons of flies during the course of a summer if all their offspring survived. Why then are we not knee-deep in insects?

A number of factors keep insect populations in check. Environmental factors such as weather and the availability of food are important. Beneficial insects, mites and pathogens that are natural enemies of insects also play a major role in their control.

INSECT NATURAL ENEMIES AND BIOLOGICAL CONTROL

All insects have natural enemies that attack one or more of their life stages.

Insects may become pests when natural enemies fail to regulate them. This often happens when an insect is introduced into a region where its natural enemies don't exist, when cultural practices favor an insect over its natural enemies, or when pesticides destroy natural enemies.

When humans introduce or manage natural enemies to suppress insect populations, it is termed biological control (bio = living) or biocontrol. In practicing biological control, a number of important principles should be kept in mind.

PRINCIPLES OF BIOLOGICAL CONTROL

1 The success of biological control agents in maintaining the "balance of nature" relies on suppressing, rather than eliminating, the pest. Because natural enemies depend on the pest for development, a certain population level of the pest is necessary to sustain them. This level may need to be high, low or intermediate. Keeping pest populations at an acceptable level may be achieved by combining the actions of natural enemies with other means of control. This is called Integrated Pest Management (IPM).

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2 In contrast to fast-acting pesticide applications, control of pests by natural enemies may take time. Natural enemies must search out pests to consume or lay eggs in them. Time may also be required for the development of a natural enemy before the pest is affected. Once established, natural enemies can offer relatively permanent controls that are self-regulating (needing no human intervention), provided environmental factors or pesticides do not create an unfavorable habitat.

3 Because natural enemies are slower than most pests at colonizing new areas, biological control has been most successful in stable environments. These are most often perennial crops such as apples and alfalfa, that require less cultivation and other practices that disrupt insect populations. However, annual crops like vegetables and corn also have biological control agents that are very effective against certain pests.

4 Biological control is more effective in some years than in others. Success will depend on environmental conditions such as weather, and management practices.

PREDATORS

Lady beetles and spiders are two well known groups of insect predators. Predators are usually larger than the insects they attack and they consume more than one prey during their development. They are most effective against insects that live in groups such as aphids, scale insects and mealybugs. Adult predators often deposit eggs near a prey population where, after hatching, the larvae search out and consume them. In general, predators are less likely than parasitoids to provide total biological control of an insect pest for two reasons: they are less selective for a single pest; and they usually don't reproduce as rapidly as the pest.

COMMON INSECT PREDATORS IN MICHIGAN

Lady Beetles (1/8" - 1/4"). Lady beetles (fig. 1a.) are common insects. Many species are found worldwide. They are generally brightly colored beetles in various shades of red, orange, brown or black, often with spots. Larvae (fig. 1b.) are elongate (1/4" - 1/2"), somewhat flattened, and are usually covered with brightly colored spots or bands. Both larvae and adults are predators, feeding mainly on soft-bodied insects like aphids, scale insects, mealybugs and whiteflies, and on the eggs of many pests.

Ground Beetles (1/8" - 1 1/2"). Ground beetles (fig. 2) have dark, shiny and somewhat flattened bodies, sometimes with iridescent blue or green coloring. Most larvae and adults are primarily predaceous. Adults and larvae generally live on or beneath the soil or in plant litter, though some climb trees. They are active mostly at night.

Lacewings (1/4" - 1"). Adults of both green and brown lacewings are fragile-looking insects with conspicuous wings containing many net like veins (fig. 3a). The larvae (fig. 3b) are usually brown, flattened and elongate, and have an "alligator like" appearance . Green lacewings are very common and found in many habitats, though they prefer somewhat open areas. Brown lacewings are found in wooded areas. The larvae and adults of both families are predaceous, and can be extremely important in the control of aphids. Larvae are sometimes referred to as "aphid lions."

Predatory Bugs (1/16" - 1 1/2"). Many "true bugs" (insects in the order Hemiptera) are predaceous on other insects, using their straw like beaks to pierce and suck body fluids from their prey (fig. 4a). The common damsel bug (fig. 4 b) is usually found on low vegetation where it uses its front legs to grasp small caterpillars, mites, aphids and plant bugs.

Predatory Flies (1/4" - 1 1/2"). Bee like hover or flower flies and large, hairy robber flies are the two main types of predatory flies. Larvae of the hover fly (fig. 5) can rival lady beetles in their consumption of aphids. Adult robber flies catch insects on the wing, but the larvae are more important predators. Robber fly larvae can substantially reduce grub populations in the soil.

Praying Mantids (2" - 4"). Praying mantids are slow-moving, green or brown insects with an elongate body and long, thickened and spiny front legs (fig. 6). They have highly movable triangular heads that are fairly distinctive. Mantids eat a variety of insects that move within range. They can be found on vegetation where they sit motionless while waiting for prey.

Non-insect Predators. All spiders are predaceous. They usually kill their prey by injecting venom. The garden spider (fig. 7) uses its web to capture insects. Also important in the control of insect populations are animals such as birds, frogs and toads, and small mammals such as mice, shrews and moles.

PARASITOIDS

The majority of insect parasitoids are tiny-to-moderate sized wasps that cannot sting humans. Some flies and a few beetles are also included in this group. Parasitoids are usually smaller than their hosts, they lay eggs on or inside the host, and their development kills the host. In contrast to predators, parasitoids need only a single host to complete their development. Adult parasitoids are often better searchers than predators, and are frequently host-specific, attacking only one or a few closely related pests. Host specificity, searching ability and a high reproductive rate make many parasitoids effective control agents because they can respond rapidly to increases in host populations. Parasitoids may attack any life stage, but most attack either eggs or larvae.

COMMON INSECT PARASITOIDS IN MICHIGAN

Ichneumon wasps (1/8" - 1 1/2"). Ichneumons are common wasps and may be the largest family of insects. Most species have slender bodies and a long ovipositor (stinger), but they are harmless to humans (fig. 8). Many are brightly patterned with yellow, brown and black. Many ichneumons attack the larvae of moths and butterflies. Some are important enemies of sawflies and other insects. Typically, they lay an egg in their host. After hatching, the ichneumon larva eats its host as it develops.

Braconid Wasps (1/16 - 1/2"). Braconids are inconspicuous brown or black wasps, usually smaller than ichneumons. They are often seen on flowers, particularly those in the carrot family. Most species are beneficial, but some attack other natural enemies such as lady beetles. Adults attack the larvae of moths, butterflies, beetles, flies and aphids, laying one or several eggs in or on the host. The silken cocoons of small braconid larvae can often be seen on the outside of the body of hosts such as caterpillars (fig. 9).

Parasitic Flies (1/4" - 3/4"). Most parasitic flies resemble houseflies, though they may be larger, stouter and covered with bristles

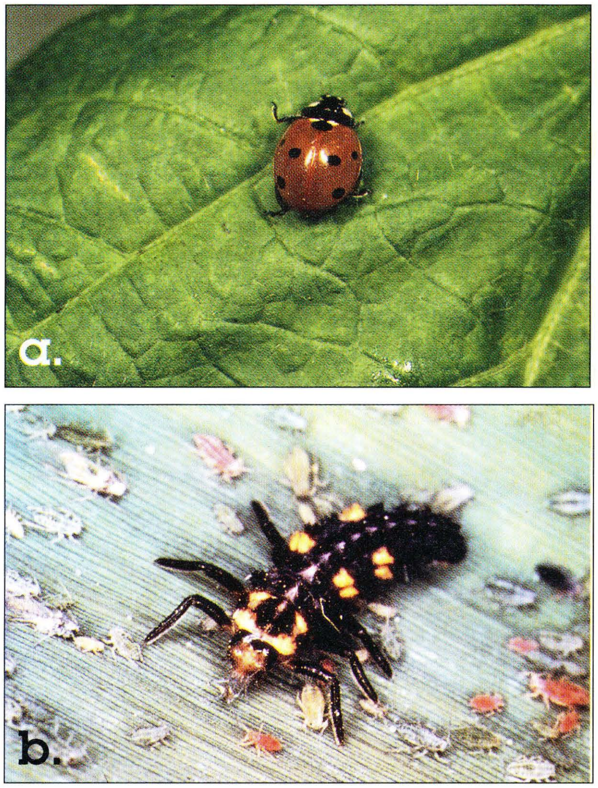

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Fig. 1 (a) Seven-spotted lady beetle adult and (b) larva attacking aphids.

Fig. 2 Ground beetle larva (top) and adult.

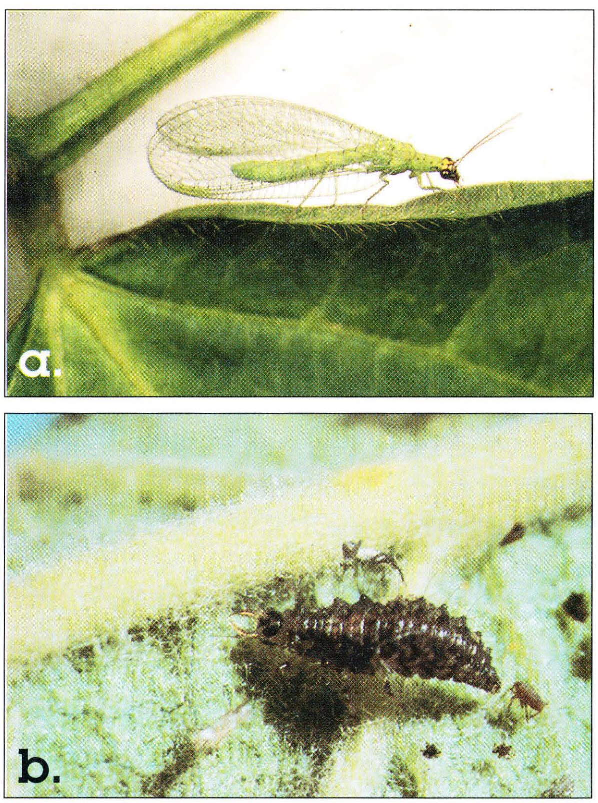

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Fig. 3 (a) Green lacewing adult and (b) larva .

Edward Grafius

Douglas Landis

Fig. 4 (a) Predaceous stink bug attacking Colorado potato beetle larva, and (b) damsel bug adult .

Douglas Landis

Fig. 5 Hover fly larva attacking aphids.

Deborah Miller

Fig. 6 Praying mantid adult.

Janyce Ryan

Fig. 7 Garden spider.

Douglas Landis

Fig. 8 Ichneumon wasps that attack European corn borer. Female with long ovipositor (stinger) on left.

Douglas Landis

Fig. 9 Tomato hornworm with many white cocoons of braconid wasps.

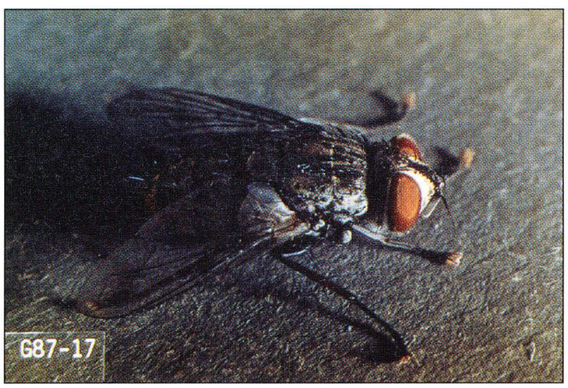

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Fig. 10 Adult parasitic tachnid fly.

Fig. 11 Virus-infected caterpillars often appear to "melt" in late stages of infection.

H. Tashiro

Fig. 12 Bacteria-infected white grub on right, showing milky color of body fluids, versus healthy grub on left.

Michael Haas

Fig.13 Fungus growing out of the body of a dead potato leafhopper.

(fig 10). Others appear more bee - or wasp like and are densely hairy. Adults often make a characteristically loud buzzing noise in flight. Parasitic flies are found in many different habitats and they attack a wide variety of insects. The larvae of moths, butterflies, beetles and sawflies are most commonly attacked.

PATHOGENS

There are three primary types of disease-causing microorganisms or "pathogens" that affect insects: bacteria, fungi and viruses. Pathogens have had only limited success in biological control programs, because they are not usually present at levels high enough to control pest populations. On the other hand, pathogens are the least visible biocontrol agents and may be much more important than they appear.

Insects infected by pathogens usually show a change in coloration and appetite, are slower moving, and may appear stunted, shriveled or swollen. Diseased individuals sometimes have very characteristic behaviors, such as clinging to the very top of a plant before dying. Most bacteria and viruses must be eaten by an insect for it to become infected, whereas fungi can enter through the body wall.

The development of microbial insecticides such as *Bacillus thuringiensis* (BT) has allowed some pathogens to be mass-produced and applied much like chemical pesticides. Unlike other biological controls, microbial insecticides provide only temporary control and may need to be reapplied. They are usually selective and therefore safe for humans, other animals and beneficial organisms.

Insect-eating nematodes are often grouped with pathogens. These nematodes are tiny, thread like worms that feed and reproduce within certain insects. Infested insects usually die within 24 hours. Because they require a moist environment, insect-eating nematodes are most effective against insects living in soil.

Viruses - Insects infected by viruses (mostly caterpillars) become pale and appear to "melt" as their fragile bodies disintegrate and the contents turn to liquid (fig. 11).

Bacteria - Insects infected by bacteria don't loose their body structure (fig. 12), but become dark and "rubbery" before ending up dried and shriveled. They may discharge fluids from the mouth and anus.

Fungi - Insects infected by fungi usually keep their shape and color, but become hard and "mummy like". They often appear "fuzzy" from the fungal growth (fig. 13).

HOW IS BIOLOGICAL CONTROL ACCOMPLISHED?

There are three basic ways to make use of insect natural enemies.

1 Natural enemies already present may be conserved or increased in effectiveness by appropriately managing their environment. Whenever possible, monitor to determine levels of pests, their damage, and beneficial insects. Conserving a specific natural enemy may require conserving a specific habitat for a period of time, as in orchard mite management, where ground covers are not mowed until predator mites have moved into trees in early summer. Food for adult parasitoids can be provided by leaving or planting nectar and pollen-producing plants near crops. Use thresholds to determine if pest levels warrant control. If an insecticide is needed, use one that targets the pest and is the least harmful to natural enemies. Even fungicides can be harmful to

biocontrol by killing fungi that are biocontrol agents. Microbial insecticides, where effective, are especially useful by not killing natural enemies.

2 Government agencies may import beneficials from other countries to provide controls for insects that have no established natural enemies. In Michigan, the alfalfa weevil has been effectively controlled by three wasp parasitoids released in the late 1960s. The cereal leaf beetle was a serious pest of cereal grains in Michigan in the 1960s. It has also been controlled by introduced natural enemies and is no longer a significant pest.

3 Beneficial insects may be made more effective through direct manipulation that changes the kind or increases the numbers through periodic or large-scale releases. Some natural enemies are available for growers and home gardeners through commercial suppliers. Successful control requires knowing the appropriate natural enemy for a particular pest, proper timing for release and, possibly, some behaviors of the pest and the natural enemy.

More information on specific crop pests and their natural enemies is available through Michigan State University Extension. Additional information on pest identification, suppliers of natural enemies and releasing natural enemies may be found in references listed in this bulletin.

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National Gardening, National Gardening Association, P.O. Box 51106, Boulder, Colorado 80321-1106

Organic Gardening, P.O. Box 35, Emmaus, Pennsy1vania 8099-0035

Crop Advisory Team Alerts (separate editions for field crops, fruit, vegetables and landscape), weekly or bi-weekly newsletters, $25 per year for each edition. Michigan State University Extension, E. Lansing, Michigan 48824-1039

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