

Make *Mother* NATURE'S Hit Squad Part of Your Team

By Michael Raupp, Ph.D.

The theme for last year's TCI EXPO 2006 in Baltimore was "team building." To my mind this presented a fine opportunity to speak about some important but unsung members of our plant care teams – beneficial insects that help reduce the numbers of pests in our landscapes.

These good guys, predators, parasitoids and pathogens are the three "Ps" of biological control. They are the unsung heroes because their presence and importance often goes unnoticed and under appreciated. For million of years before we arrived on the scene, predators, parasitoids and pathogens prevented hungry, plant-eating insects from devouring the green world. Here is a brief glimpse at some of Mother Nature's hit squad and the ways they work for us.

One of the underlying principles of both plant health care (PHC) and integrated pest management (IPM) is that we try to maximize the use of beneficial organisms. Natural enemies provide biological control. The goal of biological control is to reduce pest populations to tolerable levels, not to eliminate or annihilate all pests in a landscape. A healthy landscape is one with pests in it. Natural enemies only go where they can find food. You will not find good guys in a landscape devoid of prey needed for reproduction and growth. Some level of pests encourages and helps support the



A lady bug larva can eat more than 100 aphids a day. All photos courtesy of Michael Raupp

establishment and persistence of populations of beneficial predators and parasitoids. It may seem a bit counter-intuitive, but a landscape with some pests is a desirable goal for landscape managers.

Predators

Let's look at some of the members of Mother Nature's hit squad, the three Ps, starting with predators. When you think of a predator, what comes to mind? Most people think of organisms high in the food chain such as lions and tigers. Predators are animals larger than their prey. They will kill many victims in the course of their lifetime. For example, the multicolored Asian lady beetle, *Harmonia axyridis*, loves to spend time off the ground in trees. *Harmonia* was imported in the 1970s and 1980s and released in the southern United States to control aphids on nut bearing trees. Since then, it has spread from coast to coast, border to border, and now consumes billions of aphids every year in the urban forest.

How do you recognize lady bugs, a.k.a. lady beetles or lady bird beetles? First, be

on the lookout for eggs. When you see little yellow, spindle-shaped eggs, please leave them unmolested. Small lemon-yellow eggs are usually the next generation of a lady bug. These eggs hatch and out pops a small alligator-like creature called the larva. These demons may devour more than a thousand aphids in their youth before turning into a pupa. From the pupa



An adult *Harmonia* lady bug feasts on a smorgasbord of aphids.



The small yellow eggs of lady bugs mean that help has arrived.

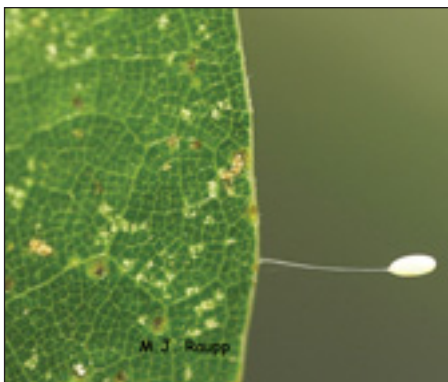
emerges the adult lady bug – an aphid killing machine. Each adult may eat 90 to 270 aphids per day. (An exception to the advice above would be small lemon-yellow eggs on an elm tree. In this case, the eggs may be those of elm leaf beetle and may deserve molestation with extreme prejudice.)

In autumn, *Harmonia* enter homes by the millions. You may wonder why *Harmonia* makes itself at home in your home. Back in its native range in Asia, this beetle seeks large, rocky outcroppings in the autumn when prey become scarce. Thousands of beetles aggregate at these outcroppings and find protected crevices and cracks to shelter them during the winter. In many parts of this land, big cliffs are not plentiful, but large houses are. After a summer of eating aphids, they enter homes for shelter. To prevent them from entering homes, caulk, screen and plug every hole you can find in your house. This will help exclude these interlopers and increase your energy efficiency as well.

Arborists sometimes ask “How well do lady bugs really work at reducing pest populations?” Here is one example. A few years ago I discovered a large planting of barberry dripping with barberry aphid. I treated four of the barberries with a systemic insecticide and four others were left as untreated controls. The plants treated with the insecticide were free of aphids after nine days. Surprisingly, the untreated plants were virtually free of aphids just eight days later. What happened? About the time that the insecticide was applied, I noticed fleets of *Harmonia* lady bugs moving onto the shrubs. Several days later the plants were crawling with hundreds of these hungry predators. These ladies of the landscape took a few more days to work, but in the end, biological control was equally effective as the insecticide at reducing aphid populations. Sometimes biological control requires just a little longer to work.

Some of my favorite predators in the landscape are lacewings. They may be the psychopaths of the insect world. The larva of the lacewing is a natural born killer. It has two big, hollow jaws used to grab an aphid with a classic pincer movement. It has a hydraulic pump in its head and, as soon as it latches onto an aphid, it pumps

digestive enzymes into the hapless victim. These enzymes begin to digest the internal tissues of the aphid while it is still alive. How gruesome. The pump is then reversed and the lacewing sucks the fluids from the victim. When the meal is nearly complete, I have seen lacewings lift the carcass of the aphid into the air and twirl it about in a somewhat macabre celebration. After completing development, the larva spins a cocoon on the surface of a leaf and pupates. From the pupa emerges a gorgeous insect with lacy wings and large golden eyes. As a youth, the lacewing is a meat-eater, but as an adult, these beauties eat nectar and pollen. The egg of a lacewing looks like a small grain of rice atop a slender stalk. Anyone who works with plants on a regular basis will see the eggs of lacewings during the months that aphids are active.



The egg of the green lacewing rests atop a stalk of protein.

Lacewings are important predators of many other insects such as lace bugs and small caterpillars, as well as spider mites.

Some lacewings are masters of disguise. While staring at a branch, I noticed a piece of animated lichen on a herky-jerky stroll down the stem. Now, lichens are usually attached to bark or a rock and they do not usually go for a walk. Upon closer inspection, noticed small legs beneath the lichen that propelled it and a set of wicked jaws protruding from the front end. This was the larva of a lacewing. Like their relatives, the green lacewings, these larvae are ferocious predators of many soft bodied insects like aphids and scale insects. In fact, I placed this debris-covered larva on a twig encrusted with oak lecanium scales and the predator proceeded to gobble them. Not only did it eat them, but it also took the



The reason these beautiful creatures are called lacewings is obvious.

empty carcasses of its victims and placed them on its back amidst the collection of lichens, bark-flakes, and other debris. What was the purpose of this? Was it some kind of bizarre trophy collection of a deranged invertebrate killer?

A fascinating study by the famed biologist Thomas Eisner shed some light on this unusual behavior. Most of us know the bug story about ants as guardians of aphids. Aphids provide ants with honeydew, a carbohydrate rich food, and ants protect aphids from insects that would like to eat them. By removing the debris from the backs of the trash collecting lacewing larvae, Eisner discovered that lacewings attempting to enter an aphid colony for dinner were immediately detected by the shepherds, the ants, and tossed out of the colony and sometimes off the tree. However, when the lacewing larvae disguised themselves in debris products made by the aphids, such as wax or skins, they easily snuck past the ants and enjoyed an aphid feast much the same way *Æsop's* wolf snuck past the shepherd for a tasty lamb dinner. So, next time you are idly watching the bark of a tree and you see a



Notice the huge pincher-like jaws of this lacewing larva that hides beneath a pile of debris.



Adult flower flies are sometimes mistaken for bees, but one pair of wings is a giveaway to their true identity.

piece of lichen go for a stroll, remember that looks can be deceiving. You may actually be watching a tiny wolf in sheep's clothing.

Another common group of predators you often see in landscapes are hover flies or flower flies. They lift-off from flowers and patrol vertically and horizontally. They search vegetation to detect colonies of aphids. When they encounter suitable numbers of aphids, they lay small white eggs nearby. In a few days eggs hatch and voracious maggots plunge into the aphid colony. Flower fly maggots have a moth hook used to subdue the victim and sucking mouthparts to lap up the blood and body fluids of the unfortunate aphid. Several years ago I was working with a friend who manages a large public landscape. We were inspecting crabapples in spring and discovered many terminals infested with aphids. My friend suggested that it was probably time to spray. We examined several branches and found syrphid fly eggs on almost every one. We decided to hold off the spray for a week to see what happened. At the end of a week most of the aphids were gone and only fat



The mother flower fly knows just where to place her egg so her hungry maggots will quickly find tasty aphids.

happy maggots remained – another case of Mother Nature's hit squad in action.

Parasitoids

The second of the three Ps of biological control are the parasitoids. Parasitoids are usually smaller than their victim, which is called the host. Recall that with predators, the predator consumes much prey during the course of its life. Parasitoids often use just a single host to develop or, in some cases, a single host can sustain the development of several parasitoids. Some are called endoparasitoids because they feed and develop inside the host. I often see endoparasitoids at work in colonies of aphids.

When you come across a gang of aphids,



Flower fly maggots make short work of aphids.

look carefully and you will often see two varieties – plump juicy aphids and crispy brown aphids. The crispy brown ones are called aphid mummies because their exoskeleton or outer skin is hard and mummified. If you look closely at these mummies, you will see that some of the mummies have a little hole or trap door on their rear ends. This is the exit hole of a small parasitic wasp that developed inside the aphid and emerged after completing its development. After emerging, the wasp will jump back into the aphid colony and find another plump juicy aphid, sting it, and lay an egg inside. The egg hatches into a little larva that consumes the aphid and creates a mummy. The circle of life continues.

When I discover a colony of aphids, first I look for predators such as lady bugs, lacewings or flower flies. Then I look for mummies. I observe a small section of leaf or stem and count all the aphids. Let's say I count 50. Next, I count the number of

mummies and let's say I find five. That is 10 percent that have been parasitized. Next, I wait a week, return to the spot, and count the aphids again. If the rate of parasitism has jumped from 10 percent to 20 percent or more, then the ballgame is probably over. If the rate of parasitism is 10 percent or less, and predators are absent, you might want to give Mother Nature's hit squad a helping hand by applying an aphid smack-down treatment of horticultural oil or insecticidal soap. If your clients are really clever and curious, you can use this teachable moment to explain how natural enemies work. They may become believers and this, ultimately, can make your job easier.

Some parasitoids develop on the outside of their host. These are called ectoparasitoids. Ectoparasitoids are often the larvae of wasps and are important in reducing pests such as white grubs in turf and many kinds of scale insects. Although the larvae of both ectoparasitoids and endoparasitoids feed on insect pests, in many cases the food of the adult is nectar and pollen.

Pathogens

The third P in our pantheon of Ps is pathogens. Pest insects get sick from microbes such as fungi, bacteria and viruses just as we do. The most famous and widely used microbial product in the tree care industry is *Bacillus thuringiensis* or Bt. Bt is a naturally occurring microbe found in soils around the world. It produces a toxic protein that binds to cells in the insect's gut, ultimately destroying the cells. This results in a rather slow and relatively prolonged demise of the insect. The three most commonly used strains of Bt in our business are Bt. spp. kurstaki, Bt. spp. tenebrionis, and Bt. spp. isrealensis. Bt. kurstaki is very effective against caterpillars, particularly young ones. Bt. tenebrionis is used to kill the larvae of beetles such as elm leaf beetle. Bt. isrealensis is used to kill the immature stages of flies. Isrealensis is formulated as the Bt dunk that you throw in a pool of water where mosquitoes are breeding. These are very good tools for your plant health care tool box.

Other important pathogens used in biological control include fungi and nematodes. *Entomophaga maimaiga* is a fungus that was imported from Asia and released in our forests. For more than a