NPMA LIBRARY UPDATE

Update

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Biocontrol Agents Used as Pest Management Tools

Biological control is a type of pest management approach where one organism is used to manage or control another. The biological control (or biocontrol) agent is often called a natural enemy or a beneficial organism. We see natural examples of this in our everyday environment when we see a native lady beetle feeding upon aphids, scale, whiteflies, mites, or mealy bugs on a rose for instance. The lady beetles get their fill of food while feasting upon a gardener's worst nightmare — aphids that will destroy the rose plant by sucking its plant juices, destroying both foliage and flower blooms.

Almost all animals have natural enemies. The pests we encounter are no exception. However, biological control is not always considered when we think of controlling a pest infestation. However, natural controls do play an important role in managing pest populations. Natural pest enemies include things like wasps, nematodes, spiders, toads and frogs, centipedes, birds, lizards, geckos, beetles, mantids, ants and small mammals.

Many kinds of organisms will attack others. In agriculture, especially in traditional cultures, such an approach has long been used to protect crops and manage pests. Birds will eat grasshoppers and crickets that can destroy a wheat crop for instance; there are famous stories about the seagulls that ate the Mormon crickets in what would become modern day Utah, and thus protected a fledgling population and their crops.

In more recent times, with the evolving new environmental and greener approaches to pest management, the biological control organisms we tend to be most interested in are the ones that might attack pests within an urban environment, such as various cockroaches, ants or flies. But, we have even heard of instances where larger pests, like rodents or toads, have been controlled naturally by bringing in snakes to pursue them.

In urban pest management scenarios, we have seen toads, lizards, bacteria, protozoa, beetles, mites, flies and wasps all employed to get rid of cockroaches in an account. Parasitoid wasps have probably had the most success in controlling cockroaches. Parasitoid wasps are tiny insects, harmless to humans; they lay their eggs in the cockroach's egg case (or ootheca). The eggs hatch into immature

We see natural examples of biocontrol in our everyday environment when we witness ladybeetles eating the aphids from our prized roses.

wasps that feed on the cockroach eggs. Wasps can reduce cockroach numbers dramatically and keep them at low levels, but they cannot completely eliminate the problem. Parasitoid wasps have been used successfully in nonresidential office buildings and warehouses, but not in residential buildings where there is much less tolerance of cockroaches and other insects. In fact, parasitoid wasps have largely been used in zoo and horticultural park and greenhouse type settings or in a city sewer system in one case; areas where introducing another insect as a control measure would be received more positively than in a home setting. (These programs are often not popular with some customers because they may find the introduction of a biological control agent to be as distasteful as the one to be controlled.) Another concern can often be that traditional pesticide use would have to be minimized or eliminated, because a beneficial organism is often even more susceptible to the products used than the one to be controlled or managed.

Some biocontrol agents highlighted recently in the news include the following scenarios:

Zombie fire ants — the use of phorid flies as a pest management tool

A recent report of research out of the University of Texas discusses zombie fire ants, created by the introduction of a parasitic phorid fly. Dr. Scott Ludwig released fire ants infected with a new type of phorid fly, a tiny parasite that preys only on red imported fire ants. The infected ants soon exhibit some very bizarre behavior. "First they become zombies, their movements under the control of the parasite. Then their heads fall off and the parasite emerges," said Ludwig, AgriLife Extension integrated pest management specialist. The "zombified," fire ant is made to wander about 55 yards away from the mound to die. "The parasite does this so it can complete development without being detected and attacked by the fire ant colony," he says. "By making their hosts wander away, the parasite is insuring its survival." The phorid fly species in Texas only attacks red imported fire ants. They inject their eggs into their bodies. In response, fire ants withdraw to their underground nests and reduce their foraging range; once established, it is hoped that earlier releases of phorid flies will spread beyond the original release sites. The parasite isn't attracted to native ant species. "We're hoping the new parasite will reduce the foraging of fire ants, and thereby allow our native ants to regain some footing," says Ludwig. The release was part of the Texas Imported Fire Ant Research and Management Project. (More information on the project and fire ant research can be found at: http://web.biosci.utexas.edu/fireant/index.html or http://fireants.tamu.edu/.)

Use of scuttle flies on termites

Malaysian scientists have recently discovered a new scuttle fly species that could act as a biological agent in controlling termite infestations. Named *Misotermes mindeni*, the new species was found to be a parasite on mound-building termites by doctoral student Kok-Boon Neoh and Professor Chow-Yang Lee of the University of Science Malaysia. The species was identified while Neoh was studying termite mounds on the University's Minden campus. The discovery was detailed in a recent issue of the Journal Sociobiology. (For more information on this research, go to: http://www.upi.com/Science_News/2009/08/20/Malaysian-scientist-finds-new-fly-species/UPI-42111250774662/.)

When infected with a parasitic phorid fly, fire ants exhibit some odd behavior. First they become zombies, their movements under the control of the parasite. Then their heads fall off and the parasite emerges.Then the "zombified," fire ant is made to wander away from its mound to die.

Use of fungus on carpenter ants

A fungus, *Ophiocordyceps unilateralis*, turns carpenter ants into the walking dead and gets them to die in a spot that's perfect for the fungus to grow and reproduce. Scientists have no clue how the fungus takes control of the brains of ants. But a new study in the September issue of the *American Naturalist* reveals an incredible set of strategies that result.

The carpenter ants nest high in the canopy of a forest in Thailand, and they trek to the forest floor to forage. The fungus prefers to end up on the undersides of leaves sprouting from the northwest side of plants that grow on the forest floor, the new study shows. That's where temperature, humidity and sunlight are ideal for the fungus to grow and reproduce and infect more ants. Once infected by the fungus, an ant is compelled to climb down from the canopy to the low leaves, where it clamps down with its mandibles just before it dies. "The fungus accurately manipulates the infected ants into dying where the parasite prefers to be, by making the ants travel a long way during the last hours of their lives," said study leader David P. Hughes of Harvard. After the ant dies, the fungus continues to grow inside it. By dissecting victims, Hughes and colleagues found that the parasite converts the ant's innards into sugars that help the fungus to grow. But it leaves the muscles controlling the mandibles intact to make sure the ant keeps its death grip on the leaf. The fungus also preserves the ant's outer shell, growing into cracks and crevices to reinforce weak spots, thereby fashioning a protective coating that keeps microbes and other fungi out. After a week or two, spores from the fungus fall to the forest floor, where other ants can be infected. "Making nests in the forest canopy might be an evolved ant strategy to avoid infection," says Hughes. The ants also seem to avoid foraging under infected areas. This too might be an adaptive strategy to avoid infection, but more study is needed to confirm it. How the fungus controls ant behavior remains unknown. "That is another research area we are actively pursuing right now," Hughes says.

Use of parasitoid wasps to control cockroach oothecae

Parasitoid wasps are an important natural enemy of cockroaches. The wasps are parasitoids of the cockroach egg case (the ootheca) and can have a significantly negative impact on outdoor cockroach populations. Most species of parasitoid wasps are associated with peridomestic cockroaches like the American and Smokybrown, which live in outdoor harborages such as palm trees, tree holes, and woodpiles. These wasps are very tiny (only 0.03-0.19 inches long!) and do not sting humans. The parasitoids live with the cockroaches in the harborage parasitizing their egg cases. When the adult male and female wasps emerge they mate immediately. The female then begins to sting other oothecae, laying her eggs inside of them. The wasp offspring eat the cockroach embryos inside the ootheca before they can hatch out. This natural system results in 60-70 percent of all cockroach egg cases being parasitized without any human interference!

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Oothecal wasp parasitoids have been tested for potential indoor use. Domestic populations of brown-banded cockroaches were successfully controlled in a California animal rearing facility by these wasps. Parasitoid wasps mass-reared and used for client accounts present some interesting challenges. Only a few individuals or special accounts would actually welcome a population of 200,000 wasps being released in their home or businesses even if they promised to eliminate a severe cockroach infestation. However, these parasitoid wasps have been used successfully in accounts such as zoological parks, animal rearing facilities, and botanical gardens. These wasps are extremely susceptible to pyrethroids, so one must use caution if wasps have been previously released in the account. The application of bait around an infested area is the best way to treat a population of peridomestic cockroaches and preserve the wasp parasitoids.

These wasps are reared by very few facilities and are therefore very expensive to use in accounts. For instance, use of the parasitoid wasp *Aprostocetus hagenowii* used by many zoological parks runs along the lines of $10,000 for a six month supply and program (which allows for weekly releases). *A. hagenowii* will attack several different species of peridomestic cockroach egg cases, including, *Periplaneta*

americana (the American cockroach), *P. fuliginosa* (the Smokybrown cockroach), *P. australasiae* (the Australian cockroach), *P. brunnea* (the Brown cockroach), *Blatta orientalis* (the Oriental cockroach), *Neostylopyga rhombifolia* (the Harlequin cockroach), and *Eurycotis floridana* (the Florida cockroach). Most warehouses providing these wasps also provide training materials to show how to properly implement the biological control of cockroaches. Keep in mind that these programs only control the embryos contained within the oothecae, and not the emerged nymphs or adults. Compatible IPM measures to control adults and nymphs must also be implemented; this usually includes sanitation, exclusion, baiting, and trapping programs, because pyrethroids would eliminate all of the wasps.

Unfortunately, currently no parasitoid wasps are available for German cockroaches. German cockroach oothecae are retained by the female (thus protecting it from the wasps) until time for hatching; their oothecae are also leathery making it difficult for a wasp to penetrate with her ovipositor (the egg laying structure). There is however a very host-specific parasitoid wasp for brownbanded cockroaches, *Comperia merceti*, an encrytid wasp; it does not attack any other species of cockroach and it is a common species in homes, laboratories and animal rearing areas; it has been used successfully in IPM programs for brownbanded cockroaches.

Biological information about *Aprostocetus hagenowii*, a eulophid wasp:

- Wasps mate immediately upon emerging as adults from an ootheca. Fertilized eggs produce female progeny, unfertilized eggs produce male progeny.
- Female wasps live seven to ten days. Females deposit eggs in hosts (oothecae) early in life (three to five days of adult life).
- Females attack one to two (occasionally three) hosts in their lifetime.
- Developmental time: 32 - 40 days (egg to adult). Dependent on temperature and number of individuals developing in host.
- Average number of female progeny per host: Dependent on host - American 45 - 55; Oriental 60 - 70.
- Sex ratio: 80 percent females.
- Broad host range on several species of peridomestic cockroaches.

For more information on *A. hagenowii*, consult the review article by LeBeck (1991).

Obviously, biological control is simply one tool in our IPM tool box, a non-toxic measure that may be incorporated into a complete urban integrated pest management program. In some cases, biological control agents have yet to be fully developed for use in a practical sense in an urban pest management program. In other cases, biological control agents are developed, but may be prohibitively expensive or undesirable for practical use with a client. In other cases, biological control may provide just the tool you've been looking for for a sensitive account, such as a zoo or animal rearing facility. Where appropriate and accepted, biological control agents are a nice alternative and a novel approach. There are situations where these agents might be a helpful measure to enhance a successful IPM program; in other cases, these options may still need development for future use and acceptance by clients.

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