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**Biological Control  
in the Nursery Part 1:**

*Predators, Parasitoids  
and Pathogens*

*Plus, Spotted  
Lanternflies Detected  
in Middle Tennessee*





# Biological Control in the Nursery

## Part 1: Predators, Parasitoids and Pathogens

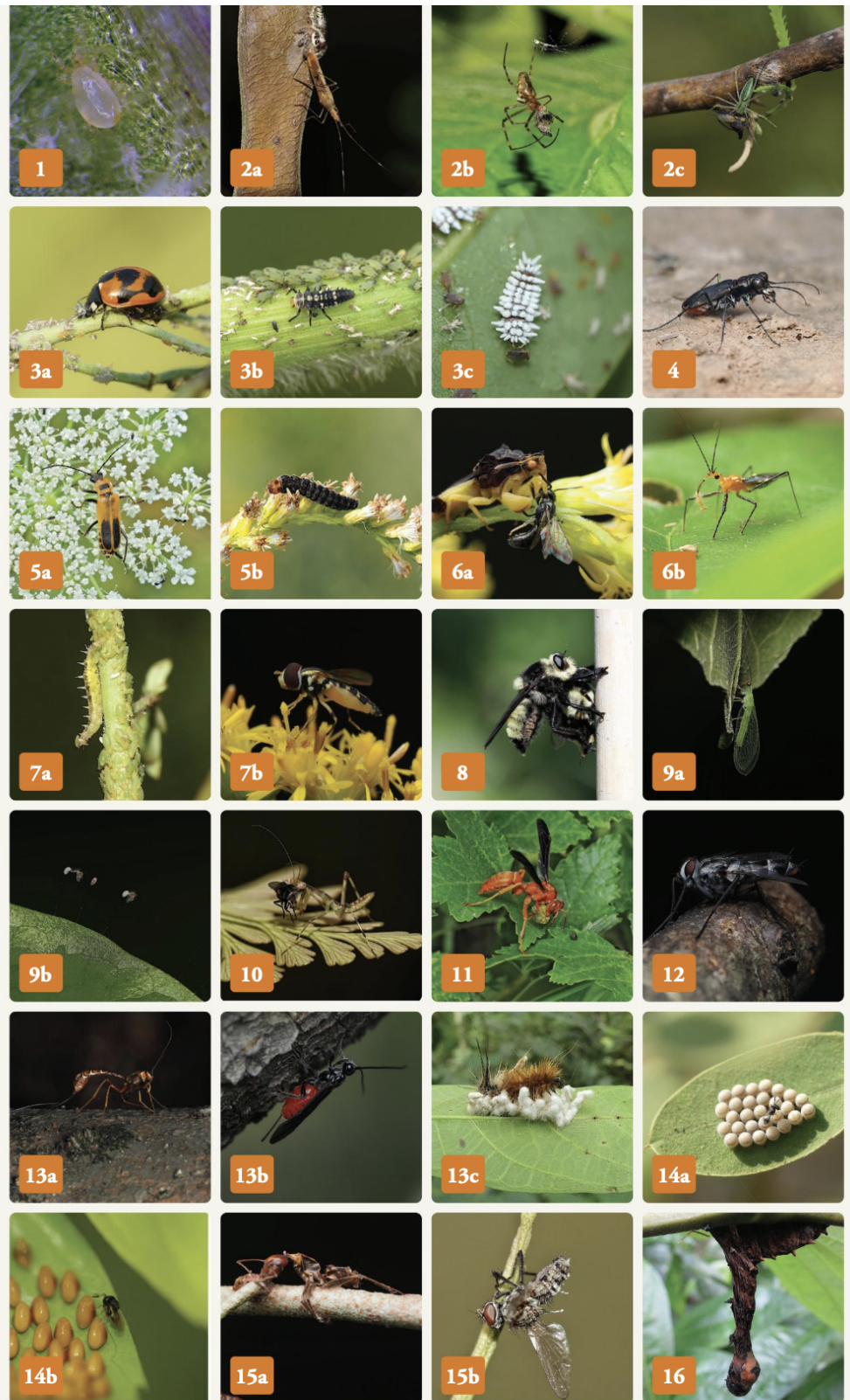
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Natural enemies of plant pests include predators, parasitoids, and pathogens. These organisms prevent pest populations from reaching outbreak levels in nature. In agriculture production, we often refer to these organisms as biological control agents to differentiate them from chemical controls. In this series, we will discuss the different types of biological control and how nurseries can incorporate biocontrol principles and agents into their production practices.

### Friend or Foe?

Not all insects are pests. In fact, of more than one million described insect species, only about 1% are considered serious pests. What about the rest? Some insects help us by keeping pest populations in check. Insects that feed on other insects, often referred to as natural enemies, are classified as either predators or parasitoids (Figures 1–16). Predators actively hunt and feed on other insects. Parasitoids lay eggs on or in other insects. Their young feed on the host insect, eventually killing it and later emerging in their adult form. The difference between “parasitoids” and the more familiar “parasites” is that a parasitoid kills its host, while a parasite will leave its host alive.



**Figures 1 to 16.** Fig 1. A predatory mite Fig 2a. Salticid spider Fig 2b. Tetragnathid spider Fig 2c. Oxyopid spider Fig 3a. Lady beetle larva with aphids, Fig 3bc. Larva of a different lady beetle species Fig 4. Tiger (ground) beetle Fig 5a. Soldier beetle adult Fig 5b. Soldier beetle larva Fig 6a. *Phymata* assassin bug adult Fig 6b. *Macracanthopsis* assassin bug nymph Fig 7a. Syrphid fly larva Fig 7b. Adult syrphid fly Fig 8. Robber fly adult Fig 9a. Lacewing adult Fig 9b. Lacewing eggs on a leaf edge Fig 10. Preying mantid Fig 11. Vespid wasp Fig 12. Tachinid parasitic fly Fig 13a. *Megarhyssa* Ichneumonid wasp Fig 13b. Braconid wasp adult Fig 13c. Braconid wasp pupae (white balls) on a caterpillar cadaver Fig 14a. *Acroclisoides* (Chalcidoid) wasp parasitizing eggs Fig 14b. Platygastrid wasp parasitizing eggs Fig 15a. An ant infected by *Ophiocordyceps* fungus Fig 15b. A fly cadaver infected by *Entomophthora* fungus Fig 16. A caterpillar cadaver infected by baculovirus.

The death of the infested host is what makes parasitoids effective as biological control agents. There are thousands of other non-insect biocontrol agents such as spiders, predatory mites, bats, and birds that all contribute to pest control. Entomopathogenic agents, including fungi, nematodes, viruses, or bacteria, are yet another important group. These biocontrols are comprised of living or killed strains of microorganisms that cause disease development in a variety of arthropod pests.

### Common Biological Control Agents in the Nursery System

The main categories of biological control agents can be described within three broad functional groups: predators, parasitoids and pathogens (Table 1). Within the predator group, there are eight orders of arthropods that act as biological control agents in nursery systems. These predator groups include mites, spiders, and several orders of insects (beetles, wasps, lace wings mantids, etc.). As previously discussed, adult parasitoids lay eggs in or on their hosts. The two main insect orders containing parasitoids are flies and wasps. Parasitoid wasps, lace wings (green lace wings in particular), and predatory mites are the three groups that have been successfully developed into commercially available biological control agents and are used widely in greenhouse production.

Plant pests, like us, also can become sickened by disease. Diseases affecting insects, known as entomopathogens, include naturally occurring microorganisms such as fungi, protozoa, viruses, nematodes, or bacteria that are specific to insects (Table 1). Often these diseases can be very specific to a narrow range of insect pests, for example infecting caterpillars but not flies or beetles. Some species and strains of entomopathogens can be produced and formulated as active ingredients in pest control products. These “microbial pesticides” are composed of living or killed strains of microorganisms that directly or indirectly impact pest survival. These strains can generally be applied to crops with the same sprayer technology as chemical pesticides. These products are often most effective when applied early to prevent pest outbreaks, not to clean up heavy infestations after they appear.

In Part 2 of this series, we will discuss ways to promote biological control agents in the nursery by conserving and promoting what is already present in the local environment and methods for augmenting natural populations of predators, parasitoids, and pathogens. 🍄

Table 1. List of biocontrol agents and their targets.

Functionality	Class	Order	Families	Targets	
Predators	Arachnida	Phytoseiidae (Predatory Mites)	Phytoseiidae (Predatory Mites)	Spider mites, broad mites, whitefly, thrips, insect eggs both as adults and larvae. (Fig. 1)	
		Araneae (Spiders)	Salticidae, Tetragnathidae, Oxyopidae etc.	Generalists, particularly of larger bodied insects, both as adults and larvae. (Fig. 2, a, b & c)	
	Insecta	Coleoptera (Beetles)	Coccinellidae (Lady Beetles or Ladybugs)	Aphids, mealybugs, and scale insects both as adults and larvae. (Fig. 3a, b & c)	
			Carabidae (Ground Beetles)	Generalist predators of insects and snails both as adults and larvae. (Fig. 4)	
			Cantharidae (Soldier Beetles)	Adults eat aphids while their soil-dwelling larvae eat beetle and moth eggs and larvae. (Fig. 5a & b)	
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		Hemiptera (True Bugs)	Anthocoridae (Minute Pirate Bugs), Geocoridae (Big-eyed Bugs), etc.	Adults and nymphs are generalist predators. (Fig. 6 a & b)	
		Diptera (Flies)	Syrphidae (Hover Flies)	Larvae are aphids predators. (Fig. 7a & b)	
	Asilidae (Robber Flies)		Adult flies are generalist predators. (Fig. 8)		
	Neuroptera	Chrysopidae (Green Lacewings)	Larvae feed on soft bodied insects. (Fig. 9 a & b)		
Mantodea	Mantidae (Preying Mantids)	Adults and nymphs are generalist predators. (Fig. 10)			
Parasitoids	Insecta	Hymenoptera (Wasps)	Vespoidea (Wasps)	Adult wasps hunt caterpillars as food for wasp larvae in nests hunt caterpillars to provide their nests with food (Fig. 11).	
		Diptera (Flies)	Tachinidae	Adults lay eggs on host moth caterpillars and beetle grubs (e.g., <i>Istocheta aldrichi</i> on Japanese beetle white grubs). (Fig. 12)	
			Superfamily (SF) Ichneumonidae	Several Family-level taxa of usually large-sized wasps that parasitize larvae, including of woodboring beetles. (Fig. 13 a, b & c)	
			(SF) Chalcidoidea	Several Family-level taxa of small-sized wasps. Many species lay their eggs inside the egg stage of pests, thereby delivering fast and efficient pest control (Fig. 14 a (chalcidoid wasps); Fig. 14 b (platygastroid wasps).	
Pathogens	Fungi	Hypocreales	Clavicipitaceae	Family-level taxa of fungi (e.g., <i>Metarhizium</i> spp.) that can infect beetles, root weevils, thrips and grasshoppers.	
			Cordycipitaceae	Family-level taxa of fungi (e.g., <i>Beauveria bassiana</i> ) that can infect whiteflies, aphids, thrips, grasshoppers and beetles Family-level taxa of fungi (e.g., <i>Beauveria bassiana</i> ) that can infect whiteflies, aphids, thrips, grasshoppers, and beetles, ( <i>Ophiocordyceps</i> sp. (Fig. 15 a) that can infest ants. and (e.g., <i>Isaria fumosorosea</i> ) that can infect caterpillars, aphids, whiteflies, and mites.	
			Entomophthoraceae	Family-level taxa of fungi (e.g., <i>Entomophthora</i> spp.) that infects flies and other insects (Fig. 15 b).	
		Nosematida	Nosematidae	Microsporidia are spore-forming unicellular parasites (e.g., <i>Nosema</i> spp. that parasitize different insects.	
		Ovavesiculida	Ovavesiculidae	Microsporidia pathogen <i>Ovavesicula popilliae</i> infects both Japanese beetles larvae and adults.	
		Eugregarinida	Actinocephalidae	<i>Stictospora</i> spp. infects a wide range of grubs, including Japanese beetle	
	Bacteria	Bacillales	Bacillaceae	<i>Bacillus thuringiensis</i> subspecies infect different groups of insects. <i>kurstaki</i> (Btk), caterpillars; <i>aizawai</i> (Bta), caterpillars; <i>israelensis</i> (Bti), mosquitoes	
		Rickettsiales	Ehrlichiceae	<i>Wolbachia</i> is a symbiotic bacterium that occurs naturally in many insects. It induces egg-sperm incompatibility called cytoplasmic incompatibility and serves as a method for controlling insect pest populations.	
	Virus	Baculovirales	Baculovirus	Nuclear polyhedrosis viruses (NPV) and granuloviruses (GV) can infect caterpillars (Fig. 16)	
	Nematoda	Rhabditida	Heterorhabditidae	<i>Heterorhabditis</i> spp. infect several soil-dwelling white grubs, root weevils, as well as caterpillars. <i>Steinernema</i> spp. infect several orders of dwelling pests including thrips and grubs.	
			Steinernematidae		