

Natural Enemies and Biological Control¹

Hugh A. Smith and John L. Capinera²

Good Bugs and Bad Bugs

Any organism that feeds on another organism is its **natural enemy**. Insects that are natural enemies of pests are called **beneficial insects**. Other arthropods such as spiders and certain mites also are beneficial.

There are two main types of beneficial arthropods, **predators** and **parasitoids**. **Predators**, such as ladybugs and spiders, will attack several different kinds of insect, and will consume several **prey** throughout their life cycle. **Parasitoids** are wasps or flies that lay their eggs on or inside other arthropods; they are also called parasites. The egg hatches and the immature parasitoid feeds on the victim, called a **host**, eventually killing it. Each developing parasitoid kills only one host in the course of its life cycle, but parasitoids are more specific in the insects they attack than predators.

Insects also suffer from diseases. Insect diseases, or **entomopathogens**, are micro-organisms that attack insects, and include bacteria, fungi, viruses, and nematodes. With few exceptions, the diseases that attack arthropods do not afflict warm-blooded animals. Sometimes insects and plant disease agents are used to control weeds.

Controlling Pests Biologically

Biological control is an approach to reducing populations of harmful organisms with natural enemies. Organisms introduced from other parts of the world are called **exotic** or **nonindigenous**, as opposed to **native** or **indigenous** organisms. Pests may be introduced into the United States and become established without natural enemies to keep them in check. Biological control of nonindigenous organisms involves finding a pest's native complement of natural enemies, and introducing these natural enemies into the new area where the pest has become established. Attempts to manage nonindigenous pests such as the mole cricket and the aquatic weed hydrilla in Florida are on-going. All nonindigenous natural enemies must be carefully studied prior to release in order to determine that they will not have an adverse environmental or economic impact.

The effectiveness of both introduced and native natural enemies can be enhanced through mass-rearing beneficial insects for release (**augmentation**) or by modifying the environment to favor predators and parasitoids (**conservation**). Many beneficial insects can be bought from commercial

1. This document is ENY-822 (IN120), one of a series of the Entomology and Nematology Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Published: July 2000. Revised: March 2011. Please visit the EDIS website at <http://edis.ifas.ufl.edu>.

2. Hugh A. Smith, assistant professor and John L. Capinera, professor/department chairman, Entomology and Nematology Department, Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, 32611.

nurseries for augmentative release. Ladybird beetles and lacewings are examples of predators that can be ordered through the mail to help control aphids, whiteflies, and other pests. Parasitoids of whiteflies, caterpillar eggs, and other pests may be purchased for release into a farm, garden, or greenhouse. In addition, some entomopathogens are available commercially in formulations which can be applied like a pesticide. The most common of these is *Bacillus thuringiensis* (Bt), a bacterium available in several strains that produce compounds toxic to distinct insect groups.

Conservation often involves establishing plants that provide alternate food sources such as nectar and pollen for beneficial insects, or selective use of insecticides so as not to injure the beneficial species. Many beneficial insects feed on the pollen of plants such as cilantro, fennel, and buckwheat. It may be possible to increase the numbers of beneficial insects by including such plants in a farm or garden. Pesticides such as Bt that kill caterpillars while causing minimal disruption to natural enemies allow agriculturalists and home-gardeners to benefit from naturally-occurring biological control.

IPM

Pest control is often most effective when used as a component of an **integrated pest management** (IPM) system. IPM involves using a variety of techniques to manage the pest in an economically viable and environmentally sound manner. IPM programs rely on the periodic examination of crops to determine if pest populations are reaching damaging levels. This is called **scouting**, which in addition provides information on the relative proportion of beneficial and harmful arthropods on a crop. Effective scouting programs can lead to significant reductions in pesticide use, because pesticides are applied only when necessary. Reduction of pesticide use is a central concern of most IPM programs, and is crucial for enhancing biological control, as most natural enemies are highly susceptible to pesticides. As pesticide use increases, populations of beneficial insects decrease. IPM programs which rely on the careful use of selective pesticides such as Bt may benefit from increased effectiveness of both native and introduced natural enemies.

Good Bugs Commonly Seen In Florida

There are many insects that are beneficial, but only a few are really important natural enemies of pests. The commonly-encountered natural enemies are: lady beetles, lacewings, bigeyed bugs, pirate bugs, flower flies, predatory gall wasps, ants, parasitic wasps, parasitic flies and predatory mites. The relative importance varies with insect pest, habitat, and season of the year.

Lady Beetles

Adult lady beetles (Figure 1) are among the most recognizable insects, but only when they are the "typical" beetles - orange with black spots. Most people do not realize that these beetles come in many colors including red, brown, or black, and often lack spots. The hemispherical shape of the adult is a helpful character, and the frantic searching behavior - they are always looking for a quick bite to eat - helps to identify lady beetles. Larvae are more difficult to recognize, and many gardeners have killed the beneficial immature stage due to inability to identify this stage. The larval stage is elongate and flattened, and usually blackish or bluish with orangish spots.

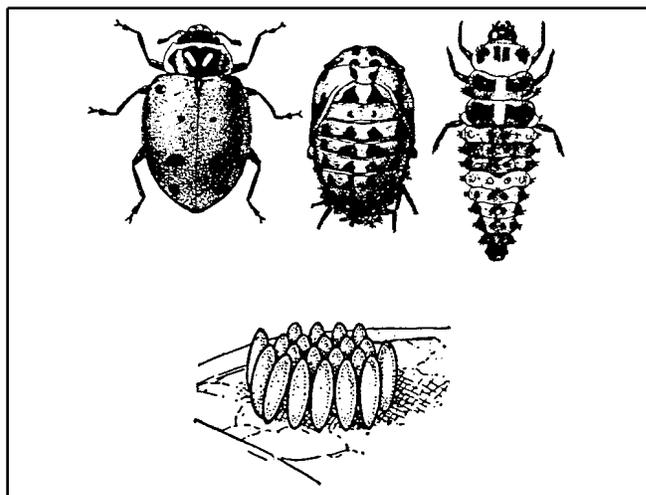


Figure 1. Adult, pupal, and larval stages of a common lady beetle (above). A lady egg cluster (below).

In Florida, one common lady beetle species has larvae with white, waxy exudate on its back. If you see a white insect crawling amongst aphids, it very likely is this lady beetle. The pupal stage is similar to the larva in color, though not capable of moving or

feeding. The eggs are yellow and deposited on end in clusters. Lady beetles feed on numerous small insects, and will attack any stage of prey that is small enough to be killed. They are most frequently found feeding among aphid colonies, but many also consume mites, scales, mealybugs, whiteflies, small caterpillars and beetle grubs, and all types of insect eggs.

Lacewings

Both green and brown lacewings (Figure 2) occur in Florida, and the pretty lacy-looking adults are quite recognizable. Like lady beetles, lacewings are often found associated with aphid colonies. However, unlike lady beetles, the adults sometimes do not feed on insects, with the larva being the beneficial stage. The large sickle-shaped mouthparts apparent in the larval stage are very effective for clamping onto prey and draining their body contents. The eggs of lacewings are placed on long thin stalks, and placed in clusters. Lacewings feed on insect eggs, scales, mealybugs, and mites as well as aphids.

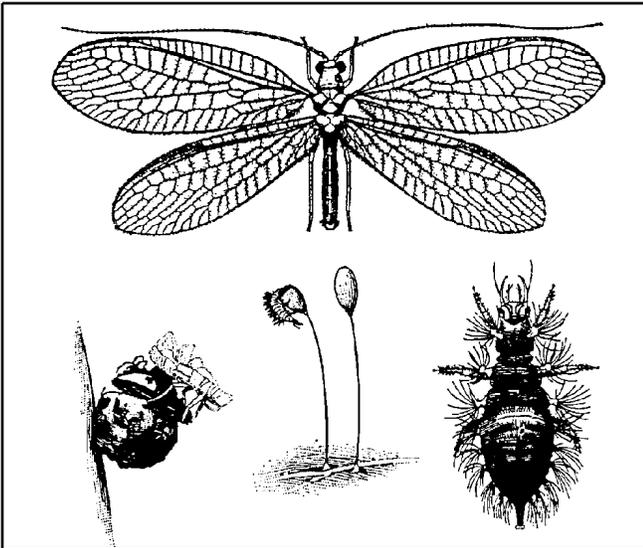


Figure 2. Lacewing adult (above). A lacewing emerging from a pupal case, emerging from an egg, and a larva (below).

Flower Flies

Flower flies (Figure 3) are black and yellow insects which resemble honey bees. As the name suggests, they often are found hovering about, or feeding on, flowers. The larvae, however, are voracious predators, and especially fond of aphids (Figure 4). The larvae are maggot-like in appearance,

with a thick body that tapers to a pointed head. They are yellowish, reddish, or greenish in color.

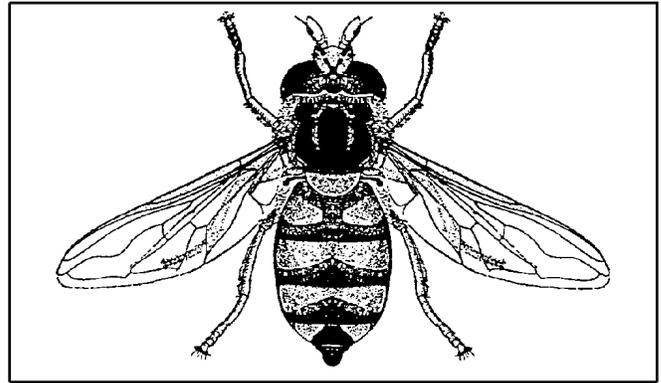


Figure 3. A typical flower fly, adult stage.

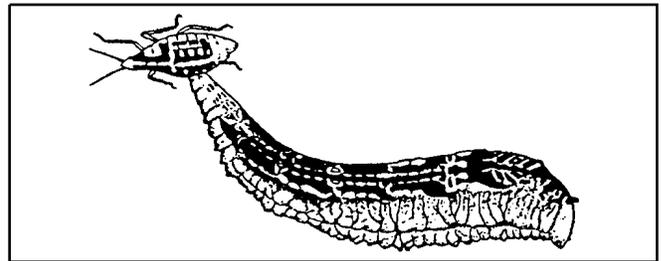


Figure 4. A flower fly larva feeding on an aphid.

Predatory Gall Midges

Larvae of predatory gall midges (Figure 5) resemble flower flies, and often are overlooked because they are so small. Most people, if they do notice these larvae, think they are very young flower flies. They commonly are found within aphid colonies, but also feed on whiteflies, scales, thrips and mites. However, the adult is strikingly different. The adult gall midge, which is rarely observed because it is active at night, is small, pale, and bears long thin legs. It cannot be confused with adult flower flies!

Bigeyed Bugs

This common predator (Figure 6) is frequently found in agricultural systems. Both the adult and immature stage are marked by oversized eyes, but are otherwise fairly nondescript, small, grayish insects. The piercing-sucking mouthparts are used to drain the fluids from moth eggs, caterpillars, thrips, and mites.

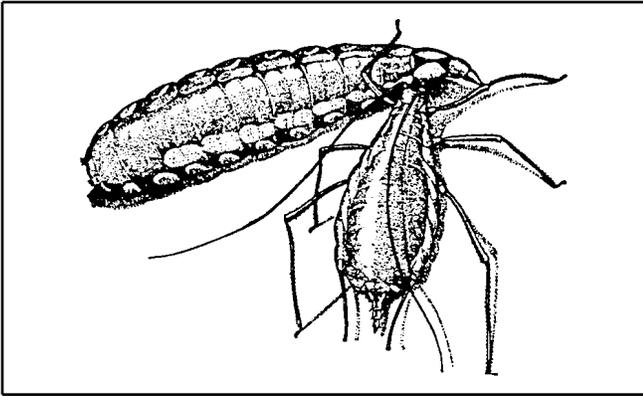


Figure 5. The larval stage of a predatory gall midge, *Aphidoletes*, feeding on an aphid.

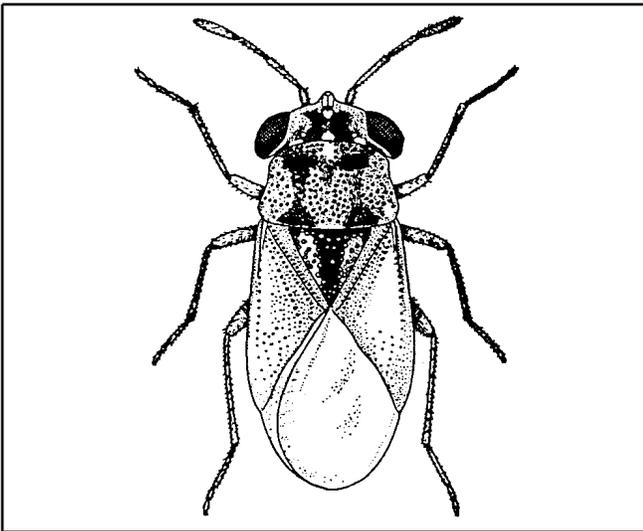


Figure 6. An adult bigeyed bug.

Minute Pirate Bugs

These very small insects are easily overlooked, but their importance as beneficial insects cannot be overestimated. Like bigeyed bugs, they feed greedily on many small organisms such as psocids, leafhoppers, aphids, thrips, and mites by draining body fluids with their piercing-sucking mouthparts. Adults (Figure 7) are silvery-white and black in color. They occur everywhere, including within crops.

Soldier Bugs or Stink Bugs

Soldier bugs, also known as stink bugs (Figure 8), are known as serious pests as well as useful predators because different species vary in their eating habits. The most common stink bug in Florida, the southern green stink bug, attacks blossoms and fruit, causing deformity and fruit drop.

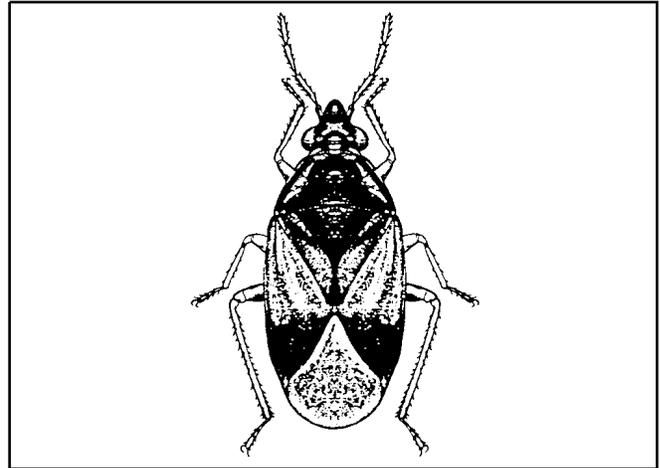


Figure 7. A minute pirate bug.

How can you distinguish between good and bad stink bugs? All stink bugs have long, thin, tubular piercing-sucking mouthparts. The good bugs use their mouthparts to extract fluid from other insects, particularly caterpillars and beetle grubs. The bad bugs use their mouthparts to extract plant sap. The mouthparts of good soldierbugs are relatively sturdy, whereas the mouthparts of pest species are relatively thin and frail. If in doubt, you might observe the bug's behavior before deciding whether it is good or bad.

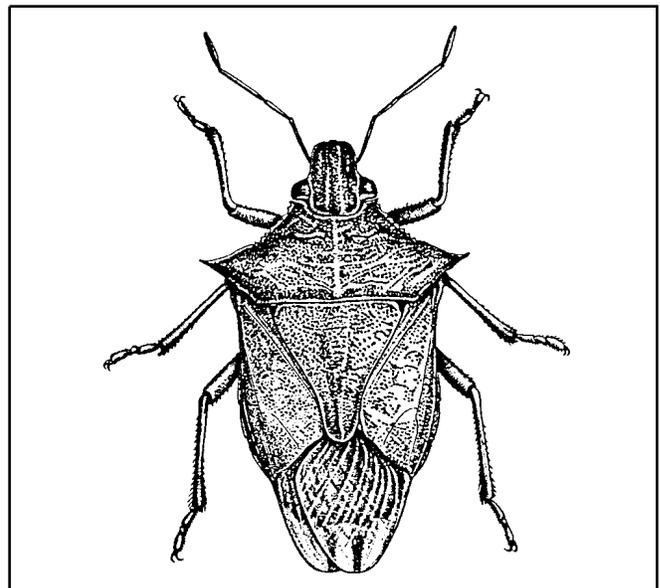


Figure 8. A predatory stink bug.

Ants

People are often surprised to hear that some ants are important predators. Even fire ants (Figure 9) can be helpful in reducing numbers of pest insects.

Farmers who have fire ant problems rarely have problems with caterpillars and other soft-bodied pests! Ants are not entirely beneficial, however, and in addition to their tendency to bite or sting, ants sometimes protect honeydew-producing insects such as aphids and scales from predation and parasitism. So ants are a mixed blessing, depending on the type of plants and pests present.

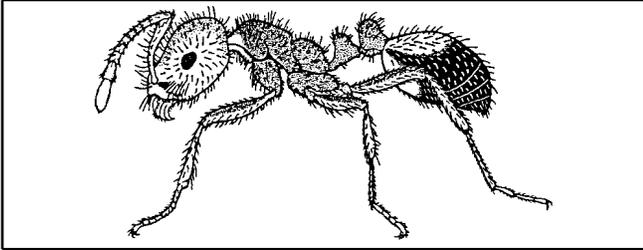


Figure 9. Red imported fire ant, a common predatory ant species.

Parasitic Wasps

Most parasitic wasps are small and inconspicuous, but wasps that parasitize insect eggs are even smaller, almost microscopic in size. Growers and gardeners are therefore often unaware that parasitoids are helping control their insect pests. Sometimes these wasps can be seen walking quickly over a leaf and tapping its surface with their antennae in search of the “scent” of the host. Parasitic wasps deposit their egg with the host insect (Figure 10, Figure 11) - usually the host egg or larval stage. The young parasite develops within or on the host insect (Figure 12), eventually killing the host. The most common evidence of parasitism is often a sickly caterpillar from which parasitoid larvae are emerging, or a dead caterpillar on which a cocoon is hanging. Parasitic wasps are important natural enemies of caterpillars, grubs, whiteflies and aphids.

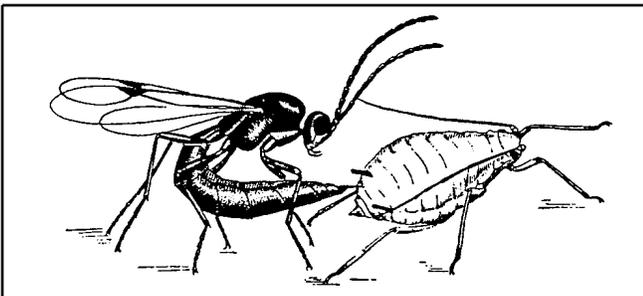


Figure 10. A parasitic wasp depositing its egg within an aphid.

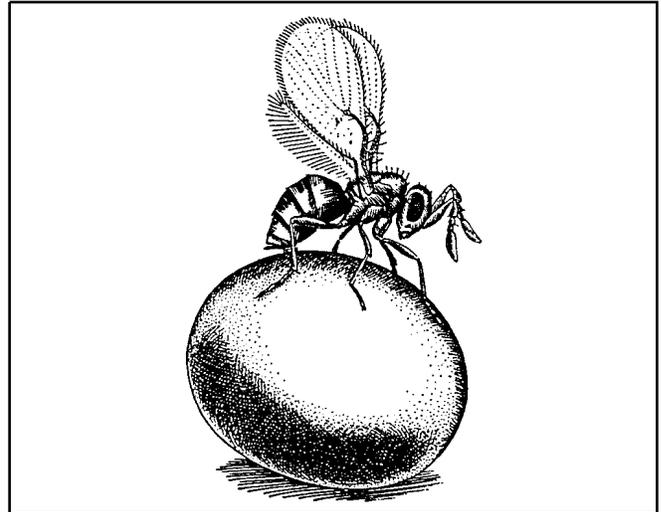


Figure 11. A *Trichogramma* wasp depositing its egg within a moth egg.

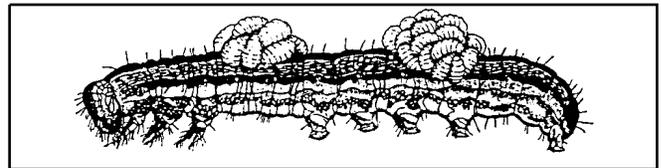


Figure 12. Clusters of parasitic wasp larvae developing externally on a caterpillar.

Parasitic Flies

Several types of parasitic flies (Figure 13) attack pests. Many deposit their eggs on the surface of the pest; upon hatching the larva burrows in and eventually kills the host insect. Others deposit their larvae into host, with the same result. However, flies lack the long egg-depositing structure found in most wasps.

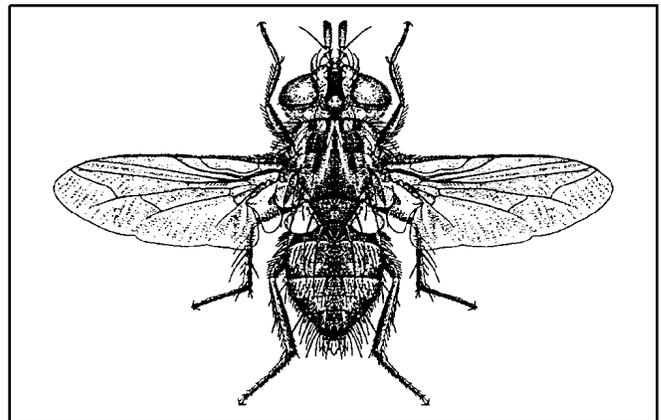


Figure 13. Adult of a parasitic fly.

Predatory Mites

Although some mites, particularly spider mites, are known as serious plant pests, many mites are beneficial. Among beneficial mites, phytoseiid mites are especially important because they are predators of plant-feeding mites and other small organisms such as thrips or insect eggs. Predatory mites (Figure 14) tend to be larger than other mites, long-legged, and move actively in their search for prey.

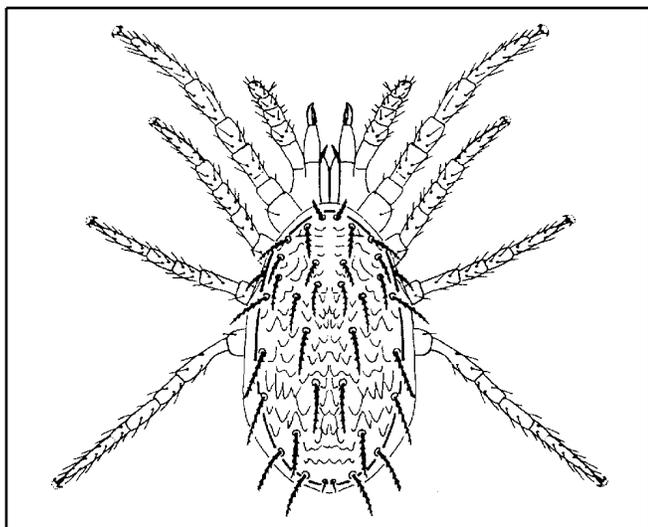


Figure 14. Phytoseiid mite.

Purchasing Natural Enemies for Release

Producers of greenhouse-grown foliage, flower, and vegetable crops sometimes augment natural biological control through purchase of predators and parasitoids. Occasionally this is also done for field-grown crops in Florida. Strawberry production is an excellent example of a crop where this is often practiced successfully. Home gardeners frequently ask about supplementing the natural biological control in their garden and yard.

There are many commercial sources of natural enemies. Quality varies among producers, however, so the purchaser should consider suppliers who have been in business for at least several years. A comprehensive list of suppliers is found at a California Department of Food and Agriculture web site on biological control:

<http://www.cdpr.ca.gov/docs/pestmgt/ipminov/bensuppl.htm>

Selecting a natural enemy for purchase is most successful if the habits and habitats of the natural enemy match the characteristics of the pest. For example, *Trichogramma* egg parasitoids are often useful for moths, the predatory mite *Pytoseiulus* for spider mite pests; the predatory mite *Neoseiulus* (*Amblyseius*) for thrips and mites; *Cryptolaemus* lady beetles for mealybugs and scales; spined soldier bugs for caterpillars; and lacewings and the predatory gall midge *Aphidoletes* for aphids. Convergent lady beetles and praying mantids often are not successful. For commercial crop producers, it is best to purchase technical assistance along with product.

Other Sources of Information

Other excellent sources of information include such books as:

- Guidelines for Purchasing and Using Commercial Natural Enemies and Biopesticides in Florida and Other States, University of Florida, EDIS, <http://edis.ifas.ufl.edu/IN849>
- Natural Enemies Handbook, University of California Pub. 3386, 154 pp. (1998)
- Natural Enemies of Vegetable Insect Pests, Cornell Extension Pub., 48 pp. (1993)

Illustrations of some common natural enemies in Florida can be found at:

- http://edis.ifas.ufl.edu/TOPIC_Beneficial_Organisms_and_Beekeeping

Other useful web sites include:

- A guide to natural enemies by Cornell University
<http://www.nysaes.cornell.edu/ent/biocontrol/>
- Nematodes for biological control by University of Nebraska
<http://nematode.unl.edu/wormepns.htm>
- Association of Biocontrol Producers
<http://www.anbp.org/>
- Featured Creatures: profiles of pest and beneficial insects from University of Florida
<http://entomology.ifas.ufl.edu/creatures>