Science Societies

Beneficial arthropods in the Cotton Belt: Parasitoids

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Beneficial Arthropods

This article is the third in a three-part series on beneficial arthropods. It will focus on the parasitoid category of beneficial insects in cotton cropping systems. This article is based upon expertise from Auburn University, Louisiana State University, Texas A&M, and the Universities of Florida, Georgia, Mississippi, Nebraska, and Tennessee.

When it comes to controlling cotton insect pests, good things come in tiny packages. Because you may not see or recognize some beneficial insects, it's easy to miss their powerful pest-control powers. Beneficial arthropods (insects and spiders) are critical for managing the beet armyworm, and they can dramatically reduce tobacco budworm and bollworm populations. They play key roles in managing many other serious cotton pests.

In the Southeast, big-eyed bugs and minute pirate bugs are good indicator species of a healthy beneficial ecosystem. Parasitic flies and wasps are less noticeable but key in curbing major cotton insect pests. They destroy a single host to complete their development, unlike predators that consume multiple prey. For example, it's easy to miss tiny *Cotesia* wasps as adults, but after they've parasitized and killed beet armyworms and other caterpillars, their fuzzy grain-shaped cocoons stuck to leaves are easier to identify.

Naturally occurring pathogens (fungi and viruses) are also effective biocontrol agents but won't be addressed in this article. Instead, we focus on the parasitoid category of beneficial insects.

Many parasitic arthropods require pollen or nectar at some point in their life cycles to survive periods of food scarcity, to overwinter, and/or to enhance their reproductive success. Cash crops, especially grains, typically lack pollen early in the season. The pests they feed upon tend to arrive/migrate later in the season, often creating an early season food shortage for these beneficial arthropods. So, it's helpful to have perennial blooming plants (cover crops such as buckwheat, sweet alyssum, clovers, etc.) on idle land, ditches, etc., to sustain them. These natural enemies' immature stages often require different food than the adult stage. For example, parasitic wasp larvae feed and develop inside insect bodies, but the adult wasp requires nectar access for a sugar source.

Most parasitoids are in the wasp order (Hymenoptera), but another important group are flies in the order Tachinidae. Parasitoids of both groups are further organized into endoparasitoids or exoparasitoids. Endoparasitoids insert their eggs into their insect hosts and their small, maggot-like larvae emerge from eggs and eat the host from the inside. By contrast, exoparasitoids attach to their host's body and feed from the outside.

Order Hymenoptera

Microplitis croceipes (Braconidae Family)

In some areas, *M. croceipes* is one of the most common parasites of cotton bollworm larvae. It is found throughout the Cotton Belt, except in California. It attacks all larvae stages but prefers the third and fourth instars. It also parasitizes budworm larvae. *Microplitis croceipes* parasitizes bollworms infesting cotton, alfalfa, sorghum, tomato, wild hosts, and corn in the whorl stage.

The adult female stings the bollworm larva and deposits her eggs inside the caterpillar. Larger larvae often drive off the parasite before it can sting. The wasp's egg hatches into a grub, which feeds inside the bollworm for about eight days. The parasitized bollworm soon stops feeding. Once full grown, the wasp grub bores out of the dead bollworm and spins a white cocoon. The adult wasp emerges from the cocoon in about a week. Development from egg to adult requires about 15 days. There are three or four generations per year, and the wasps overwinter in the soil as mature larvae (prepupae) inside cocoons.

Joseph LaForest, University of Georgia, Bugwood.org

ID: Adults are large dark brown to black wasps about ⅓ inch long. The

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Photo by Jerry A. Payne, USDA-ARS, Bugwood.org

abdomen and legs are yellow to red, and the wings are dark. The cocoons are off-white to yellowish and smooth with long ridges.

Chelonus insularis (Braconidae Family)

Chelonus insularis is found throughout the Cotton Belt. It parasitizes eggs of the bollworm, beet armyworm, fall armyworm, and several other armyworm species.

The female places her egg inside the bollworm or armyworm larva while the larva is still inside the egg. The larva hatches and develops normally for several days but soon appears shrunken and dry as the *Chelonus* larva feeds internally. The parasitized host larva then spins a fine-meshed, yellow silk cocoon, called the "death-cell," around itself. About two days, later the armyworm larva dies. A day later, the full-grown larva emerges from the shriveled body of the armyworm and pupates nearby.

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ID: This small (⅛ inch) robust wasp has a small white patch on each side of the front of the abdomen.

Bracon mellitor (Braconidae Family)

Bracon mellitor is native to the U.S. and found throughout the Cotton Belt and northern Mexico. *Bracon hebetoris* is a related species. *Bracon mellitor* is often the most common insect parasite of the boll weevil (grubs). It also parasitizes other weevil species and some caterpillars, including the pink bollworm. Adult wasps feed on nectar produced at the base of cotton squares.

The female *B. mellitor* searches cotton squares and bolls and probes the fruit with her ovipositor to detect weevil grubs inside. The female drills through the fruit and paralyzes the grub by stinging it. A single egg is then placed on the grub or nearby in the grub's cavity. The egg hatches in a day, and the tiny parasite larva pierces the paralyzed weevil grub and feeds on its body fluids. After four to five days, the parasite larva is full grown, and it spins a white silk cocoon in which it pupates inside the weevil's cell. The adult wasp emerges from the cocoon in about three to six days and escapes by chewing through the square or boll. Female wasps live about three weeks and produce about 160 eggs each. Winter is spent as a mature larva (prepupa) inside the cocoon.

ID: The adult *B. mellitor* is a brownish-orange wasp about 1/16 to 3/16 inch long. The dark eyes, antennae, and legs and the dusky areas on the wings give it a black appearance. The abdomen is broad, and the female has a black ovipositor (stinger) almost as long as her body.

Cotesia marginiventris (Braconidae Family)

Until the success of the boll weevil eradication program and the introduction of Bt cotton in the 1990s, entomologists didn't fully appreciate the impact of *Cotesia marginiventris*. It parasitizes larvae of bollworms, budworms, loopers, and fall and southern armyworms. These gregarious braconids can attack

hosts up to 100 times their size. Their venom subdues the host larvae, and then they lay multiple eggs in them.

The adult wasp lays her egg inside the host caterpillar. The egg hatches in one to two days, and the parasite grub feeds inside the caterpillar for about six days. The mature grub then bores out of the caterpillar, causing it to die, and spins a white cocoon around itself. The adult wasp emerges from the cocoon about four to five days later. A single female can parasitize/kill 200 to 300 host caterpillars during its 10- to 14-day life. There may be four to six generations per year.

Debbie Waters, University of Georgia, Bugwood.org

ID: Adults are black-brown wasps with long antennae. Females have a noticeable ovipositor. This a small wasp, about ⅛ inch long, slender and black. The solitary white cocoons, resembling rice, contain pupae of *C. marginiventris* and attach to cotton leaves.

Meteorus Species (Braconidae Family)

Meteorus species attack a wide range of caterpillars, including beet, fall, and southern armyworms in a variety of crops and wild plants.

Females lay eggs in nearly all larval stages of their hosts, typically on small larvae. After feeding internally for 10 to 12 days, the parasite grub emerges from the host and spins its football-shaped cocoon while suspended from the leaf on a silken thread. The adult lives three to six weeks and can parasitize 150 to 300 hosts in its life span. There appear to be three or four generations per year.

Flickr/Katja Schulz

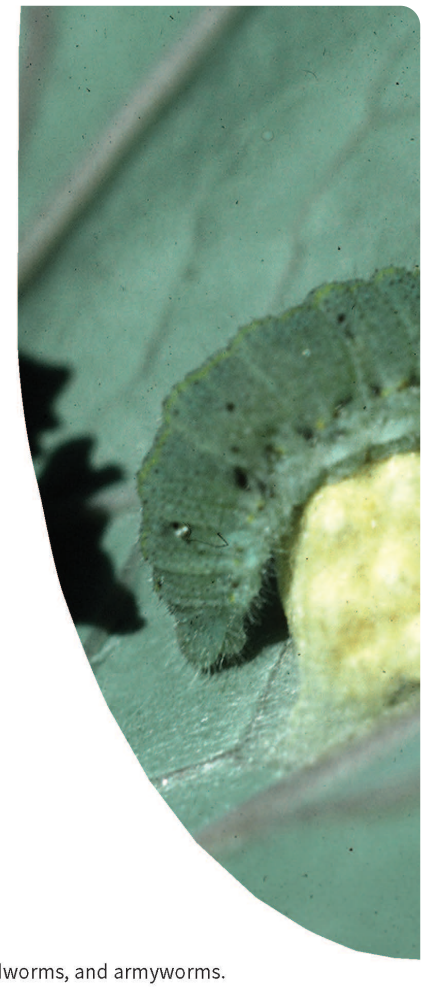
ID: Adults are slender golden-brown wasps about ¼ inch long. Females have a long stinger (ovipositor) projecting backward from the abdomen about the length of the abdomen. Cocoons are brown, about ⅓ inch long, shaped like a football and are suspended from the leaf on a filament.

Hyposoter **wasp adult. Photo by Wikimedia Commons/Slimguy**

Lysiphlebus testaceipes (Braconidae Family)

Lysiphlebus testaceipes attacks the cotton aphid and other aphids such as greenbugs in wheat.

The female pierces the cotton aphid and deposits an egg inside. The egg hatches in about two days, and the parasitoid grub feeds internally on the living aphid. The grub is full grown in about a week when the aphid becomes swollen and tan and dies. The parasitized aphid, attached to a leaf, is termed a "mummy." The grub enters the pupal stage, and about four to five days later, the adult wasp emerges through a hole cut towards the back of the aphid mummy. Development from egg to adult requires about two weeks. A single female can parasitize about



100 aphids during her four- to five-day life span.

David Cappaert, Bugwood.org

ID: *Lysiphlebus testaceipes* is a shiny, slender black wasp about the size of a cotton aphid. Wasps can often be seen in aphid colonies as they sting (parasitize) aphids. More commonly, you see the parasitized aphid mummies (dead swollen aphids stuck to leaves). They are tan to gold and contain a developing wasp or have a hole cut in the top through which the wasp emerged.

Cardiochiles nigriceps (Braconidae Family)

Cardiochiles nigriceps is one of the most important budworm parasitoids. It's widely distributed across the southeastern Cotton Belt west to Oklahoma and Texas. It can only successfully parasitize budworm larvae and a related species, *Heliothis subflexa*, which is not a cotton pest. Wasps sting bollworm larvae, but the parasite eggs do not develop, and the bollworm survives. This wasp also occasionally parasitizes beet armyworm larvae. All sizes of budworm larvae are attacked, but it prefers late second and third instars.

Adult female wasps sting budworm larvae and deposit eggs internally. Eggs hatch into grubs, which feed internally for about two weeks. Small budworm larvae continue to grow once parasitized while those in the fourth and fifth instars do not. Once full grown, the parasitoid grub emerges from the dead budworm larva and spins a cocoon in the soil. The adult wasp emerges in about two weeks and lives for about two weeks. There are about three or four generations per year. Wasps overwinter as pupae in the soil.

R.J. Reynolds Tobacco Company, Bugwood.org

ID: These brightly colored wasps may hover around cotton plants searching for caterpillars. Adults are about ¼ inch long with long antennae and very dark wings. The head and thorax are black. The abdomen and middle and hind legs are red, accounting for its name, the "red-tailed" wasp. The ovipositor (stinger) is short and black and often not visible.

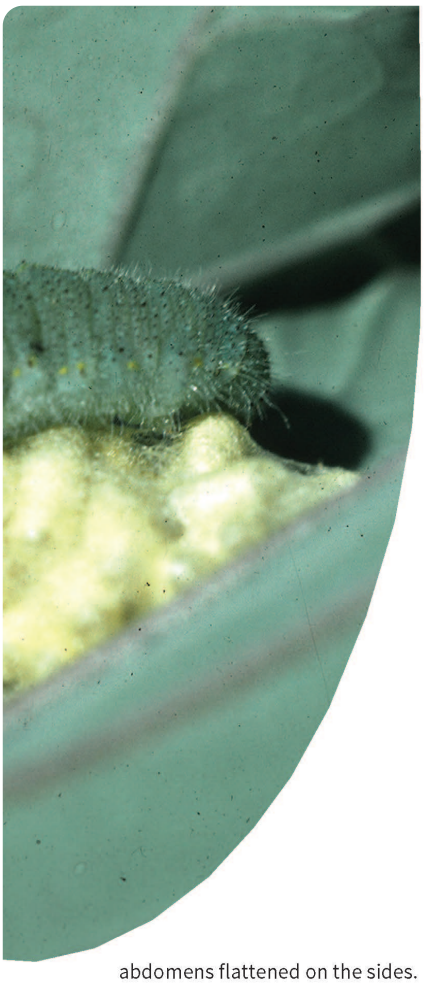
Hyposoter Wasps (Ichneumonidae Family)

Hyposoter wasps attack a wide range of caterpillars, including bollworms, budworms, and armyworms. Although *Hyposoter* species live throughout the Cotton Belt, they are more prevalent from Texas westward.

The adult female attacks small caterpillars, laying a single egg inside. The parasite grub emerges from the larva after 8 to 10 days and spins a cocoon on the leaf. The adult parasite emerges from the cocoon five to seven days later.

Wikimedia Commons/Slimguy

ID: These slender elongated wasps (¼ inch long) have mostly orange



Whitney Cranshaw, Colorado State University, Bugwood.org

abdomens flattened on the sides. The abdomen is narrowly attached to the thorax. Cocoons are attached to leaves, shaped like short fat sausages, banded in silver/grey and black.

Looper Parasite

Copidosoma floranum (Encyrtidae family) parasitic wasps are found throughout the Cotton Belt. They attack cabbage and soybean loopers. A single female can parasitize 10 to 30 loopers.

Late in the season, these parasites can practically eliminate a soybean looper population in a single generation.

Adult wasps sting looper eggs, laying a single egg in the host egg, usually on leaf undersides. After the looper hatches, the nucleus in the wasp egg divides repeatedly, and each nuclei becomes a wasp larva. Up to 2,000 wasps can develop in a single host looper. The parasitized looper requires a bit longer to develop than an unparasitized looper and eats up to 50% more host or crop foliage than an unparasitized looper. Development from egg to adult requires about 17 to 27 days, and there are two or three generations per year.

ID: This tiny (1/16 inch) shiny black wasp resembles a small fly. Looper caterpillars parasitized by *Copidosoma* are most easily recognized after they spin their pupation cell on leaves' undersides. Unparasitized loopers form a green pupa that later darkens to brown. Parasitized loopers, in contrast, fail to pupate, but instead elongate, causing the head to fold into a hook shape under the body. The larva takes on a cream or light tan color and appears to be made of styrofoam. Each of the "foam" cells in the caterpillar's body is a developing wasp.

Telenomus and *Trissolcus* Species (Platygastridae Family)

These beneficial parasites are found throughout the Cotton Belt. They parasitize the eggs of different stink bug species, sometimes including predaceous stink bugs. Some species attack many species of stink bugs while others parasitize only a few species. *Trissolcus basalis* is an important parasite of the southern green stink bug, a cotton pest.

The parasite females lay their eggs in stink bug eggs, usually only one parasite egg per host egg. A single wasp develops in each egg. Parasitized stink bug eggs turn black within a few days of parasitism. The adult parasite emerges from the egg about 8 to 20 days after the parasite egg is placed in the stink bug egg. Adult parasites live about two to six weeks and can parasitize from 30 to more than 100 stink bug eggs in a lifetime.

Trissolcus species

Guido Bohne, Bugwood.org

ID: These are tiny (1/20 to 1/10 inch), shiny black wasps with antennae that are elbowed downward. The wings have very little venation. The body shape varies from slender and somewhat flattened top to bottom, to short and very stout.

Aphelinid Wasps

***Eretmocerus* and *Encarsia* species** (Aphelinidae family) are among the most important natural whitefly enemies. They're so tiny that they're seldom seen (about 1/25 inch long). *Eretmocerus* and *Encarsia* species are distributed throughout the Cotton Belt, but the range of individual species is variable and often unknown.

These wasps parasitize whitefly nymphs, creating a hole and feeding on their body fluids. A single female

Photo by Whitney Cranshaw, Colorado State University, Bugwood.org

wasp parasitizes 40 to 50 whitefly nymphs and kills many other nymphs by direct feeding.

ID: The circular hole cut in the top of the nymph through which the adult wasp escaped is a good way to identify their presence. Whitefly nymphs parasitized by some *Encarsia* species turn black while those parasitized by *Eretmocerus* do not.

Adult wasps search for whitefly nymphs and lay an egg in the nymph (*Encarsia*) or under the nymph (*Eretmocerus*). In contrast, whitefly pupae from which an adult whitefly emerged have a "T" shaped slit in the pupal skin.

Nymphs parasitized by *Eretmocerus* species are dark amber compared to the lighter-colored healthy nymphs. Development from egg to adult requires 18 to 25 days for *Eretmocerus* species and somewhat less for *Encarsia* species.

Mymarid Wasps

Anaphes iole (Mymaridae family) is an important parasite of eggs of the lygus bug (*Lygus hesperus*) and the tarnished plant bug (*L. lineolaris*). *Anaphes iole* occurs in Louisiana, California, and Arizona and is probably present through most of the Cotton Belt.

The adult parasite deposits her egg into the lygus eggs, which are inserted into plant tissue. The wasp egg hatches into a grub, which consumes the lygus egg and pupates. A single adult wasp later emerges from the lygus egg. Development from egg to adult requires about 15 days.

ID: These tiny wasps, less than 0.04 inch, have very slender hind wings. Parasitized of *Lygus* species are black.

Trichogramma Wasps

Trichogramma pretiosum, ***Trichogramma exiguum***, and ***Trichogramma minutum*** are extremely tiny wasps that develop inside moth and butterfly eggs. *Trichogramma* wasps parasitize eggs of bollworms, budworms, loopers, and other caterpillar pests. Some species also parasitize green lacewing eggs. They rarely parasitize fall armyworm eggs or beet armyworm, which are covered by scales left by the female moth. *Trichogramma pretiosum* is found throughout most of the Cotton Belt while *T. exiguum* has been reported from Alabama, Arkansas, and Texas and may be present in other areas.

The adult female places one or more eggs inside the host egg using her "stinger" (ovipositor). The egg(s) hatch in a day, and the wasp larvae feed inside the egg for about three days and then pupate inside the host egg. Dark deposits on the inside of the host egg cause it to turn black. After four to five days, the adult wasp cuts a hole in the side of the host egg and emerges. Development from egg to adult requires 8 to 10 days. Adults live about 10 days. *Trichogramma* wasps parasitize all stages of bollworm/ budworm eggs except those within a few hours of hatch (black-head stage). Adults are active throughout the season. Immature

Photo by Jerry A. Payne, USDA-ARS, Bugwood.org

stages overwinter in host eggs, and adults are active during warmer winter days in southern climates.

Flickr/CIMMYT

ID: Adults are rarely seen in the field because of their small size. Black bollworm and budworm eggs signal the presence of *Trichogramma* wasps. Adults resemble tiny ants and are difficult to see. Identification of the species requires high magnification and specialized training. A powerful hand lens or microscope is necessary to clearly see these minute parasites. Adults are yellow and brown, and the wings have only a few veins.

Order Diptera (Flies)

Tachinid Fly

Archytas marmoratus is an important parasite of the larval stage of the bollworm, fall armyworm, budworm, black cutworm, and related moth species in cotton, alfalfa, and corn. Medium to large larvae, fourth and fifth instars, are most commonly parasitized.

The adult *A. marmoratus* fly deposits maggots, rather than eggs, on cotton leaves where bollworms and budworms feed. The bluish-green maggots can lie in wait several days and quickly attach themselves to bollworms or other caterpillars crawling within reach. The maggot penetrates the bollworm/budworm larva but does not begin to eat or develop. Parasitized bollworms continue to feed and develop normally. Once the bollworm or budworm has entered the soil and pupated, the fly maggot begins to consume the pupa. The maggot feeds for 6 to 10 days and then pupates. A single adult fly emerges about 8 to 10 days after the host pupates. A female can produce 2,000 or more maggots during her life span of 50 to 70 days. Winter is spent in the adult stage.

Eucelatoria bryani parasitizes bollworm, budworm, and fall armyworm larvae from Mississippi west to Arizona.

Lespesia archippivora parasitizes many different kinds of caterpillars, including bollworm, fall armyworm, beet armyworm, cabbage looper, and black cutworm, throughout the Cotton Belt.

Lespesia and *Eucelatoria* adults deposit their eggs or larvae in or on the host caterpillar.

Flickr/CIMMYT

ID: *A. marmoratus* is a large, stocky fly about ½ inch long with long black bristles on its abdomen and thorax. The silvery-white face is characteristic of this species, found throughout the southern U.S. *Lespesia archippivora* is a small (4-8 mm) gray fly that runs and flies quickly. *Eucelatoria bryani* is an active, grayish-black fly about ¼ inch long with a reddish tinge at the tip of its abdomen.

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