Science Societies

Beneficial arthropods of the Corn Belt and Great Plains

By Susan Winsor

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Beneficial Arthropods

This article is the first in a three-part series on beneficial arthropods. It will highlight some beneficial insects that kill crop pests and are largely unnoticed in the Corn Belt and Great Plains. The focus will be on two groups of insects that survive by eating insect pests of crops: predators and parasitoids. Information for this article comes from the University of Illinois, Iowa State University, Kansas State University, Michigan State University, University of Minnesota, Texas A&M University, and Utah State University.

Most insects (99% of species) are benign or even beneficial for farming. Beneficial insects work almost invisibly, helping farmers grow crops. For example, pollinators are beneficial insects, but aren't the only helpers. This article will focus on those beneficial insects that kill crop pests and largely go unnoticed. Naturally occurring pathogens (fungi and viruses) are also effective biocontrol agents but won't be addressed here. Instead, we will focus on two groups of insects that survive by eating insect pests of crops: predators and parasitoids.

Many of these insects require pollen or nectar at some point in their life cycle to survive periods of prey scarcity, to overwinter and/or to enhance their reproductive success. Cash crops, especially grains, typically lack pollen early in the season. The pests they prey upon arrive/migrate later in the season, creating an early-season food shortage for these beneficial insects. So, it's helpful to have perennial blooming plants or cover crops (such as buckwheat, sweet alyssum, clovers, etc.) on idle land or marginal areas of a field 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.

The two main categories of insects that act as natural enemies to pests are parasitoids and predators. Parasitoids' prey are often quite species specific, whereas predators typically feed on many insects. Although more than 100 insect families contain predators, about 12 contain the major species that are the workhorses of the "everyday heroes" in our fields. These predators are found across a wide crop variety throughout the season. One important group, for example, are lady beetles.

Some of the most common natural enemies are detailed below.

Parasitoids: Wasps (Hymenoptera Order)

Most parasitoids are in the wasp order (Hymenoptera), but another important group are flies in the order Tachinidae. Parasitoids of both of these taxonomic groups can be 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 prey's body and feed from the outside.

Braconid Wasps (Braconidae Family)

Larvae are parasitoids of many aphid species, each parasitizing a particular type of insect (aphids, caterpillars, beetles, etc.). This is a very large family of parasitoids with species that parasitize almost every other insect family. Some are important parasitoids of corn pests' larval stage.

- ***Lysiphlebus testaceipes*** **is a small Braconid wasp that parasitizes wheat and sorghum aphids.**

ID: Cocoons' presence is often the most apparent evidence of a braconid wasp attack. Often the larvae will spin silken cocoons on or near the host's body. Some are tiny while others are huge.

- ***Cotesia*** **species include multiple wasp species that prey on fall armyworm, corn earworm, black cutworm, cabbage looper, and**

Top photo: David Cappaert, Bugwood.org. Bottom photo: R.J. Reynolds Tobacco Company, Bugwood.org.

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diamondback moth. *Cotesia* species are gregarious braconids that can attack hosts up to 100 times larger than they are. They use venom to subdue the host larvae and then lay multiple eggs on them.

ID: Adults are black–brown wasps with long antennae. Females have a noticeable ovipositor.

Trichogramma Wasps (Trichogrammatidae Family)

They parasitize the eggs of many caterpillars and other pests, especially European corn borer and corn earworm.

Column 1 photo: Victor Fursov/Wikimedia Commons. Column 2 photo: USDA APHIS PPQ, Bugwood.org.

ID: Adults resemble tiny ants and are difficult to see. They parasitize Lepidoptera eggs. Their presence can be detected by the blackening of the shell of the host egg.

Aphelinid Wasps (Aphelinidae Family)

The family Aphelinidae contains about 1,100 species that all attack aphids.

ID: Very small wasps that are dark brown to black, some more or less orange, yellow, or yellow-brown. They are as small as the aphids they attack and may be hard to see. The adults also kill some of their hosts directly by host feeding.

- ***Aphelinus certus***, Aphelinidae family, was imported from Asia to help control soybean aphids. Its quick response to low populations of soybean aphid and its specific appetite for soybean aphids and closely related species, unlike more generalist predators like insidious flower bugs (*Orius insidiosus*), creates a greater potential to biologically control them. The importation of this exotic species into North America was approved by the USDA because of its specific use on soybean aphids and closely related species in its native Asian habitat. University of Minnesota and USDA studies suggest that this parasitoid may maintain soybean aphid populations below 250 aphids per plant (the economic threshold for insecticide treatment). Time will

tell whether this imported exotic wasp lives up to its potential to biologically control soybean aphid.

Ichneumonid Wasps (Ichneumonidae Family)

There are an estimated 3,100 North American species of Ichneumonid wasps. These wasps have long skinny waists. Some species kill European corn borer, true armyworm, wheat stem sawfly, and alfalfa weevil. Ichneumonids lay eggs in the host and hatch into larvae that feed within the host, killing it. Other common hosts are the larvae and pupae of Lepidoptera (moths and butterflies) and Coleoptera (beetles). Ichneumonids prefer cool, moist climates and require nectar/aphid honeydew as a sugar source and water.

ID: They are slender and vary from black to yellow-brown. They have long antennae with 16 or more segments. The female's ovipositor is permanently extended and at least as long as the body. Some species attack hosts in concealed locations like stems or rolled leaves, immobilizing the hosts with venom.

Imported Exotic Predators May Be Promising

The samurai wasp, *Trissolcus japonicus*, is a promising potential parasitoid with a specific appetite for brown marmorated stink bugs (BMSB). In its native northeastern Asia, the tiny parasitic wasp effectively controls them, parasitizing 60–90% of BMSB egg masses. They lay eggs over an extended period, so they keep attacking BMSB during an entire season as new generations emerge.

Because BMSB is a season-long pest and can feed on hundreds of plant species, including many adjacent to crop fields, it's difficult to control with pesticides. Samurai wasps can follow BMSB across the landscape into all different habitats across large areas.

The samurai wasp will not eradicate BMSB—that is not how biological control works. A successful biocontrol agent reduces pest densities to a low equilibrium density where the wasps and BMSB coexist, but BMSB would no longer create enough damage to be considered a pest. Besides the benefits of biocontrol, the samurai wasp fills a pest-control niche that pesticides can't by following stink bugs beyond places where pesticides are applied. This can include habitats where BMSB overwinter, like woodlots and forests. The sesame-seed-sized wasp lays its eggs *inside* stinkbug eggs. These wasp embryos consume stink bug embryos.

Like its prey, BMSB, the samurai wasp was introduced into the U.S. accidentally (in 2014). It's now in 12 states (Pennsylvania, New York, New Jersey, Maryland, Delaware, West Virginia, Virginia, Ohio, California, Michigan, Utah, and Washington), the District of Columbia, and British Columbia, Canada.

Michigan State University and others are intensively studying its effectiveness as a BMSB biocontrol agent. The BMSB's ability to decimate many fruits and crops spurred Canada and New Zealand to pre-emptively approve samurai wasp releases for BMSB control.

Column 1 photo: Jim Occi, BugPics, Bugwood.org. Column 2 photo: Wikimedia Commons/Oregon State University.

- ***Bathyplectes curculionis* and *Bathyplectes anuris* are the only two wasps that parasitize alfalfa weevil larvae and adults.**

Parasitoids: Flies (Diptera Order)

Tachinid Flies (Tachinidae Family)

Tachinid flies are a large and variable family of true flies, with more than 1,300 species in North America alone. They attack several caterpillars including European corn borers, corn earworm, fall armyworm, and black cutworm. Other prey include green cloverworm, bean leaf beetle, immature alfalfa looper, beetles, butterflies, moths, sawfly, earwig, true bugs, and grasshopper. Females may deposit eggs into or on the host or lay the eggs on leaves near the caterpillars to be consumed. Other species give birth to live larvae able to find caterpillars within their bore holes in plant stems. They are endoparasitoids, meaning they feed within the body of the host insect.

Column 1 photo: David Cappaert, Bugwood.org. Column 2 photo: Ronald Smith, Auburn University, Bugwood.org.

ID: They resemble large, hairy, house flies.

Predators: Beetles (Coleoptera Order)

Lady beetles (Coccinellidae Family)

There are more than 450 species of lady beetles in North America. Both adults and larvae are predators. Many large species are primarily predators of aphids but may also prey on the eggs and small larvae of corn borer, cereal leaf beetle, and bean leaf beetle. Other species specialize in preying on mites, scale insects, whiteflies, and mealybugs. Most lady beetles also consume pollen and nectar as supplementary foods. Lady beetles are common in tasseling corn fields where they are attracted to the pollen. Like some aphid predators, they are cannibalistic in the larval stage. The larvae usually resemble little alligators.

ID: Eggs are yellow to orange in color, oval shaped, and laid in tight clusters. Larvae are grey or black; more mature larvae also have brightly colored orange or yellow patches.

Four of the most common lady beetles in crop fields are:

- **Convergent lady beetle, *Hippodamia convergens*.**

ID: They have two white lines behind the head that converge.

Beetles have 0 to 12 spots on an orange or red body.

- **Multicolored Asian lady beetles, *Harmonia axryridis.* This invasive species is predatory on many species of aphid and other soft-bodied insects, including alfalfa weevil. Adults can be pests of some fruit crops.**

ID: They vary from yellow to red with or without spots. Beetles have an M-shaped black marking behind their head.

- **Twelve-spotted lady beetle, *Coleomegilla maculata.***

ID: Pink with 12 black spots; eggs are yellow to orange. Adults feed on insects and pollen.

- **Seven-spotted lady beetle, *Coccinella septempunctata*.**

ID: An invasive species, this beetle is the largest species in crop fields. Wing covers are red or orange, and always have seven black spots, the seventh spanning the top of both wing covers at the forward edges.

Ground Beetles (Carabidae Family)

These large flightless beetles are found in all field crops. Adults prey on many ground-dwelling insects such as root maggot, rootworm, caterpillar, black cutworm, slug, and other soft-bodied insects. Most adults remain on the ground, but some smaller species may ascend plants in search of prey.

Larvae prey on soft-bodied insect stages and earthworms in the soil. Many species also eat seeds, including weed seeds, which they often prefer over larger crop seeds.

Rove Beetles (Staphylinidae Family)

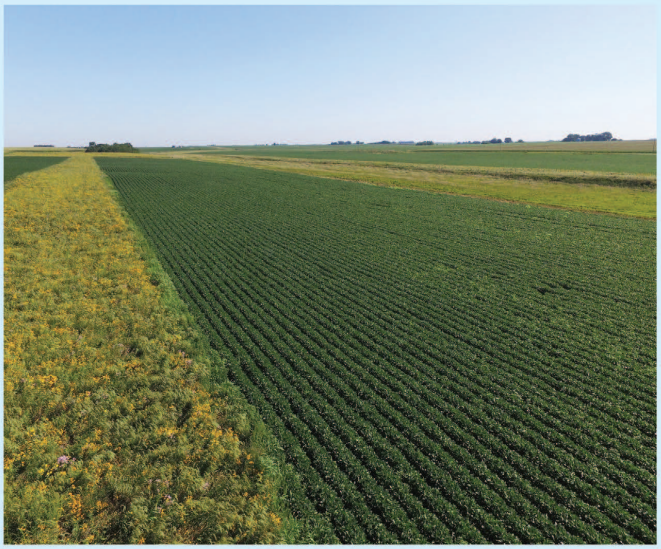
Rove beetles are extremely diverse in size, habitat preference, and feeding habits. They live mostly on or under the soil surface and in leaf litter.

ID: Typically slender, black and shiny, some are metallic blue or green and range greatly in size, depending upon species. Adults have pincer-like mandibles that project forward from the head. The wings are concealed below wing covers that are very short, less than the length of the thorax.

Mature larvae have two projections at the end of the

Three Ways to Implement Pest Biocontrol Agents

On a larger scale than what farmers typically implement, there are three ways to increase biocontrol insect or natural enemy insect numbers:



Classical control involves importing natural enemies of invasive insect pests from the pest's native region. If identified as specific enough to attack only the target pest, these agents can be released in North America to combat invasive pests like the soybean aphid, BMSB, and Japanese beetles.

Samurai wasps and a few tachinid wasp species are examples of imported biocontrol agents studied in the U.S. to control BMSB and soybean aphids, respectively (see related sidebar).

Augmentation involves purchasing specific natural enemies for pest control in small, contained areas like greenhouses. Both predators and parasitoids are available commercially for this practice. Outdoors, this would be ineffective due to the large numbers of natural enemies required to disperse within a crop field.

Conservation practices improve predators' and parasitoids' habitats to increase their populations. Examples are planting prairie strips (like the photo shown here) and other perennial plants amid or surrounding cash crop fields. These conservation practices often bring ancillary benefits for pollinators, soil erosion control, bird habitat, and biodiversity.

Column 1 photo, top: Wikimedia Commons/Sanja565658. Bottom: Joseph Berger, Bugwood.org. Column 2 photo: Lynn Betts, NRCS/SWCS.

Photo by Nicolas VENNER/Flickr.

abdomen, are typically dark in color, with a large head and prominent pincer-like mouths.

Collops Beetle (Melyridae Family)

These small red and black beetles eat soft-bodied insects including armyworms, whiteflies (eggs, nymphs, and adults), lygus bug nymphs, aphids, mites, and lepidopteran eggs and small caterpillars.

Collops beetle

Predators: Lacewings (Neuroptera Order)

Green Lacewing (Chrysopidae Family)

Chrysoperla carnea and Chrysoperla plorabunda are two species found in a wide range of habitats and are important predators of aphids and other small, soft-bodied insects. Most green lacewings are predacious only as larvae; adults feed on pollen and nectar. The larvae have "extraoral digestion": they pierce their prey, injecting enzymes to digest the contents, and suck out the body fluids. Prey include aphids, including Russian wheat aphid, weevil larvae, plant bug, thrip, mite, leafhopper eggs, leafminer, mealybug, and the eggs and larvae of Lepidoptera and Diptera.

They frequent agricultural crops such as corn, sorghum, cotton, potatoes, sugar beets, cole crops, tomatoes, peppers, eggplants, asparagus, leafy greens, apples, strawberries, and other plants.

ID: Adults are pale yellow to bright green with two large pairs of clear, lacy wings that fold like a tent over their narrow body. They have long, slender antennae.

Larvae are elongated and vary greatly in coloration (usually brownish) and have distinctive large, sickle-shaped mouthparts (mandibles). Some species have clumps of short bristles, and others pile the empty shells of their victims on their backs for camouflage, giving them the common name "trash bugs."

Brown Lacewing (Hemerobiidae Family)

Hemerobius spp., both larvae and adults, can be predaceous. They aren't as common in soybeans and corn as green lacewings.

Brown lacewing

ID: Adults are brown, very slender, and have pincer-like mouths parts and transparent wings, and are smaller than green lacewings.

Predators: True Bugs (Hemiptera Order)

Minute Pirate Bug (Anthocoridae Family)

Insidious flower bugs, *Orius insidiosus* (eastern North America), are among the most common generalist predators in Midwestern field crops. They are also key predators of soybean aphid (early season especially) and corn earworm eggs. Emerging in early spring, their diet consists of many small pests, including thrip, aphid, mite, small caterpillars, armyworm, and insect eggs. Their small size allows them to reach prey in curled leaves and tight locations not accessible to larger predators. Adults overwinter in leaf litter and emerge in early spring.

Column 1 photo: Whitney Cranshaw, Colorado State University, Bugwood.org. Column 3 photo: Wikimedia Commons/Katja Schulz.

ID: Adult *O. insidiosus* are shiny with a black and white X pattern on their back and pointed head. Immature nymphs are wingless and orange to reddish brown.

Big-Eyed Bugs (Geocoridae Family)

Big-eyed bugs prey upon many kinds of crop and pasture insect and mite pests. Both nymphs and adults are predatory but also feed on pollen and nectar. Their piercing/sucking mouthparts stab and drain their small prey such as spider mite, insect eggs, aphid, thrip, and small caterpillars. They can eat as many as 1,600 spider mites before reaching adulthood, and adults may consume as many as 80 mites per day.

ID: Adults are black, gray, or tan with proportionately large eyes on the sides of their heads. Eggs are deposited singly or in clusters on leaves near potential prey.

Spined Soldier Bug (Pentatomidae Family)

Podisus maculiventris is a medium-sized predatory stink bug that preys on a wide variety of other arthropods, especially larval forms of Lepidoptera and Coleoptera. Nymphs and adults suck fluids from their prey: soft-bodied insects such as aphid, alfalfa weevil larvae, and caterpillar.

ID: Grey-brown. Adults have pointed shoulders and a dark spot at the wing tips.

Assassin Bugs (Reduvidae Family)

Assassin bugs are top-level predators that feed on many insects, weevils, and even lady beetles but are mostly disruptors of biological control because they will attack almost anything that moves in front of them, including other beneficial insects.

Damsel Bugs (Nabidae Family)

Nabis americoferus eats aphids, weevil larvae, moth eggs, small caterpillars, fleahopper, whitefly, mites, and tarnished plant bug nymphs.

ID: slender, tan to gray and sometimes black with long antennae and legs and prominent eyes. They are elongated in shape like assassin bugs but are smaller and less colorful. They have a narrow head and a long beak that folds back under the head. The neck is wider than the head.

Column 1 photo, top: John Ruberson, Kansas State University, Bugwood.org. Bottom: Russ Ottens, University of Georgia, Bugwood.org. Middle column, top: Gerald J. Lenhard, Louisiana State University, Bugwood.org. Bottom: Whitney Cranshaw, Colorado State University, Bugwood.org. Column 3, top: Winston Beck, Iowa State University, Bugwood.org.

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