



## Biological Control Organisms for Insects and Mites

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Online at: [www.cdpr.ca.gov/docs/impinov/bensuppl.htm](http://www.cdpr.ca.gov/docs/impinov/bensuppl.htm)

A wide variety of beneficial organisms are offered for sale by several suppliers to assist in management of insects and mites. The following is a partial listing current as of July 28, 2002.

This is organized in three sections. First is a brief description of organisms with potential applications. At the end of the section is a reference to sources where they may be purchase. This is followed by a brief listing of pest groups and the associated potential biological controls. At the end is a listing of addresses of many suppliers/producers.

### Predators of Insects/Mites

**Convergent Lady Beetle/Lady Beetles** – When sold as “lady beetles” or “ladybugs” the species involved is the convergent lady beetle, *Hippodamia convergens*, a native lady beetle found throughout most of North America. Purchased lady beetles are all field collected insects, captured in high elevation areas of California where they periodically migrate to and mass aggregate, allowing easy collection. Ability of the collected lady beetles to reproduce is suspended (they are in “reproductive diapause”) so eggs are not produced for several weeks after release. (Pre-feeding lady beetles prior to release can allow some egg maturation to start and a few companies provide such “pre-conditioned” lady beetles.) Lady beetles tend to readily disperse from the area of release. Since they store well, lady beetles are available most of the year, although supplies often are limited by midsummer.

Sources: 1, 2, 4, 7, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 21, 22, 24, 25, 26, 28, 29, 30, 31, 32, 34, 35, 36, 37, 38

**Pink Lady Beetle/12-spotted Lady Beetle** – The 12 spotted lady beetle, *Coleomegilla maculata* (C-Mac) is a native species to the region and common in agricultural areas, particularly alfalfa fields. In addition to aphids, it commonly feeds on eggs of beetles (e.g., Colorado potato beetle, Mexican bean beetle) egg masses of some caterpillars and pollen.

Sources: 2, 23, 32

**Multicolored Asian Lady Beetle** – The multicolored Asian lady beetle, *Harmonia axyridis*, is a species that was purposefully introduced into North America and has now become widely distributed, recently colonizing Colorado. It is a fairly large species with highly variable markings and is a voracious predator of aphids, particularly on shade trees. However, it has the somewhat unfortunate habit of often wintering in homes, where it may be a nuisance problem. They go into dormancy (diapause) when day length becomes less than 16 hours.

Sources: 10, 19, 22, 32, 37

**Mealybug Destroyer** – The mealybug destroyer, *Cryptolaemus montrouzieri*, is a tropical species of lady beetle used to control citrus mealybug. They primarily feed on eggs and some small nymphs. The predatory larvae are covered with wax threads and appear similar to mealybugs.

Sources: 4, 7, 8, 9, 10, 15, 17, 18, 19, 20, 21, 22, 24, 26, 28, 29, 30, 32, 24, 26, 37, 38

**Whitefly Predator** – Lady beetles in the genus *Delphastus* feed on eggs and small nymphs of whitefly, particularly sweetpotato/silverleaf whitefly. High populations of whiteflies must be present to maintain reproduction of these predators. (**Note:** There has often been confusion as to the specific identity of *Delphastus* sold by suppliers. Although most list the organism as *D. pusillus*, *D. catalinae* probably predominates in most cultures for sale.)

Sources: 2, 8, 10, 16, 17, 19, 20, 21, 22, 24, 29, 32, 34, 35, 36, 37, 38

**Spider Mite Destroyer** – Tiny, dark lady beetles in the genus *Stethorus* develop as predators of spider mites.

Sources: 29, 32, 34, 37

**Scale Predator** – A beetle, *Rhyzobius* (= *Lindorus*) *lopanthae*, develops as a predator of scales, particularly various armored scales (Diaspididae). Some soft scales (Coccidae) may be eaten, although effectiveness of the beetle is inhibited by the presence of honeydew.

Sources: 2, 18, 19, 20, 21, 24, 26, 32, 37, 38

**Green Lacewings** – Green lacewings (*Chrysoperla* spp.) are general predators of a wide variety of insects, including aphids, and soft-bodied insect larvae. The most common species sold are *Chrysoperla rufilabris*, a native of southeastern U.S. mostly associated with trees/shrubs, and *C. carnea*, a native western species found most commonly in agricultural



settings. *C. comanche* is also sold. They are one of the most widely available insects used in biological control, functioning as a sort of general predators. They are usually sold as eggs, most often mixed with a carrier such as rice hulls to be sprinkled around plants. Some suppliers apply the eggs to cards that can be hung on plants. Less commonly adults, or pupae shipped in cells, may also be purchased. Shipped insects should be released soon after receipt as the larvae are cannibalistic and eggs should not be chilled. Ants are an important predator of the eggs and may disrupt the effectiveness of a release if abundant. Adults are not predatory but feed on nectar and pollen.

Sources (*C. rufilabris*): 1, 7, 18, 21, 24, 25, 26, 29, 30, 31, 32, 34, 35, 36, 38

Sources (*C. carnea*): 1, 7, 8, 9, 18, 21, 22, 25, 30, 32, 38

Sources (*C. comanche*): 18, 21

Sources (unspecified *Chrysoperla* species): 2, 3, 4, 10, 11, 12, 13, 14, 15, 16, 17, 27, 28

**Chinese Mantid** – The Chinese mantid, *Tenodera aridifolia sinensis*, is the only species of commercial trade. They are sold as egg cases (oothecae) each containing about 200 eggs. Adult Chinese mantids reach a size of about 4 inches and are the largest mantids found in North America. They are poorly adapted to surviving winter conditions in Colorado, almost invariably dying out. (Other species of mantids, notably the common European mantid, *Mantis religiosa*, do overwinter successfully in parts of Colorado, particularly if winters are mild.) Mantid egg cases are usually available only during spring through early summer. They are generalist predators of a wide variety of insects, including some beneficial species. Their effectiveness for control of pests is marginal, but they are striking insects that are an attractive complement to the garden.

Sources: 1, 2, 4, 8, 13, 15, 20, 21, 27, 28, 30, 31, 32, 34, 35, 36, 37, 38

**Aphid Predator Midge** – Larva of a tiny fly, *Aphidoletes aphidimyza* develops as predator of aphids. It is a native insect of the region, found most commonly in late summer within aphid colonies. *A. aphidimyza* is sold for use in greenhouses, supplied as pupae that disperse after they transform to the adult stage. When used during winter supplemental lighting must be provided to maintain a minimum of 16 hours of daylight or the predators become dormant.

Sources: 2, 9, 10, 14, 15, 17, 18, 20, 21, 22, 24, 26, 29, 30, 32, 36, 37, 38

**Spider Mite Predator Midge** – Larvae of another gall midge, *Feltiella acarisuga*, are sometimes sold for control of twospotted spider mite. *Therodiplos persicae*, also a gall midge, also will feed on spider mites.

Sources (*Feltiella acarisuga*): 32

Sources (*Therodiplos persicae*): 22

**Sixspotted Thrips** – The sixspotted thrips, *Scolothrips sexmaculatus*, is a predator of spider mites, reported adapted to hot and dry conditions.

Sources: 2, 7, 32

**Spider Mite Predators/Predatory Mites** – About five species of commercially available predatory mites (Phytoseiidae family) appear to have some potential application under Colorado conditions, particularly for greenhouse and interiorscape use. Each has a range of temperature and humidity under which they are most efficient, and some require humidity conditions rarely reached in Colorado. The more experienced suppliers/producers can provide consultation as to appropriate species to consider.

Sources (Western predatory mite, *Galendromus occidentalis*): 2, 6, 8, 17, 21, 24, 28, 30, 32, 36, 37, 38

Sources (*Neosieulus californicus*): 2, 6, 8, 13, 17, 20, 21, 22, 24, 26, 28, 29, 30, 32, 36, 38

Sources (*Amblyseius fallacis*): 6, 13, 17, 26, 32, 37, 38

Sources (*Mesosieulus longipes*): 2, 6, 8, 17, 20, 21, 24, 29, 30, 32, 36, 38

Sources (*Phytoseiulus persimilis*): 2, 4, 6, 7, 8, 9, 13, 16, 17, 20, 21, 22, 24, 26, 28, 29, 30, 32, 34, 36, 37, 38

Sources (Predatory mites, unspecified and/or mixtures): 34

**Thrips Predators/Predatory Mites** – Two species of commercially available predatory mites (*Amblyseius cucumeris*, *A. degenerans*) feed primarily on thrips, particularly flower thrips. Pollen may be an important part of the diet of these predators.

Sources (*Amblyseius cucumeris*): 8, 9, 13, 15, 17, 18, 20, 21, 22, 24, 26, 28, 29, 30, 32, 34, 36, 37, 38

Sources (*Amblyseius degenerans*): 22, 24, 32, 37, 38

**Pirate Bugs** – Pirate bugs (*Orius* spp.) are small black and white bugs that are generalist predators of small insects (e.g., thrips, aphids), mites, and insect eggs. Many species are present in the region and they are very important natural controls. At least four species are sold commercially.

Sources (*Orius insidiosus*): 2, 10, 15, 16, 17, 22, 24, 26, 29, 32, 34, 36, 37, 38

Sources (*Orius laevigatus*): 22

Sources (*Orius majusculus*): 22

Sources (Unspecified *Orius* sp.): 4, 8, 17, 20, 21, 30, 31, 35



**Big-eyed Bug** – Big-eyed bugs, *Geocoris* spp., are predatory seed bugs that feed on a wide variety of insects, including aphids, soft-bodied insect larvae, and insect eggs. Several species are native to the region. *Geocoris punctipes* appears to be the species commercially available.

Sources: 2, 4, 32

**Predatory Plant Bug** – A predatory plant bug, *Deraeocoris brevis*, is a generalist predator of soft-bodied insects and is native to the region.

Sources: 21, 38

**Spined Soldier Bug** – The spined soldier bug, *Podisus maculiventris*, is a native species of stink bug that is predatory on many types of caterpillars and leaf beetle larvae. Experimental work with the species is limited, although naturally occurring populations have often been reported as useful biological control agents.

Sources: 2, 32

**Soil Predator Mite** – The soil dwelling mite, *Hypoaspis miles*, is a generalist predator of insects that spend part of their life cycle in the soil, including fungus gnat larvae and pupae of thrips. Once introduced, *H. miles* usually can reproduce and establish.

Sources: 2, 8, 16, 17, 20, 21, 22, 24, 26, 29, 32, 34, 37, 38

## Parasites/Parasitoids of Insects

**Trichogramma Wasps** – Several species of *Trichogramma* species wasps exist, all of which attack and kill various kinds of insect eggs. Insect larvae already hatched are not susceptible to *Trichogramma* attack. Most of the eggs parasitized by *Trichogramma* are from insects in the order Lepidoptera (Moths and Butterflies), which includes cutworms, codling moths, cabbageworms and armyworms. Although some *Trichogramma* wasps are naturally present in the Rocky Mountain region, they are usually found in low numbers. Commercially available *Trichogramma* wasps are often used as a form of a biological insecticide where they are expected to eliminate most of the developing eggs of pests shortly after release. High levels of control are not often achieved in practice, but the wasps may effectively supplement existing controls. Multiple releases of *Trichogramma* wasps are recommended, since persistence of the parasites may be short-term. Several different species of trichogramma wasps are produced (e.g., *T. minutum*, *T. platneri*, *T. pretiosum*) and they have different habits. The more sophisticated suppliers will provide advice on which species is most appropriate for the intended crop and pest.

Sources (*Trichogramma minutum*): 1, 2, 7, 8, 10, 14, 17, 18, 21, 30, 31, 32, 36, 38

Sources (*Trichogramma brassicae*): 7, 26, 31, 32

Sources (*Trichogramma platneri*): 2, 8, 14, 18, 21, 26, 31, 32, 38

Sources (*Trichogramma pretiosum*): 1, 2, 8, 14, 17, 18, 21, 26, 30, 31, 32, 36, 38

Sources (*Trichogrammatoidea bactrae*): 8, 18, 21, 32, 38

Sources (Unspecified *Trichogramma* species): 3, 4, 12, 13, 15, 16, 20, 25, 27, 29, 35

**Fly Parasites (Fly Predators)** – Several species of parasitic wasps develop in the pupae of filth breeding flies species of *Muscidifurax* (*M. raptor*, *M. zaraptor*, *M. raptorellus*), *Spalangia* (*S. cameroni*, *S. endius*, *S. nigroaenea*) and *Nasonia vitripennis*. These are used to suppress nuisance flies in areas of livestock or where manure storage otherwise is stored.

Sources (*Muscidifurax raptor*): 4, 7, 20, 30, 32, 35

Sources (*Muscidifurax zaraptor*): 8, 18, 20, 26, 28, 30, 32, 33, 36, 38

Sources (*Muscidifurax raptorellus*): 26, 32, 33, 36

Sources (*Spalangia cameroni*): 32, 32

Sources (*Spalangia endius*): 18, 28, 30, 38

Sources (*Spalangia nigroaenea*): 30

Sources (*Nasonia vitripennis*): 8, 18, 28

Sources (Unspecified mixtures of fly parasites): 1, 3, 12, 14, 20, 22, 24, 25, 27, 31, 35, 37

**Aphid Parasites** – Several small parasitic wasps are commercially available, primarily for control of aphids in greenhouses or interiorscapes. Some are generalists, other more specific as to the aphids they will attack. Among the most commonly available (and their hosts) are *Aphelinus abdominalis* (green peach aphid), *Aphidius colemani* (melon/cotton aphid, green peach aphid), *Aphidius ervi* (potato aphid, pea aphid, green peach aphid), and *Aphidius matricariae* (green peach aphid).

Sources (*Aphelinus abdominalis*): 2, 22, 32

Sources (*Aphidius colemani*): 2, 8, 9, 10, 14, 20, 22, 24, 26, 31, 32, 37, 38

Sources (*Aphidius matricariae*): 2, 10, 18, 21, 26, 29, 32, 35, 37, 38

Sources (*Aphidius ervi*): 2, 9, 18, 20, 22, 26, 32, 38



**Greenhouse Whitefly Parasite** – A small wasp, *Encarsia formosa*, attacks and develops within immature whitefly nymphs. Introduction of this parasitic wasp has proven useful for whitefly management in warm greenhouses (average temperatures above 72°F). The whitefly parasite is supplied on cards, as developing wasps within whitefly nymphs. The latter turn black when hosting this parasite.

Sources: 2, 4, 7, 8, 9, 12, 15, 16, 17, 18, 20, 22, 24, 26, 27, 28, 29, 30, 31, 32, 34, 35, 36, 37, 38

**Sweetpotato Whitefly Parasite** – Another parasite of whiteflies is *Eretmocerus eremicus* (= nr. *californicus*). Originally developed to help manage sweetpotato whitefly it also is an effective natural enemy of greenhouse whitefly. Adult stages may kill many developing whiteflies by stinging them and blood feeding. Whitefly nymphs parasitized by this insect turn a golden color.

Sources: 2, 9, 17, 20, 21, 24, 26, 32, 36, 37

**Mexican Bean Beetle Parasite** – *Pediobius foveolatus* is a small, parasitic wasp that develops within immature stages of the Mexican bean beetle. Releases should be made shortly after bean beetle eggs are first detected. This insect does not survive winters in the region.

Sources: 2, 32

**Mealybug Parasites** – Several species of parasitic wasps are parasites of mealybug nymphs. Most commonly available is *Leptomastix dactylopii*, a parasite of citrus mealybug. *Leptomastidea abnormis* also is specific to citrus mealybug, while *Anagyrus pseudococci* has a somewhat broader host range and develops on Comstock mealybug as well citrus mealybug.

Sources (*Leptomastix dactylopii*): 2, 7, 20, 21, 22, 32, 38

Sources (*Leptomastidea abnormis*): 32

Sources (*Anagyrus pseudococci*): 32

**Armored Scale Parasite/Golden Chalcid** – A small parasitic wasp, *Aphytis melinus*, develops in many armored scales associated with interiorscape plants. (It is not a parasite of armored scales found on landscape plants in Colorado).

Sources: 2, 7, 14, 17, 18, 20, 21, 24, 26, 30, 32, 37, 38

**Soft Scale Parasite** – A parasitic wasp, *Metaphycus helvolus*, is useful for managing black scale and hemispherical scale on interiorscape plants.

Sources: 2, 7, 18, 20, 21, 24, 26, 30, 32, 36, 38

**Caterpillar Parasites** – Two species of parasitic wasps attack young stages of caterpillars associated with certain vegetable crops. *Cotesia marginiventris* is a parasite of various loopers, such as cabbage looper. *Cotesia plutellae* is a parasite of diamondback moth larvae.

Sources (*Cotesia marginiventris*): 2, 32

Sources (*Cotesia plutellae*): 2, 4, 14, 32

**Leafminer Parasites** – Two species of parasitic wasps are used to control leafminers (*Liriomyza* spp.). *Diglyphus isaea* tends to be most efficient in warmer environments; *Dacnusa sibirica* in cooler temperatures.

Sources (*Diglyphus isaea*): 2, 7, 15, 18, 20, 22, 28, 32, 36, 38

Sources (*Dacnusa sibirica*): 7, 9, 15, 17, 20, 22, 28, 32, 37, 38

**Lygus Bug Egg Parasite** – A minute wasp, *Anaphes iole*, is a parasite of eggs of Lygus bugs, which are occasional pests of fruit crops.

Sources: 17, 32, 38

## Pathogens of Insects

***Bacillus thuringiensis* var. *kurstaki*** – The *kurstaki* strain of the bacterium *Bacillus thuringiensis* (Bt) is a bacterial disease organism that has been formulated into a number of microbial insecticides. Trade names include Dipel, Thuricide, Javelin, Deliver, MVP II, and Safer Caterpillar Killer. Applied as a dust or spray to foliage, applications of this strain is effective for control of most leaf-feeding Lepidoptera - webworms, cabbageworms, leafrollers, tussock moths, etc. (Cutworms and armyworms are often less sensitive to Bt.) This product is widely available at Colorado nurseries.

Sources: 9, 12, 20, 21, 22, 30, 31, 34, 36

***Bacillus thuringiensis* var. *israelensis*** – The *israelensis* (or H-14) strain of *Bacillus thuringiensis* is effective for control of certain fly larvae, notably mosquitoes, blackflies, and fungus gnats. (It is not effective against houseflies, blowflies, shore flies and many other fly species.) Formulations sold for use as a soil drench to control fungus gnats include Knock-Out Gnats, Gnatrol, Vectobac, Mosquito Dunks, Mosquito Rings, Aquabac, and Bactimos Briquets are sold for use in water to control mosquitoes and blackflies. Mosquito Dunk is carried by some Colorado nurseries.

Sources: 2, 8, 9, 11, 12, 21, 24, 28, 30, 31, 34, 36



***Bacillus thuringiensis* var. *san diego*** — The *san diego* (= *tenebrionis*) strain of *Bacillus thuringiensis* is effective for control of certain leaf beetle larvae, notably Colorado potato beetle and elm leaf beetle. The formulations sold as Novodor and Colorado Potato Beater is available from some suppliers.

Sources: 11, 12, 21, 31

**Milky Spore** – Milky spore is a bacterium (*Bacillus popillae*) that is applied to soil to infect larvae of the Japanese beetle. It is not effective for the white grubs present in Colorado, although other naturally occurring species of milky spore bacteria naturally occur.

Sources: 2, 29, 31, 35

**Parasitic (Predatory) Nematodes/*Heterorhabditis* spp.** – Insect-parasitic nematodes in the genus *Heterorhabditis* are applied to soil as a drench to control larvae of various insects. They are capable of penetrating the body of insect larvae and are the most effective from control of soil-dwelling white grubs and root weevils, as well as caterpillars. Several *Heterorhabditis* species are available, which vary some in pathogenicity to insects and sensitivity to temperature. Among those available are *H. bacteriophora* (= *heliolithidis*) (HeteroMask, Grub-Away, BioStrike Hb, GrubStake Hb), *H. indica* (Grub Stake Hi), *H. marelatus*, and *H. megidis*.

Sources (*Heterorhabditis bacteriophora*): 2, 5, 7, 8, 10, 16, 17, 18, 21, 23, 26, 30, 32, 34, 35, 36, 37, 38

Sources (*Heterorhabditis indica*): 23, 32

Sources (*Heterorhabditis marelatus*): 26, 32

Sources (*Heterorhabditis megidis*): 22

Sources (Unspecified *Heterorhabditis* sp.): 9, 11, 12, 14, 20, 29

**Parasitic (Predatory) Nematodes/*Steinernema* spp.** – Insect-parasitic nematodes in the genus *Steinernema* are similarly applied to soil as a drench to control larvae of various insects. They are somewhat more specific in their host range and do poorly on beetle larvae, but do have a wide range that includes most other insects that have some life stages in soil. Most commonly available is *Steinernema carpocapsae* which is used for control insects such as cutworms, thrips pupae, and fungus gnat larvae. *Steinernema feltiae* (= *bibionis*) (ScanMask, Gnat Not) is thought more effective for control of fly larvae such as fungus gnats and is widely used in greenhouse settings as well as for outdoor use.

Sources (*Steinernema carpocapsae*): 5, 8, 10, 11, 16, 17, 21, 24, 26, 27, 30, 32, 34, 35, 36, 37, 38

Sources (*Steinernema feltiae*): 5, 9, 10, 12, 13, 17, 21, 22, 23, 26, 32

Sources (Unspecified *Steinernema* sp.): 1, 2, 9, 14, 20, 29

***Nosema locustae*/Grasshopper Spore** – A microsporidian parasite of some grasshoppers, *Nosema locustae*, is sold as a bait formulation. It produces a fairly slow developing infection that weakens insects and usually kills them when they are molting. Adult insects are unlikely to be affected. The spores are perishable and should be used fairly soon after manufacture and/or stored with some refrigeration. M&R Durango produces the NoLo bait formulation; Semaspore is produced by Planet Natural.

Sources: 2, 4, 8, 20, 26, 28, 31, 36

***Beauveria bassiana*** – *Beauveria bassiana* is a naturally occurring fungus disease that affects a very wide range of insects - including aphids, whiteflies, psyllids, billbugs and caterpillars. Environmental conditions, particularly humidity, seem critical for the applied spores to successfully germinate and infect insects, a limiting condition often in Colorado. Newly infected insects often are somewhat light brown; when the fungus sporulates it covers the insect with white spores.

Available formulations are sold as Mycotrol and Naturalis.

Sources: 11, 20