BIOLOGICAL CONTROL ORGANISMS FOR INSECTS AND MITES

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

Regulatory Note: Under current pesticide law, biological control organisms that involve microbes – such as bacteria, viruses, or fungi – are classified as pesticides and can only be used on crops for which they are labeled. These are in the section *Pathogens of Insects*. "Higher" organisms used for insect control – such as other insects, predatory mites and nematodes – are exempt and can be used on all crops.

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 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, 5, 8, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 23, 24, 25, 26, 27, 28, 30, 32, 33, 34

Twospotted Lady Beetle. The twospotted lady beetle, *Adalia bipunctata*, is an aphid predator that most commonly forages on shade trees, shrubs, and fruit trees. It is widely established and common in most of North America.

Sources: 7, 23

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. Effectiveness declines during periods of short day length or in cool conditions.

Sources: 4, 5, 6, 7, 10, 12, 13, 14, 19, 20, 21, 23, 25, 26, 28, 30, 33, 34

Whitefly Predator. The lady beetle *Delphastus pusillus* (=*catalinae*) feed on eggs and small nymphs of whitefly, particularly sweetpotato whitefly. High populations of whiteflies must be present to maintain reproduction of these predators.

Sources: 4, 5, 7, 10, 13, 21, 23, 25, 26, 30, 33, 34

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

mites.

Sources (*Stethorus punctillum*): 4, 13, 21, 23, 25, 30, 33, 34
Sources (Unspecified *Stethorus* spp.): 5

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: 6, 14, 20, 21, 23, 30, 34

Scale Predator. The scale picnic beetle**,** *Cybocephalus nipponicus*, is a small black (female) to black/orange (male) beetle. It feeds on armored scales, including euonymus scale, San Jose scale, and elongate hemlock scale. It may also be a predator of other scales.

Sources: 6, 30

Fungus Gnat Predator. The rove beetle, *Atheta coriaria*, develops as a predator of shore flies, fungus gnats and small soil dwelling Diptera larvae. It is also sold to control thrips stages in soil.

Sources: 4, 6, 7, 13, 23, 29, 33

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 is *Chrysoperla rufilabris*, a native of southeastern US mostly associated with trees/shrubs, and *C. carnea*, a native western species found most commonly in agricultural settings. *Chrysoperla 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, 4, 5, 6, 13, 16, 18, 19, 20, 25, 27, 28, 30, 32, 33, 34
Sources (*C. carnea*): 1, 7, 10, 11, 19, 21, 22, 23, 29
Sources (*C. comanche*): 19
Sources (Unspecified *Chrysoperla* spp. and/ or Mixtures): 3, 12, 23, 24, 26
Sources (Unspecified *Chrysoperla* spp.): 3, 5, 6, 10, 12, 13, 17, 18, 20, 26, 28, 31, 34, 35, 42, 44

Brown Lacewing. Barber's brown lacewing (*Sympherobius barberi*) is a species newly available for commercial sale. It is sold in the adult stage for use in suppressing aphids in greenhouses but is native to North America and common in many natural areas of the southern US.

Sources: 23 (Canadian supplier)

Chinese Mantid. The Chinese mantid, *Tenodera aridofolia*, is the only species of commercial trade. They are sold as egg cases (oothecae) each containing approximately 100-200 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 northern areas and may die out where winters are sufficiently harsh. 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, 5, 8, 10, 14, 19, 21, 23, 24, 25, 26, 27, 28, 30, 32, 33

Aphid Predator Midge. Larva of a tiny fly, *Aphidoletes aphidimyza*, develops as a predator of aphids. It can be found outdoors, most commonly in late summer, within aphid colonies. *Aphidoletes 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: 4, 5, 6, 7, 10, 11, 12, 13, 14, 19, 21, 22, 23, 25, 28, 29, 30, 33, 34

Spider Mite Predator Midge. Larvae of the gall midge *Feltiella acarisuga* (=*Therodiplosis persicae*) are sold for control of twospotted spider mite.

Sources: 4, 7, 12, 13, 21, 23, 30, 33, 34

Marmalade Hoverfly. A syrphid fly, *Episyrphus balteatus*, is sold in the pupal stage for use in tomato greenhouses to supplement aphid control and to serve as an incidental pollinator.

Sources: 7

Spider Mite Predators/Predatory Mites. Several species of commercially available predatory mites (Phytoseiidae family) appear to have some particular applications particularly for greenhouse and interiorscape use where humidity is adequate. Each predatory mite species has a range of temperature and humidity under which they are most efficient, and some require humidity conditions rarely reached in arid areas of the country. The more experienced suppliers/producers can provide consultation as to appropriate species to consider.

Sources (*Neoseiulus (=Amblyseius) californicus*): 4, 6, 7, 9, 10, 12, 13, 19, 21, 22, 24, 27, 29, 30, 33, 34
Sources (*Neoseiulus (=Amblyseius) fallacis*): 4, 7, 9, 10, 13, 23, 27, 30, 33, 34
Sources (*Amblyseius andersoni*): 6, 7, 13, 21
Sources (*Galendromus (=Mesoseiulus, = Metaseiulus) occidentalis*): 4, 7, 9, 10, 13, 21, 24, 27, 30, 34
Sources (*Mesoseiulus (=Phytoseiulus) longpipes*): 4, 9, 10, 13, 19, 21, 23, 27, 30, 33, 34
Sources (*Phytoseiulus persimilis*): 4, 6, 7, 9, 12, 13, 18, 19, 20, 21, 22, 23, 24, 27, 28, 29, 30, 33, 34
Sources (Unspecified predatory mites and/or Mixtures): 2, 5, 11, 21, 23, 25, 26, 32, 33

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

Sources (*Amblyseius (=Typhlodromips) swirskii*): 4, 6, 7, 10, 11, 12, 13, 20, 21, 22, 23, 29, 33
Sources (*Neoseiulus (=Amblyseius) cucumeris*): 4, 5, 6, 7, 10, 11, 13, 21, 22, 23, 24, 25, 28, 29, 30, 33, 34
Sources (*Amblyseius degenerans*): 7, 23, 29
Sources (Thrips predators mixed with Pirate Bugs): 11

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 two species are sold commercially.

Sources (*Orius insidiosus*): 4, 5, 6, 7, 10, 12, 13, 14, 18, 20, 21, 23, 25, 28, 29, 30, 33, 34
Sources (*Orius laevigatus*): None
Sources (*Orius majusculus*): 7 (Canadian supplier)

Sources (Thrips predators mixed with Pirate Bugs): 11

Whitefly Predator Bug. *Dicyphus hesperus* is a generalist predator that will feed on whiteflies, thrips, spider mites and insect eggs. It is a member of the insect family Miridae (plant bugs) and will also sometimes feed on plants. It is used primarily to supplement other natural enemies released in tomato greenhouses.

Sources: 23 (Canadian supplier)

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: 6, 7, 13, 23, 28, 30, 33

Zelus renardii. The assassin bug *Zelus renardii* is a generalist predator that feeds on many insects in yards and gardens. It is sold in the egg stage.

Sources: 4

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

Sources (*Hypoaspis miles (=Stratiolaelaps scimitus*)): 4, 5, 6, 7, 10, 11, 13, 20, 21, 22, 23, 25, 28, 29, 30, 33, 34
Sources (*Gaeolaelaps gillespiei*): 23 (Canadian supplier)

Hister Beetle. *Carcinops pumilio* is a species of hister beetle, which are predators of fly larvae. It is sold in the adult stage, primarily for suppression of flies in poultry rearing facilities

Sources: 30

Parasites/Parasitoids of Insects

Trichogramma Wasps. Several species of *Trichogramma* wasps exist, all of which attack and kill various kinds of insect eggs. Insect larvae already hatched are not susceptible to *Trichogramma* attack. Eggs that *Trichogramma* will parasitized are from insects in the order Lepidoptera (moths and butterflies), which includes cutworms, codling moth, cabbageworms and armyworms. 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, 4, 10, 13, 18, 20, 23, 29, 30
Sources (*Trichogramma brassicae*): 4, 6, 10, 13, 14, 18, 20, 29, 30
Sources (*Trichogramma platneri*): 4, 10, 13, 19, 29, 30, 33
Sources (*Trichogramma pretiosum*): 1, 4, 6, 10, 13, 18, 19, 20, 23, 29, 30

Sources (*Trichogramma bactrae*): None
*Sources (*Trichogramma ostriniae*): 23
Sources (Unspecified *Trichogramma* spp. and/or Mixture): 2, 5, 6, 14, 21, 24, 25, 26, 27, 28

Fly Parasites (Fly Predators). Several parasitic wasps develop in the pupae of filth breeding flies, including 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 that develop on manure or other breeding sites produced by confined livestock. They are most widely marketed to suppress flies in horse facilities.

Sources (*Muscidifurax raptor*): 1
Sources (*Muscidifurax zaraptor*): 24
Sources (*Spalangia endius*): 1, 24
Sources (*Nasonia vitripennis*): 24
Sources (Unspecified mixtures of fly parasites): 4, 6, 10, 13, 14, 17, 19, 21, 25, 26, 27, 28, 30, 31, 33

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*): 4, 6, 7, 20, 22, 23, 30, 34
Sources (*Aphidius colemani*): 4, 6, 7, 10, 11, 12, 13, 14, 20, 21, 22, 23, 28, 29, 30, 33, 34
Sources (*Aphidius matricariae*): 5, 7, 13, 23, 25, 30, 33
Sources (*Aphidius ervi*): 4, 6, 7, 11, 13, 20, 21, 22, 29, 30, 34
Sources (Unspecified *Aphidius* species and/or Mixture): 6, 7, 21, 23

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 72^0F). The whitefly parasite is supplied on cards, as developing wasps within whitefly nymphs. The latter turn black when hosting this parasite.

Sources: 4, 5, 6, 7, 10, 11, 13, 14, 19, 20, 21, 22, 23, 24, 25, 26, 28, 29, 30, 33, 34
Sources (Mix of *Encarsia formosa* and *Eretmocerus eremicus*): 7, 11, 20, 22, 23, 30

Sweetpotato Whitefly Parasite. A parasite of whiteflies is *Eretmocerus eremicus*. Originally developed to help manage sweetpotato whitefly it also is an effective natural enemy of greenhouse whitefly. Adult stages may kill many developing whiteflies in the manner of a predator, by puncturing them with the ovipositor then feeding on the hemolymph/blood. Whitefly nymphs parasitized by this insect turn a golden color. Another whitefly parasite, *E. mundus*, also is used to control *Bemisia* spp.

Sources (*Eretmocerus eremicus*): 4, 6, 7, 11, 13, 14, 20, 21, 22, 23, 29, 30, 34
Sources (*Eretmocerus mundus*): 23
Sources (Mix of *Encarsia formosa* and *Eretmocerus eremicus*): 7, 11, 20, 22, 23, 30

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 go into winter dormancy and thus rarely, if ever, survives winters.

Sources: 4, 6, 14, 18, 30, 33

Mealybug Parasitoid. *Anagyrus pseudococci* is a parasitoid of mealybugs in the genera *Psedococcus* (e.g, longtailed mealybug) and *Planococcus* (e.g., citrus mealybug). (Note: The mealybug parasitoid *Leptomastix dactylopii* was widely available in earlier surveys, but apparently is no longer sold in the United States.)

Sources: 7, 13

Armored Scale Parasite/Golden Chalcid. A small parasitic wasp, *Aphytis melinus*, develops in many armored scales associated with interiorscape plants.

Sources: 4, 6, 10, 13, 14, 20, 21, 23, 24, 26, 30

Diamondback moth Parasitoid. *Cotesia plutellae* is a parasitoid of diamondback moth larvae.

Sources (*Cotesia plutellae*): 30

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 sibrica* in cooler temperatures.

Sources (*Diglyphus isaea*): 4, 6, 7, 10, 11, 13, 14, 20, 21, 22, 23, 24, 28, 29, 30, 33
Sources (*Dacnusa sibirica*): 4, 11, 22, 23, 24, 29, 30
Sources (Mixture): 6, 21

Entomopathogenic Nematodes

("Predator Nematodes", "Parasitic Nematodes", "Beneficial Nematodes")

Parasitic (Predatory) Nematodes- *Heterorhabditis* species. 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* (=*heliothidis*) (e.g., HeteroMask, Grub-Away, BioStrike Hb, GrubStake Hb), *H. indica* (e.g., Grub Stake Hi), *H. marelatus*, and *H. megidis.*

Sources (*Heterorhabditis bacteriophora*): 4, 6, 7, 8, 10, 13, 16, 18, 20, 22, 27, 33
Sources (*Heterorhabditis megidis*): 11
Sources (Unspecified *Heterorhabditis* spp.): 1
Source (Unknown predatory nematodes/Mixture of *Heterohabditis* and *Steinernema*): 2, 5, 10, 12, 14, 18, 21, 25, 26, 32, 33

Parasitic (Predatory) Nematodes - *Steinernema* species. 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*) (e.g., 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*): 1, 4, 6, 7, 8, 10, 13, 18, 20, 27, 33
Sources (*Steinernema feltiae*): 1, 4, 6, 7, 8, 10, 11, 13, 16, 19, 20, 23, 24, 27, 28, 30, 33, 34
Sources (*Steinernema kraussei*): 7, 13
Sources (Unspecified *Steinernema* spp.): 1, 22
Source (Unknown predatory nematodes/Mixture of *Heterohabditis* and *Steinernema*): 2, 5, 10, 12, 14, 18,

21, 25, 26, 32, 33

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Pathogens of Insects

Note: Several pathogens of insects have been commercialized. Under federal law those which are formulated to include single cell organisms (bacteria, fungi, viruses) are regulated as pesticides and their use must fully comply with label directions. Insect parasitic nematodes, also included in this section, are exempt from federal regulation.

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, and Foray, among others. 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 nurseries and mail order garden catalogs.

Sources: 11, 16, 19, 20, 21, 27, 28. Also available from a few local nurseries and some garden catalogs.

Bacillus thuringiensis* var. *israelensis. The *israelensis* (or H-14) strain of *Bacillus thuringiensis* is effective for control of certain fly larvae, notably mosquitoes, black flies, and fungus gnats. (It is not effective against house flies, blow flies, shore flies and many other fly species.) Formulations sold for use as a soil drench to control fungus gnats include Knock-Out Gnats and Gnatrol. Vectobac, Mosquito Dunks, Mosquito Rings, Bactimos Briquets are sold for use in water to control mosquitoes and black flies. Increasingly formulations to control mosquito larvae in water are available through nurseries; formulations labeled for fungus gnats are available through mail order (e.g., "Knock Out Gnats") and in some formulations sold in nurseries (e.g., "Mosquito Dunks").

Sources: 4, 10, 15, 19, 20, 23, 24, 27, 28, 30, 33 and many nurseries

Bacillus thuringiensis* var. *galleriae. The *galleriae* strain of *Bacillus thuringiensis* is effective against white grubs and is presently sold as the formulation *grubGone!*

Sources: grubGone!, grubHALT, beetleGone! and beetleJUS are some of the formulations of this newly available product that are presently available through online sources.

Milky Spore. Milky spore is a bacterium (*Paenibacillus* (*=Bacillus) popillae*) that is applied to soil to infect larvae of the Japanese beetle.

Sources: 4, 14, 15, 27, 28

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. 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: 4, 13, 20, 21, 30

Metarhizium anisopliae. *Metarhizium anisopliae* is a ubiquitous fungal pathogen of insects ("green muscardine"). A strain of this (F52) is marketed under the trade name Met52. Granular formulations are sold to be incorporated into soil for control of certain insects with soil stages (e.g., root weevils, thrips). The liquid formulation is labeled for use as a foliar spray or soil drench on ornamental plants, turfgrass and certain vegetables (e.g., onions, cucurbits, peppers, tomatoes) and small fruits (e.g., grape, raspberry, strawberry).

Sources: 8, 13, 20, 28

Fly Fungus. The fungus *Peacilomyces fumosoroseus* is sold under the trade names Preferal and NoFly WP for use on ornamental crops to control aphids and whiteflies. Sustained high humidity is essential for this to effectively infect insects.

Sources: 13

***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^{R} bait formulation; Semaspore^{R} is produced by Planet Natural.

Sources: 4, 6, 10, 13, 19, 20, 21, 24, 27, 28, 33

Insect Viruses. The commercial availability of viruses to control insects is new and they do not yet appear to be distributed through the sources of this survey. However, they can be acquired by direct contact of the manufacturers. Two present manufacturers include Certis USA (http://www.certisusa.com/) and BioTEPP (http://biotepp.com/) and three viruses are distributed. All are allowed for use in certified organic production (OMRI listed).

Codling moth *Granulosis* virus: CYD-X (Certis USA), Virosoft (BioTEPP)
NPV virus of *Heliothis/Helicoverpa*: Gemstar LC (Certis USA)
NPV virus of *Spodoptera*: Spod-X (Certis USA)

Commercially Available Biological Control Organisms - Organization by Associated Pest Groups

Biological control is always only one component of any Integrated Pest Management program. However, the following commercially available organisms may have some application for the following pest groups. The headings used refer to organisms, or groups of organisms, described in the above section.

Pest Group	Potentially Useful Biological Controls
Aphids	Convergent Lady Beetle/Lady beetles, Twospotted Lady Beetle, Green Lacewings, Aphid Predator Midge, Pirate Bugs, Big-eyed Bug, Predatory Plant Bug, Aphid Parasites, *Beauveria bassiana*
Whiteflies	Whitefly Predator, Green Lacewings, Pirate Bugs, Greenhouse Whitefly Parasite, Sweetpotato Whitefly Parasite, *Beauveria bassiana*
Mealybugs	Mealybug Destroyer, Green Lacewings, *Lindorus lopanthae*, Mealybug Parasitoid
Armored Scales	Scale Predators, Green Lacewings, Armored Scale Parasite/Golden Chalcid

Soft Scales	Scale Predators, Green Lacewings
Thrips	Thrips Predators/Predatory Mites, Pirate Bugs, Sixspotted Thrips, Soil Predator Mite, Parasitic (Predatory) Nematodes/*Steinernema* spp., Fungus Gnat Predator
Spider Mites	Spider Mite Destroyer, Spider Mite Predator Midge, Spider Mite Predators/Predatory Mites, Pirate Bugs
Leaf Beetles	Green Lacewings, Spined Soldier Bug, Predatory Plant Bug, *Beauveria bassiana*
Mexican Bean Beetles	Green Lacewings, Predatory Plant Bug, Mexican Bean Beetle Parasite, Spined Soldier Bug
Caterpillars	Green Lacewings, Pirate Bugs, Predatory Plant Bug, Spined Soldier Bug, *Trichogramma* Wasps, Caterpillar Parasites, *Bacillus thuringiensis* var. *kurstaki*, Insect Viruses
Leafminers	Leafminer Parasites
White Grubs	Parasitic (Predatory) Nematodes-*Heterorhabditis* spp.
Grasshoppers	*Nosema locustae*/Grasshopper Spore, Chinese Mantid
Fungus Gnats	Soil Predator Mite, *Bacillus thuringiensis* var. *israelensis*, *Steinernema feltiae*
Mosquitoes	*Bacillus thuringiensis* var. *israelensis*
Flies (Nuisance)	Fly Parasites (Fly Predators), hister beetles

Sources

US and Canadian Suppliers of Biological Controls for Insects and Mites

1. A-1 Unique Insect Control
5504 Sperry Drive
Citrus Heights, CA 95621
Phone: (916) 961-7945
Fax: (916) 967-7082
Email: ladybugs@a-1unique.com
Web site: www.a-1unique.com

2. Allied Aqua
18120 Chianti Ct.
Smithville, MO 64089
Phone: (816) 659-2299
Email: info@alliedaqua.com
Web site: www.alliedaqua.com

3. American Insectaries, Inc.
243 S. Escondido Blvd #318
Escondido, CA 92025
Phone: (760) 747-2920
Fax: (760) 489-0353
Email: info@americaninsectaries.com
Web site: www.americaninsectaries.com

4. ARBICO Organics
10831 N. Mavinee Dr. Ste. 185
Oro Valley, AZ 85737
Phone: (800) 827-2847
Email: info@arbico.com
Web site: www.arbico-organics.com

5. Atlantis Hydroponics
2561 West Point Ave
College Park, GA 30337
Phone: (678) 510-0032
Fax: (678) 510-0037
Web site: www.atlantishydroponics.com

6. Beneficial Insectary
9664 Tanqueray Ct.
Redding, CA 96003
Phone: (530) 226-6300/(800) 477-3715
Fax: (530)226-6310/(888) 472-0708
Email: info@insectary.com
Web site: www.insectary.com
Retail Web site: www.greenmethods.com

7. Biobest Biological Systems
P.O. Box 506
McFarland, CA 93250
Phone: (855) 224-6237
Fax: (661) 792-6880
Email: info@biobest-use.com
Web site: www.biobestgroup.com

8. Biologic Company
P.O. Box 177
Willow Hill, PA 17271
Phone: (717) 349-2789
Fax: (801) 912-7137
Web site: www.biologicco.com

9. Biotactics, Inc.
25139 Briggs Rd.
Romoland, CA 92585
Phone: (951) 943-2819
Fax: (951) 928-2041
Email: sales@benemite.com
Website: www.benemite.com

10. Buglogical Control Systems
P.O. Box 32046
Tuscon, AZ 85751
Phone: (520) 298-4400
Email: info@buglogical.com
Web site: www.buglogical.com

11. Crop King
134 West Drive
Lodi, OH 44254
Phone: (330) 302-4203
Fax: (330) 302-4204
Web site: www.cropking.com

12. EcoSolutions Inc.
2948 Landmark Way
Palm Harbor, FL 34684
Phone: (727) 787-3669
Email: ecosolutions@mindspring.com
Web site: www.ecosolutionsbeneficials.com

13. Evergreen Grower's Supply
15822 SE 114th Ave
Clackamas, OR 97015
Phone: (503) 908-1946
Email: info@evergreengrowers.com
Website: www.evergreengrowers.com

14. Extremely Green Gardening Company
P.O. Box 2021
Abington, MA 02351
Phone: (888) 878-1801
Fax: (781) 878-5582
Email: info@extremelygreen.com
Website: www.extremelygreen.com

15. Gardener's Supply Co.
128 Intervale Rd.
Burlington, VT 05401
Phone: (888) 833-1412
Website: www.gardeners.com

16. Gardens Alive!
5100 Schenley Pl.
Lawrenceburg, IN 47025
Phone: (513) 354-1482
Email: service@gardensalive.com
Website: www.gardensalive.com

17. Great Lakes IPM, Inc.
10220 Church Road
Vestaburg, MI 48891
Phones: (989) 268-5693/(989) 268-5911
(800) 235-0285
Fax: (989) 268-5311
Email: glipm@greatlakesipm.com
Website: www.greatlakesipm.com

18. Green Home
850 24th Ave
San Francisco, CA 94121
Phone: (877) 282-6400
Email: info@greenhome.com
Website: www.greenhome.com

Note: **GreenMethods.com** is the retail site for the Beneficial Insectary, listed above as #6

19. Harmony Farm Supply & Nursery
3244 Gravenstein Hwy North
Sebastapol, CA 95472
Phone: (707) 823-9125
Email: info@harmonyfarm.com
Website: www.harmonyfarm.com

20. Hummert International
4500 Earth City Expressway
Earth City, MO 63045
Phone: (800) 325-3055
Fax: (314) 506-4510
Website: www.hummert.com

21. Hydro-Gardens
8765 Vollmer Rd.
Colorado Springs, CO 80908
Phone: (888) 693-0578
Fax: (800) 634-6362
Email: hgi@hydro-gardens.com
Website: www.hydro-gardens.com

22. Koppert Biological Systems
1502 Old US-23
Howell, MI 48843
Phone: (810) 632-8750
Fax: (810) 632-8770
Email: asktheexpert@koppertonline.com
Website: www.koppertonline.com

23. Natural Insect Control (NIC)
3737 Netherby Rd.
Stevensville, Ontario, Canada, L0S 1S0
Phone: (905) 382-2904
Fax: (905) 382-4418
Email: info@nicniagara.com
Website: www.naturalinsectcontrol.com

24. Natural Pest Controls
8864 Little Creek Dr.
Orangevale, CA 95662
Phone: (916) 726-0855
Email: jhadden@surewest.net
Website: www.natpestco.com

25. Nature's Control
P.O. Box 35
Medford, OR 97501
Phone: (541) 245-6033
Fax: (800) 698-6250
Email: info@naturescontrol.com
Website: www.naturescontrol.com

26. Orcon
P.O. Box 931
Harbor City, CA 90710
Phone: (310) 952-5040
Fax: (310) 830-3025
Website: www.organiccontrol.com

27. Peaceful Valley Farm Supply
P.O. Box 2209, 125 Clydesdale Court
Grass Valley, CA 95945
Phone: (888) 784-1722
Website: www.groworganic.com

28. Planet Natural
1612 Gold Ave.
Bozeman, MT 59715
Phone: (800) 289-6656/(406) 587-5891
Fax: (406) 587-2240
Email: helpdesk@planetnatural.com
Website: www.planetnatural.com

29. Plant Products Co. Ltd.
9900 Mount Elliott St
Detroit, MI 48211
Phone: (248) 661-4378
Email: info@plantproducts.com
Website: www.plantproducts.com

30. Rincon-Vitova Insectaries, Inc.
P.O. Box 1555
Ventura, CA 93002
Phone: (805) 643-5407/(800) 248-2847
Fax: (805) 643-6267
Email: bugnet@rinconvitova.com
Website: www.rinconvitova.com

31. Spalding Laboratories
P.O. Box 10000
Reno, NV 89510
Phone: 1 (888) 562-5696
Fax: 1 (866) 738-9632
Website: www.spalding-labs.com

32. Territorial Seed Company
P.O. Box 158
Cottage Grove, OR 97424
Phone: (800) 626-0866
Fax: (888) 657-3131
Email: info@territorialseed.com
Website: www.territorialseed.com

33. Tip Top Bio-Control
P.O. Box 7614
Westlake Village, CA 91359
Phone: (805) 445-9001
Fax: (805) 482-7846
Email: customerservice@tiptopbio.com
Website: www.tiptopbiocontrol.com

34. IPM Laboratories, Inc.
980 Main Street
Locke, New York 13092
Phone: (315) 497-2063
FAX: (315) 497-3129
Email: ipminfo@ipmlabs.com
Website: www.ipmlabs.com

Another source of lists of biological control suppliers is the **Association of Natural Biological Control Producers**. The web site address is: ANBP.org