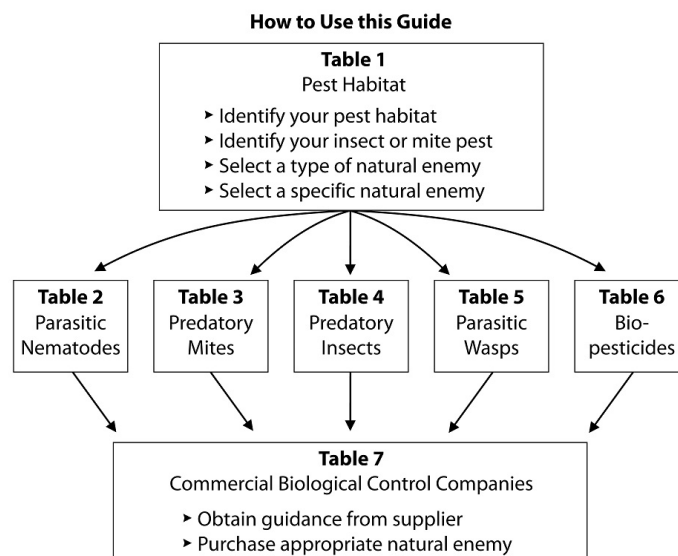


Guidelines for Purchasing and Using Commercial Natural Enemies and Biopesticides in North America¹

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This guide provides assistance in selecting, purchasing, and using commercially available natural enemies and biopesticides for managing accurately diagnosed pest problems. It therefore applies only to situations in which the cause of a pest problem is known and a biological control solution is sought. To choose a commercial natural enemy product, first use Table 1 to locate the habitat of your plant or animal pest and identify the insect or mite. Then, consider using some of the listed types of natural enemies (parasitic nematodes, predatory mites, predatory insects, and parasitic wasps) and biopesticides available to manage these pests. Products often can be used in combination when there is more than one pest problem, and sometimes a product will manage a pest for which it was not intended. The reference numbers correspond with the numbered scientific names of natural enemy and biopesticide products in Tables 2–6. Table 6 provides scientific and product names for some of the most common microbial insecticides, nematicides and fungicides that can be used to manage the indicated types of pests alone or, if compatible, in combination with insect and mite natural enemies. Biopesticides included in Table 6, but not referenced in Table 1, are an insecticide for mosquito larvae (#76), another for grasshoppers (#78), products for nematodes that damage plants (#83 and #84), and eight microbial fungicides (#85–92). The biological

control companies named in Tables 2–6 are listed in Table 7, along with their websites. Sources of information on obtaining and using commercial natural enemies follow in the next section.



Biological control companies typically provide customer service to assure that their products are used appropriately. Information they supply includes the availability and cost of natural enemies and biopesticides, descriptions of target

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pests and their biology, and recommendations for applying and evaluating their products. Product instructions usually indicate the habitats and seasons in which the pests are encountered, developmental stages that are susceptible to parasitism or predation, and relevant behavior of the natural enemies, e.g., how far they move and how many pests they can parasitize or consume. Companies included in the detailed species lists (Tables 2–5), are members of the Association of Natural Biocontrol Producers (ANBP). Producers and distributors belonging to ANBP are preferred because they adhere to a quality assurance policy and code of ethics for the industry and promote research and education on the use of natural enemies. Sources not listed are most garden centers, companies with very limited geographic markets or product lines, suppliers without websites, governmental and other non-commercial producers, so-called big-box stores, and outlets for which information was difficult to find or use.

An easy-to-use guide is available to help customers assess the quality of natural enemies received from suppliers, “Grower Guide: Quality Assurance of Biocontrol Products” (see Sources of Information). It is essential to determine that the purchased living organisms are healthy and able to survive long enough to provide biological control in the pest habitat. Suppliers try to provide high-quality natural enemy products but are unable to control conditions during shipment and handling. Temperature extremes, condensation from ice packs, restricted oxygen supply, high organism densities, and long shipping and storage times are some of the factors that can adversely affect natural enemy quality. Therefore, customers should open packages immediately on arrival to provide a better environment for the organisms and detect any potential problems. At least, packages should be inspected for condensation or a fermenting smell, and the number of living and dead organisms should be estimated. If pupae or parasitized host organisms are shipped, the number of emerging adults should be recorded; a sex ratio of at least 40–45% females is expected. Customers are advised to make sure that most eggs hatch or adults are able to move, if products are shipped in these stages of development. Notes should be made on the product name, company batch number, date received, packaging type and condition, number of organisms in the package, and any other pertinent observations on the appearance and performance of the product. After completing the general check, customers can perform additional quality assurance testing, recording the test methods, number of organisms tested and date, or use the products as soon as possible. The supplier should be notified immediately if there is a problem with the products.

Customers who use biological control products generally want to be directly involved in solving their pest problems. This involvement is essential because products must first be selected and deployed according to general instructions and subsequently evaluated for site-specific effectiveness. It may be necessary to try different products or application procedures, or to modify the environment in ways that enhance the impact of natural enemies. This may involve changing how plants are grown or adding food, companion plants and refuges for natural enemies. The impacts of commercial natural enemies can be limited to the stage that is released or be long-term if they reproduce and become established. Typically, several pests are present and, if some must be managed with pesticides, it is necessary to know which pesticides are compatible with the natural enemies. Other considerations are how to release the natural enemies and in what developmental stages. They can be introduced, for example, on special plants with non-pest hosts, so called “banker plants,” added as eggs, or allowed to fly from release containers. These kinds of considerations may be addressed in instructions from the source companies or gleaned from the references in this guide.

Commercial biological control products described in this guide have been thoroughly tested and given federal and state approval to assure that they can be released into the environment safely. The products are marketed directly by producers or provided by suppliers after obtaining the necessary shipping permits for natural enemies or EPA registrations for biopesticides. Only products (nematodes, mites, and insects) that are insectary-reared, as opposed to field collected (e.g., lady beetles), and biopesticides that appear to be useful and available in North America are included. The guide will be updated periodically because products may be discontinued and new ones become available. Companies with ANBP membership will be contacted directly for their updated information. Specialized products, such as those used for weed management, have been excluded from the guide. More biological control products and sources can be derived from the internet and additional companies that sell natural enemies are listed in the last table.

Table 1. Habitats of plant or animal pests in North America, typical pests, type of commercial natural enemies available to manage each pest, and species reference number.

Habitats of Plant or Animal Pests	Identified Pest	Commercial Natural Enemies	
		Type	No. (see Tables 2–6)
Citrus	aphids	predatory insects	30, 32, 36–38, 40
		microbial insecticides	77, 80
	beetles (grubs)	parasitic nematodes	3, 8
		microbial insecticides	74, 77, 81
	caterpillars	predatory insects	35–38, 40
		parasitic wasps	66, 67
		microbial insecticides	71, 73, 79, 81
	mealybugs	predatory insects	23, 25, 40
		parasitic wasps	54
	mites	predatory mites	18, 19
	scales	predatory insects	25
		parasitic wasps	43, 55
	thrips	predatory mites	16
		predatory insects	32, 40
		microbial insecticides	81
	whiteflies	predatory insects	24, 32, 36–38, 40
Fruits, Vegetables, and Tree Crops	aphids	predatory insects	30, 32, 33, 36–38, 39, 40
		parasitic wasps	42, 47–49
		microbial insecticides	77, 80
	beetles (grubs)	parasitic nematodes	2
		predatory insects	35
		parasitic wasps	57
		microbial insecticides	74, 75, 77, 81
	caterpillars	predatory insects	24, 32, 36–38, 40
		parasitic wasps	50, 51, 66, 67, 70
		microbial insecticides	71, 73, 79, 81
	fungus gnats	predatory insects	12, 29
		microbial insecticides	72
	leafminers	parasitic wasps	52, 56
		microbial insecticides	81
	mealybugs	predatory insects	23, 25, 39, 40, 54
	mites	predatory mites	17–20, 22
		predatory insects	31, 41
	scales	predatory insects	25, 27
	thrips	predatory mites	12, 15, 18
		predatory insects	29, 32, 40, 36–38
		microbial insecticides	81
	whiteflies	predatory mites	16
		predatory insects	23, 32–34, 36–38, 39, 40
	psyllids (tomato/potato psyllid)	parasitic wasps	58
	<i>Lygus</i> bugs (strawberries)	parasitic wasps	53
	root-knot nematode (greenhouse tomatoes)	parasitic nematodes	6

Ornamental Plants and Landscapes	aphids	predatory insects	30, 32, 33, 36–38, 39, 40
		parasitic wasps	42, 47–49
		microbial insecticides	77, 80, 81
	beetles (grubs)	parasitic nematodes	1–3, 7, 11
		predatory insects	35–38
		microbial insecticides	74, 75, 77, 81
	caterpillars	predatory insects	24, 32, 36–38, 40
		parasitic wasps	66, 70
		microbial insecticides	71, 73, 79, 81
	fungus gnats	parasitic nematodes	5, 11
		predatory mites	12, 13
		predatory insects	25, 29
		microbial insecticides	72
	leafminers	parasitic nematodes	5
		parasitic wasps	52, 56
		microbial insecticides	81
	mealybugs	parasitic nematodes	1
		predatory insects	23, 25, 39, 40
		parasitic wasps	55
	mites	predatory mites	17–22
		predatory insects	31
	scales	predatory insects	25, 27
	thrips	parasitic nematodes	5, 11
predatory mites		12, 13, 15, 16, 18	
predatory insects		29, 32, 36–38, 40	
microbial insecticides		81	
whiteflies	predatory mites	16	
	predatory insects	24, 32, 34, 36–39, 40	

Greenhouses and Interiorscapes	aphids	predatory insects	30, 33, 39, 40
		parasitic wasps	42, 44, 47–49
		microbial insecticides	77, 80, 82
	caterpillars (eggs)	predatory insects	24, 32, 36–38, 40
		parasitic wasps	66
		microbial insecticides	71, 73, 79, 81
	fungus gnats	parasitic nematodes	4
		predatory mites	13
		predatory insects	29
		microbial insecticides	72
	leafminers	parasitic wasps	52, 56
		microbial insecticides	81
	mealybugs	predatory insects	23, 39, 40
		parasitic wasps	55, 56
	mites	predatory mites	17–22
		predatory insects	31
	scales	predatory insects	27
		parasitic wasps	43, 55
	thrips	predatory mites	13, 18
		predatory insects	29
microbial insecticides		81	
whiteflies	predatory insects	24, 33, 34, 39, 40	
	parasitic wasps	44–46	
Turf and Lawns	caterpillars	parasitic nematodes	9
		microbial insecticides	71, 73, 79, 81
	beetles (grubs)	parasitic nematodes	9, 11
		microbial insecticides	74, 77, 81
mole crickets	parasitic nematodes	8, 11	
Animal Waste	filth flies	predatory insects	28
		parasitic wasps	59–66

Table 2. Parasitic nematodes. Numbered biological control products [family, genus and species], some target pests, and source companies.

Parasitic Nematodes	
Heterorhabditidae	Source Company (see Table 7)
1. <i>Heterorhabditis bacteriophora</i> (cucumber, scarab, Japanese and flea beetles, thrips, white grubs, corn root worms, Colorado potato beetles, black vine weevils, and root mealybugs, on ornamentals, trees and shrubs)	Crop Defenders • Syngenta Bioline • Buglogical Control Systems • Hydro-Gardens • Distribuciones IMEX S.A. de C.V. • Green Methods • Evergreen Growers Supply • Rincon-Vitova • IPM Laboratories • Sound Horticulture • BASF • ARBICO • BioWorks • Beneficial Insectary • Tip Top Bio-Control • Natural Insect Control • Sierra Biological • Bio Control Solution • Biobest • Koppert • M&R Durango • Entomology Solutions
2. <i>Heterorhabditis megidis</i> (vine weevil larvae on ornamentals, trees, shrubs and strawberries)	Natural Insect Control • Bio Control Solution • Koppert
3. <i>Heterorhabditis</i> spp. (vine weevil larvae and other soil borne beetle larvae on ornamentals, trees and shrubs)	Hydro-Gardens • Natural Insect Control • Beneficial Insectary • M&R Durango • IPM Laboratories • Syngenta Bioline • Green Methods • Koppert
Steinernematidae	
4. <i>Steinernema carpocapsae</i> (fungus gnats on potted plants)	Sierra Biological • Natural Insect Control • Entomology Solutions • Buglogical Control Systems • BASF • Koppert • Rincon-Vitova • Hydro-Gardens • Beneficial Insectary • M&R Durango • Green Methods • IPM Laboratories • ARBICO • Sound Horticulture • Syngenta Bioline • Biobest • Crop Defenders • Tip Top Bio-Control • Evergreen Growers Supply
5. <i>Steinernema feltiae</i> (thrips, fungus gnats and leafminers on ornamentals)	Green Methods • Syngenta Bioline • Crop Defenders • M&R Durango • Buglogical Control Systems • EcoSolutions • Sierra Biological • Tip Top Bio-Control • Hydro-Gardens • Natural Insect Control • BioWorks • Koppert • ARBICO • Rincon-Vitova • Beneficial Insectary • Biobest • Bio Control Solution • Entomology Solutions • BASF • Orcon • Distribuciones IMEX S.A. de C.V. • IPM Laboratories • Sound Horticulture • Evergreen Growers Supply
6. <i>Steinernema feltiae</i> MG-13 (root-knot nematodes on greenhouse tomatoes)	Sierra Biological
7. <i>Steinernema kraussei</i> (black vine weevil)	Biobest • ARBICO • Rincon-Vitova • Evergreen Growers Supply • Sound Horticulture • BASF
8. <i>Steinernema riobrave</i> (mole crickets, root weevils on citrus)	Sierra Biological • Sound Horticulture
9. <i>Steinernema</i> spp. (grubs, caterpillars, and fungus gnats)	Green Methods • Natural Insect Control • Hydro-Gardens • IPM Laboratories • Beneficial Insectary
Other Nematode Mixes	
10. <i>Heterorhabditis bacteriophora</i> and <i>Steinernema carpocapsae</i> (soil borne pests)	Sierra Biological • Entomology Solutions • Sound Horticulture
11. <i>Steinernema feltiae</i> and <i>Heterorhabditis</i> spp. mix (soil borne pests)	Hydro-Gardens • ARBICO • Entomology Solutions • Natural Insect Control

Table 3. Predatory mites. Numbered biological control products [family, genus and species], some target pests, and source companies.

Predatory Mites	
Laelapidae	Source Company (see Table 7)
12. <i>Gaeolaelaps gillespiei</i> (fungus gnats, thrips)	Crop Defenders • Anatis Bioprotection • Natural Insect Control • Applied Bio-nomics
13. <i>Stratiolaelaps scimitus</i> (also called <i>Hypoaspis</i> or <i>Stratiolaelaps miles</i>) (fungus gnats and thrips on potted plants, bedding plants, and seedlings)	Sound Horticulture • Evergreen Growers Supply • Natural Insect Control • Beneficial Insectary • Everwood Farm • IPM Laboratories • Natural Enemies • Green Methods • Hydro-Gardens • Crop Defenders • EcoSolutions • Buglogical Control Systems • Syngenta Bioline • Tip Top Bio-Control • M&R Durango • Anatis Bioprotection • Rincon-Vitova • Entomology Solutions • Biobest • Applied Bio-nomics • Koppert • ARBICO • Bio Control, S.A.
Phytoseiidae	
14. <i>Amblyseius andersoni</i> (spider, russet, rust and broad mite)	IPM Laboratories • Green Methods • Hydro-Gardens • Rincon-Vitova • Syngenta Bioline • Entomology Solutions • ARBICO • Biobest • Sound Horticulture • Evergreen Growers Supply • Crop Defenders • Beneficial Insectary
15. <i>Amblyseius degenerans</i> (also called <i>Iphiseius degenerans</i>) (thrips, broad and spider mites on peppers and ornamentals)	Bio Control, S.A. • Natural Insect Control • Distribuciones IMEX S.A. de C.V. • Biobest • Crop Defenders
16. <i>Amblyseius swirskii</i> (whiteflies and thrips on vegetables, melons, and ornamentals)	Evergreen Growers Supply • Biobest • Natural Insect Control • ARBICO • Green Methods • Distribuciones IMEX S.A. de C.V. • EcoSolutions • Crop Defenders • Rincon-Vitova • IPM Laboratories • BioWorks • Tip Top Bio-Control • Syngenta Bioline • Hydro-Gardens • Beneficial Insectary • Koppert • Bio Control, S.A. • Everwood Farm • Sound Horticulture
17. <i>Neoseiulus californicus</i> (formerly called <i>Amblyseius californicus</i>) (two-spotted spider, broad and cyclamen mites on ornamentals, vegetables, fruit, and potted plants)	Associates Insectary • Beneficial Insectary • Hydro-Gardens • Koppert • Buglogical Control Systems • EcoSolutions • Crop Defenders • Bio Control, S.A. • Syngenta Bioline • ARBICO • Distribuciones IMEX S.A. de C.V. • Evergreen Growers Supply • Sound Horticulture • Rincon-Vitova • Everwood Farm • Biobest • Natural Insect Control • M&R Durango • Tip Top Bio-Control • Green Methods • IPM Laboratories • Orcon
18. <i>Neoseiulus cucumeris</i> (formerly called <i>Amblyseius cucumeris</i>) (two-spotted spider mite and tarsonemid mites, and flower thrips on all crops)	Tip Top Bio-Control • Bio Control, S.A. • Koppert • Rincon-Vitova • Distribuciones IMEX S.A. de C.V. • Anatis Bioprotection • Entomology Solutions • Natural Insect Control • Applied Bio-nomics • Hydro-Gardens • Beneficial Insectary • Sound Horticulture • Crop Defenders • Buglogical Control Systems • M&R Durango • IPM Laboratories • Biobest • EcoSolutions • Natural Enemies • Everwood Farm • ARBICO • Evergreen Growers Supply • Green Methods • Syngenta Bioline • Orcon
19. <i>Neoseiulus fallacis</i> (formerly called <i>Amblyseius fallacis</i>) (two-spotted spider, European red, and citrus red mites on many crops)	EcoSolutions • ARBICO • Beneficial Insectary • Entomology Solutions • Tip Top Bio-Control • Biobest • Applied Bio-nomics • Anatis Bioprotection • Rincon-Vitova • Sound Horticulture • ARBICO • Green Methods • Crop Defenders • Natural Enemies • IPM Laboratories • Evergreen Growers Supply • M&R Durango • Natural Insect Control
20. <i>Galendromus occidentalis</i> (spider, eriophyid, and russet mites on ornamentals and vegetables in greenhouses and interiorscapes)	IPM Laboratories • ARBICO • Evergreen Growers Supply • Buglogical Control Systems • EcoSolutions • Biobest • Hydro-Gardens • Natural Insect Control • Rincon-Vitova • Sound Horticulture
21. <i>Mesoseiulus longipes</i> (also called <i>Phytoseiulus longipes</i>) (two spotted spider mites in greenhouses and interiorscapes)	M&R Durango • Natural Insect Control • Hydro-Gardens • Evergreen Growers Supply • Sound Horticulture • Buglogical Control Systems • IPM Laboratories • ARBICO • EcoSolutions • Rincon-Vitova • Tip Top Bio-Control
22. <i>Phytoseiulus persimilis</i> (spider mites on many crops)	Entomology Solutions • Anatis Bioprotection • Green Methods • GrowLiv • Tip Top Bio-Control • Koppert • Biobest • Rincon-Vitova • Hydro-Gardens • Orcon • EcoSolutions • Applied Bio-nomics • Buglogical Control Systems • Natural Enemies • Everwood Farm • Crop Defenders • Sound Horticulture • Distribuciones IMEX S.A. de C.V. • ARBICO • IPM Laboratories • M&R Durango • Evergreen Growers Supply • Syngenta Bioline • Bio Control, S.A. • Beneficial Insectary • Natural Insect Control

Table 4. Predatory insects. Numbered biological control products [family, genus and species], some target pests. and source companies.

Predatory Insects	
Coleoptera	
Coccinellidae	Source Company (see Table 7)
23. <i>Cryptolaemus montrouzieri</i> Mealybug destroyer (mealybugs on citrus, ornamentals, and vegetables, including greenhouses and interiorscapes)	IPM Laboratories • Evergreen Growers Supply • Beneficial Insectary • Associates Insectary • Hydro-Gardens • Natural Enemies • Buglogical Control Systems • Bio Control, S.A. • Foothill Agricultural Research • Sound Horticulture • Biobest • Everwood Farm • Green Methods • Koppert • Natural Insect Control • Orcon • Syngenta Bioline • Entomology Solutions • EcoSolutions • Rincon-Vitova • M&R Durango • Distribuciones IMEX S.A. de C.V. • Tip Top Bio-Control • ARBICO
24. <i>Delphastus catalinae</i> Whitefly predator (greenhouse, banded-winged, sweetpotato, woolly, azalea, hibiscus, cloudywinged, citrus, and rhododendron whiteflies on ornamentals, vegetables, fruit, and citrus, including greenhouses and interiorscapes)	Orcon • Biobest • Crop Defenders • Anatis Bioprotection • Entomology Solutions • Applied Bio-nomics • Tip Top Bio-Control • Natural Enemies • Koppert • Sound Horticulture • ARBICO • Natural Insect Control • Evergreen Growers Supply • Rincon-Vitova • IPM Laboratories
25. <i>Rhyzobius lophanthae</i> (also called <i>Lindorus lophanthae</i>) (hard and soft scales and mealybugs on ornamentals, vegetables, citrus and fruit)	Evergreen Growers Supply • M&R Durango • Rincon-Vitova • Hydro-Gardens • Sound Horticulture • IPM Laboratories • Green Methods • ARBICO • Natural Insect Control • Beneficial Insectary • EcoSolutions
26. <i>Stethorus punctillum</i> (two-spotted spider mites)	Applied Bio-nomics • Natural Insect Control • Crop Defenders • Sound Horticulture • Beneficial Insectary • ARBICO • Anatis Bioprotection • Tip Top Bio-Control • Natural Enemies • Evergreen Growers Supply • Entomology Solutions • IPM Laboratories • Green Methods • Rincon-Vitova
Cybocephalidae	
27. <i>Cybocephalus nipponicus</i> Scale picnic beetle (euonymus and San Jose scale on ornamentals, vegetables, and fruit, including greenhouses and interiorscapes)	Rincon-Vitova • Beneficial Insectary
Histeridae	
28. <i>Carcinops pumilio</i> (flies in manure)	Beneficial Insectary • Anatis Bioprotection • Entomology Solutions • IPM Laboratories
Staphylinidae	
29. <i>Dalotia coriaria</i> (also called <i>Atheta coriaria</i>) (fungus gnats, shore flies and thrips in vegetables and ornamentals, including greenhouses and interiorscapes)	ARBICO • Evergreen Growers Supply • Tip Top Bio-Control • Entomology Solutions • Sound Horticulture • Natural Insect Control • Rincon-Vitova • Biobest • Natural Enemies • M&R Durango • Syngenta Bioline • Bio Control, S.A. • Green Methods • Applied Bio-nomics • Beneficial Insectary • IPM Laboratories • Anatis Bioprotection
Diptera	
Cecidomyiidae	
30. <i>Aphidoletes aphidimyza</i> (aphids in citrus, ornamentals, fruits, and vegetables, including greenhouses and interiorscapes)	Anatis Bioprotection • Rincon-Vitova • Natural Enemies • Applied Bio-nomics • ARBICO • Green Methods • Buglogical Control Systems • Syngenta Bioline • Natural Insect Control • M&R Durango • Beneficial Insectary • Everwood Farm • Biobest • Evergreen Growers Supply • Sound Horticulture • Tip Top Bio-Control • Distribuciones IMEX S.A. de C.V. • EcoSolutions • Entomology Solutions • Orcon • Bio Control, S.A. • IPM Laboratories • Hydro-Gardens • Crop Defenders • Koppert
31. <i>Feltiella acarisuga</i> (spider mites in ornamentals and vegetables, including greenhouses and interiorscapes)	Rincon-Vitova • Tip Top Bio-Control • Koppert • ARBICO • Hydro-Gardens • EcoSolutions • Biobest • Bio Control, S.A. • Crop Defenders • Distribuciones IMEX S.A. de C.V. • IPM Laboratories • Everwood Farm • Natural Insect Control
Hemiptera	
Anthocoridae	
32. <i>Orius insidiosus</i> Minute pirate bug (thrips, aphids, and whiteflies on ornamentals, vegetables, and citrus, including greenhouses and interiorscapes)	Koppert • Bio Control, S.A. • GrowLiv • Hydro-Gardens • Natural Insect Control • Syngenta Bioline • Tip Top Bio-Control • Evergreen Growers Supply • Everwood Farm • Biobest • Distribuciones IMEX S.A. de C.V. • M&R Durango • Green Methods • Rincon-Vitova • IPM Laboratories • Beneficial Insectary • Sound Horticulture • Crop Defenders • Anatis Bioprotection • ARBICO • EcoSolutions • Entomology Solutions

Reduviidae	
33. <i>Zelus renardii</i> Assassin bug (generalist predator)	ARBICO
Miridae	
34. <i>Dicyphus hesperus</i> (greenhouse and tobacco whiteflies)	Biobest • GrowLiv
Pentatomidae	
35. <i>Podisus maculiventris</i> Spined soldier bug (Colorado potato beetles and caterpillars on ornamentals, vegetables, and citrus)	ARBICO • Crop Defenders • Entomology Solutions • Beneficial Insectary • Biobest • Anatis Bioprotection • Sound Horticulture • Rincon-Vitova • Green Methods • Natural Insect Control • IPM Laboratories
Neuroptera	
Chrysopidae	
36. <i>Chrysoperla carnea</i> Green lacewing (aphids and other small soft bodied insects on ornamentals, citrus, fruit, and vegetables)	GrowLiv • Syngenta Bioline • Natural Insect Control • Biobest • Bio Control, S.A. • Buglogical Control Systems • Everwood Farm • Hydro-Gardens • Anatis Bioprotection • Orcon • Koppert
37. <i>Chrysoperla rufilabris</i> Green lacewing (aphids and other small soft bodied insects on ornamentals, citrus, fruit, and vegetables)	ARBICO • Crop Defenders • Green Methods • Tip Top Bio-Control • Entomology Solutions • Sound Horticulture • IPM Laboratories • Rincon-Vitova • Natural Insect Control • Beneficial Insectary
38. <i>Chrysoperla spp.</i> Lacewing (aphids and other small soft bodied insects on ornamentals, citrus, fruit, and vegetables)	Anatis Bioprotection • M&R Durango • Beneficial Insectary • ARBICO • EcoSolutions • Evergreen Growers Supply • Green Methods • Kunafin • Natural Insect Control
Hemerobiidae	
39. <i>Micromus variegatus</i> Brown lacewing (aphids, whiteflies, and mealybugs on vegetables and ornamentals)	Applied Bio-nomics • Crop Defenders • Natural Insect Control • Anatis Bioprotection
40. <i>Sympherobius barberi</i> Brown lacewing (mealybugs, psyllids, thrips, mites, whiteflies, aphids, small caterpillars, leafhoppers, and insect eggs on grapes, citrus, tree crops, and greenhouse crops)	Foothill Agricultural Research • Sound Horticulture • ARBICO • Rincon-Vitova
Thysanoptera	
Thripidae	
41. <i>Scolothrips sexmaculatus</i> (spider mites on fruit trees)	ARBICO

Table 5. Parasitic wasps. Numbered biological control products [family, genus and species], some target pests, and source companies.

Parasitic wasps	
Hymenoptera	
Aphelinidae	Source Company (see Table 7)
42. <i>Aphelinus abdominalis</i> (potato aphids on ornamentals, fruits, and vegetables, including greenhouses)	ARBICO • Crop Defenders • Distribuciones IMEX S.A. de C.V. • Rincon-Vitova • Bio Control, S.A. • Koppert • IPM Laboratories • Evergreen Growers Supply • Syngenta Bioline • Sound Horticulture • Green Methods • Natural Insect Control • Beneficial Insectary • Everwood Farm • Biobest
43. <i>Aphytis melinus</i> (oleander and citrus scales, including greenhouses)	Hydro-Gardens • Natural Insect Control • IPM Laboratories • Koppert • EcoSolutions • Beneficial Insectary • M&R Durango • Orcon • Rincon-Vitova • Tip Top Bio-Control • Sound Horticulture • Foothill Agricultural Research • Evergreen Growers Supply • ARBICO • Associates Insectary • Green Methods • Sespe Creek Insectary
44. <i>Encarsia formosa</i> (whiteflies in greenhouses)	Koppert • Biobest • Natural Insect Control • Entomology Solutions • IPM Laboratories • Evergreen Growers Supply • Crop Defenders • Everwood Farm • Anatis Bioprotection • Orcon • Bio Control, S.A. • Buglogical Control Systems • Rincon-Vitova • Green Methods • ARBICO • Beneficial Insectary • M&R Durango • Hydro-Gardens • Tip Top Bio-Control • Applied Bio-nomics • Sound Horticulture • Syngenta Bioline
45. <i>Eretmocerus eremicus</i> (sweetpotato whiteflies, including greenhouses and interiorscapes)	GrowLiv • M&R Durango • Anatis Bioprotection • Beneficial Insectary • Sound Horticulture • ARBICO • Green Methods • Tip Top Bio-Control • Distribuciones IMEX S.A. de C.V. • IPM Laboratories • Biobest • Syngenta Bioline • Natural Insect Control • Koppert • Rincon-Vitova • Bio Control, S.A. • Evergreen Growers Supply • Hydro-Gardens • Crop Defenders • Everwood Farm
46. <i>Eretmocerus mundus</i> (sweetpotato and tobacco whiteflies in greenhouses)	Bio Control, S.A. • Koppert • Natural Insect Control
Aphidiidae	
47. <i>Aphidius colemani</i> (cotton, melon, green peach, and other aphids on vegetables, fruit, and ornamentals, including greenhouses and interiorscapes)	Sound Horticulture • Everwood Farm • Entomology Solutions • Natural Insect Control • M&R Durango • Distribuciones IMEX S.A. de C.V. • IPM Laboratories • Bio Control, S.A. • Green Methods • Tip Top Bio-Control • Beneficial Insectary • GrowLiv • Evergreen Growers Supply • Rincon-Vitova • Buglogical Control Systems • ARBICO • Koppert • Hydro-Gardens • Biobest • Syngenta Bioline • Crop Defenders
48. <i>Aphidius ervi</i> (potato, pea, and green peach aphids on vegetables, fruit, and ornamentals, including greenhouses and interiorscapes)	Green Methods • M&R Durango • Crop Defenders • Sound Horticulture • Distribuciones IMEX S.A. de C.V. • Beneficial Insectary • Syngenta Bioline • Entomology Solutions • Rincon-Vitova • Tip Top Bio-Control • Hydro-Gardens • ARBICO • Biobest • Everwood Farm • Koppert • Evergreen Growers Supply • Natural Insect Control • IPM Laboratories • Bio Control, S.A.
49. <i>Aphidius matricariae</i> (green peach aphids on vegetables, fruit, and ornamentals, including greenhouses and interiorscapes)	M&R Durango • Crop Defenders • Evergreen Growers Supply • Sound Horticulture • Tip Top Bio-Control • Anatis Bioprotection • Biobest • IPM Laboratories • Natural Insect Control • EcoSolutions
Bethylidae	
50. <i>Goniozus legneri</i> (navel orangeworm on almonds)	Rincon-Vitova
Braconidae	
51. <i>Cotesia vestalis</i> (also known as <i>Cotesia plutellae</i>) (diamondback moth on cruciferous crops)	ARBICO
52. <i>Dacnusa sibirica</i> (leafminers on vegetables, fruit and ornamentals, including greenhouses and interiorscapes)	Beneficial Insectary • Entomology Solutions • Natural Insect Control • Bio Control, S.A. • Evergreen Growers Supply • Everwood Farm • ARBICO • Koppert • Hydro-Gardens • Sound Horticulture • IPM Laboratories • Rincon-Vitova
53. <i>Peristenus relictus</i> (<i>Lygus</i> bugs in strawberries)	Rincon-Vitova
Encyrtidae	
54. <i>Anagyrus pseudococci</i> (mealybugs on grapes and citrus)	Koppert • Rincon-Vitova • ARBICO • Foothill Agricultural Research • Associates Insectary • Biobest
55. <i>Metaphycus</i> spp. (black, brown, and other scales in citrus, including greenhouses, and interiorscapes)	EcoSolutions • Hydro-Gardens

Eulophidae	
56. <i>Diglyphus isaea</i> (vegetable, tomato, serpentine, and chrysanthemum leafminers on vegetables, fruit, and ornamentals, and in greenhouses and interiorscapes)	Biobest • Distribuciones IMEX S.A. de C.V. • IPM Laboratories • Bio Control, S.A. • Sound Horticulture • Rincon-Vitova • Natural Insect Control • Syngenta Bioline • Koppert • Beneficial Insectary • Evergreen Growers Supply • Green Methods • ARBICO • Hydro-Gardens • Everwood Farm
57. <i>Pediobius foveolatus</i> (Mexican bean beetle on vegetables)	Entomology Solutions • ARBICO • IPM Laboratories • Beneficial Insectary • Sound Horticulture • Rincon-Vitova • Green Methods
58. <i>Tamarixia triozae</i> (tomato or potato psyllid, on tomato, sweet and hot pepper, and eggplant)	Biobest • Distribuciones IMEX S.A. de C.V.
Pteromalidae	
59. <i>Muscidifurax raptor</i> (flies in garbage, manure, and compost)	Beneficial Insectary • Natural Insect Control • Entomology Solutions • Anatis Bioprotection • IPM Laboratories
60. <i>Muscidifurax raptorellus</i> (flies in garbage, manure, and compost)	Anatis Bioprotection • Tip Top Bio-Control • ARBICO • Spalding Laboratories • Entomology Solutions • Green Methods • Evergreen Growers Supply • Natural Insect Control • Beneficial Insectary • IPM Laboratories • M&R Durango • Rincon-Vitova • Koppert
61. <i>Muscidifurax zaraptor</i> (flies in garbage, manure, and compost)	Evergreen Growers Supply • Buglogical Control Systems • Natural Insect Control • Beneficial Insectary • Rincon-Vitova • Green Methods • Entomology Solutions • Spalding Laboratories • ARBICO • M&R Durango
62. <i>Muscidifurax</i> spp. (flies in garbage, manure, and compost)	Beneficial Insectary • Entomology Solutions • Rincon-Vitova • Sound Horticulture • IPM Laboratories • ARBICO • Green Methods
63. <i>Nasonia vitripennis</i> (flies in garbage, manure, and compost)	ARBICO • Buglogical Control Systems
64. <i>Spalangia cameroni</i> (flies in garbage, manure, and compost)	Spalding Laboratories • Entomology Solutions • Rincon-Vitova • Beneficial Insectary • Green Methods • Evergreen Growers Supply
65. <i>Spalangia endius</i> (flies in garbage, manure, and compost)	Kunafin • Entomology Solutions • Beneficial Insectary
Trichogrammatidae	
66. <i>Trichogramma brassicae</i> (caterpillar eggs on vegetables, fruit, citrus, and ornamentals, including greenhouse, and interiorscapes)	Koppert • Tip Top Bio-Control • Natural Insect Control • Orcon • Entomology Solutions • Anatis Bioprotection • Beneficial Insectary • IPM Laboratories • Kunafin • ARBICO • Green Methods • Sound Horticulture • Rincon-Vitova • M&R Durango • Biobest • Evergreen Growers Supply • Syngenta Bioline • Buglogical Control Systems
67. <i>Trichogramma minutum</i> (caterpillar eggs on fruit trees in eastern U.S. orchards)	Buglogical Control Systems • Green Methods • Anatis Bioprotection • IPM Laboratories • Rincon-Vitova • M&R Durango • Orcon • Tip Top Bio-Control • Beneficial Insectary • Evergreen Growers Supply • ARBICO • Entomology Solutions • Natural Insect Control
68. <i>Trichogramma ostriniae</i> (European corn borer on corn and peppers, and grape berry moth on grapes)	Natural Insect Control • IPM Laboratories • Entomology Solutions • Anatis Bioprotection
69. <i>Trichogramma platneri</i> (caterpillar eggs in fruit trees in western U.S. orchards)	ARBICO • Evergreen Growers Supply • Entomology Solutions • Rincon-Vitova
70. <i>Trichogramma pretiosum</i> (moth eggs on vegetables, field crops, and ornamentals)	Koppert • Evergreen Growers Supply • Orcon • Sound Horticulture • Rincon-Vitova • Natural Insect Control • Buglogical Control Systems • IPM Laboratories • Green Methods • M&R Durango • Hydro-Gardens • Beneficial Insectary • Bio Control, S.A. • Tip Top Bio-Control • Entomology Solutions

Table 6. Biopesticides. Microbial insecticides, nematicides, and fungicides (genus and species, product names, and some target pests). Check the **IR-4 Searchable Database for Biopesticide and Organic Pest Management Solutions** to locate companies currently marketing these products (<http://ir4.rutgers.edu/Biopesticides/LabelDatabase/index.cfmlinks>).

Biopesticides
Microbial Insecticides
71. <i>Bacillus thuringiensis aizawai</i> (Bta) Xentari, Florbac, Agree, Design, Ketch (caterpillars)
72. <i>Bacillus thuringiensis israelensis</i> (Bti) Skeetal, Mosquito Dunks, Bactimos, Gnatrol, Aquabac, Vetobac, Teknar (mosquitoes, blackfly larvae and fungus gnats)
73. <i>Bacillus thuringiensis kurstaki</i> (Btk) Thuricide, Dipel, Crymax, Foray, BioBit, Scutello, Crymax WDG, Deliver, Javelin, Baritone (caterpillars)
74. <i>Bacillus thuringiensis tenebrionis</i> (Btt) Novodor, Raven, Potato Shield, Foil (beetle larvae)
75. <i>Bacillus popilliae</i> Milky Spore (Japanese beetles)
76. <i>Bacillus sphaericus</i> VectoLex, Spherimos (mosquito larvae)
77. <i>Beauveria bassiana</i> Naturalis-O, L and T, Mycotrol, Botanigard (aphids, grubs, chinch bugs, grasshoppers, crickets, and sod webworms)
78. <i>Nosema locustae</i> Nolo Bait, Semispore Bait (grasshoppers)
79. Nucleopolyhedrosis virus (NPV) Gem-Star, NPV, Spod-X (caterpillars)
80. <i>Paecilomyces fumosoroseus</i> PreFeRal, PFR-97 (aphids)
81. <i>Saccharopolyspora spinosa</i> Entrust (caterpillars, beetle larvae, thrips and leafminers)
82. <i>Verticillium lecanii</i> Vertalec (aphids in greenhouses)
Microbial Nematicides
83. <i>Steinernema feltiae</i> MG-13 (<i>Meloidogyne incognita</i> , root-knot nematode on greenhouse tomatoes); technically not a microbial product. Available from Sierra Biological (see Table 7)
84. <i>Myrothecium verrucaria</i> DiTera (nematodes)
Microbial Fungicides
85. <i>Agrobacterium radiobacter</i> Galltrol-A, Gallex, NoGall K1026 (crown gall)
86. <i>Bacillus pumilis</i> Activate, Ballad Plus, Sonata (fungal diseases)
87. <i>Bacillus subtilis</i> Serenade, Cease (fungal and bacterial diseases)
88. <i>Gliocladium virens</i> SoilGard, Gliomix (<i>Pythium</i> , <i>Rhizoctonia</i> , <i>Fusarium</i>)
74. <i>Pseudomonas fluorescens</i> Blight Ban (fire blight)
89. <i>Reynoutria sachalinensis</i> Regalia (Powdery mildew and <i>Botrytis</i> grey mold)
90. <i>Streptomyces</i> spp. Mycostop, RootGuard, Agrimycin, Actinovate (<i>Fusarium</i> , damping off, <i>Pythium</i> , <i>Phytophthora</i> , and fire blight)
91. <i>Trichoderma</i> spp. Plant Shield, Plant Gard, Binab-T, Root Shield (<i>Pythium</i> , <i>Rhizoctonia</i> , <i>Fusarium</i> , <i>Cylindrocladium</i> , and <i>Thielaviopsis</i>)

Table 7. Member companies of the Association of Natural Biocontrol Producers that market nematodes, mites, and insects for pest management in North America. Products available from these companies are listed in Tables 2–6. For companies that produce or sell biopesticides, visit the *IR-4 Biopesticide and Organic Database for Integrated Pest Management* (see sources of information section).

Company	Website
Anatis Bioprotection	http://anatisbioprotection.com
Applied Bio-nomics	http://www.appliedbio-nomics.com
ARBICO Organics	http://www.arbico-organics.com
Associates Insectary	http://www.associatesinsectary.com
BASF Agricultural Specialties	http://betterplants.basf.us.com
Beneficial Insectary	http://www.insectary.com
Biobest Canada	http://www.biobest.ca
Biobest USA	http://www.biobest.be
Bio Control, S. A.	http://www.biocontrol.cr
BioWorks	http://www.bioworksinc.com
Buglogical Control Systems	http://www.buglogical.com
Crop Defenders	http://www.cropdefenders.com/
Distribuciones Imex S. A. de C. V.	http://www.imex.mx/
EcoSolutions	http://www.ecosolutionsbeneficials.com
Entomology Solutions	http://www.bugsbehavingbadly.com/
Evergreen Growers Supply	http://www.evergreengrowers.com
Everwood Farm	http://www.everwoodfarm.com/
Foothill Agriculture Research	http://farincinsectary.wix.com/far-inc-website
Green Methods	http://greenmethods.com
GrowLiv	http://www.growliv.com/
Hydro-Gardens	http://www.hydro-gardens.com
IPM Laboratories	http://www.ipmlabs.com
Koppert Biological Systems	http://www.koppert.com
Kunafin “The Insectary”	http://www.kunafin.com
M & R Durango	http://goodbug.com
Natural Enemies Bio. Pest Mgmt.	http://naturalenemiesbiocontrol.com/
Natural Insect Control	http://www.naturalinsectcontrol.com/
Orcon (Organic Control)	http://organiccontrol.com/
Rincon-Vitova	http://www.rinconvitova.com
Sespe Creek Insectary	http://www.anbp.org/products_sespecreek.htm
Sierra Biological Inc.	http://www.sierrabiological.com/
Sound Horticulture	http://soundhorticulture.com/
Spalding Laboratories	https://www.spalding-labs.com
Syngenta Bioline	http://www.syngenta-bioline.com
Tip Top Bio-Control	http://www.tiptopbiocontrol.com/

Table 8. Additional companies selling natural enemies.

Company	Website
A-1 Unique Insect Control	http://www.a-1unique.com
AgBioChem	http://www.agbiochem.com
American Insectaries	http://www.betterbugs.com
Andermatt Biocontrol	http://www.biocontrol.ch
BCP Certis	http://www.bcpcertis.com
Binab	http://www.algonet.se/~binab/index2.html
Biocontrol Network	http://www.biconet.com
Biofac Crop Care	http://www.biofac.com
BioLogic Company	http://www.biologicco.com
Biotactics	http://www.benemite.com
Bonide	http://www.bonideproducts.com
California Agriculture Supply	http://www.californiaaagsupply.com/
Certis	http://www.certisusa.com
Eartheasy	http://www.eartheasy.com
Gardens Alive	http://www.gardensalive.com
Global Horticultural	http://www.globalhort.com/
Harmony Farm Supply	http://harmonyfarm.com
Marrone Bio Innovations	http://www.marronebioinnovations.com/
Natural Pest Controls	http://www.natpestco.com/
North Country Organics	http://www.norganics.com
Peaceful Valley	http://www.groworganic.com
Planet Natural	http://www.planetnatural.com
Plant Products Company	http://www.plantprod.com
Three Trees Farm	http://www.redwiggler.com
Troy Biosciences	http://www.troybiosciences.com
Valent BioSciences	http://www.valentbiosciences.com

Sources of Information on Obtaining and Using Commercial Natural Enemies and Biopesticides

Appropriate Technology Transfer for Rural Areas (ATTRA), National Sustainable Agriculture Information Service (<https://www.ncat.org>) [This service provides searchable databases for sustainable agriculture, including biological control.]

Association of Natural Biocontrol Producers (ANBP) Website (<http://www.anbp.org>). [This is a global commercial biological control organization with members primarily in North America. The website lists producers, distributors, practitioners, and contributing members. Most of the producers and distributors list their products.]

Buitenhuis, R. 2014. Grower Guide: Quality Assurance of Biocontrol Products. Vineland Research and Innovation

Centre, Ontario, Canada (http://www.vinelandresearch.com/sites/default/files/grower_guide_pdf_final.pdf)

Copping, L. G. (ed.). 2001. The BioPesticide Manual. British Crop Protection Council. Surrey, UK. 528 p. [This book contains a comprehensive listing and technical descriptions of biopesticides.]

Electronic Data Information Source (EDIS) Website (<http://edis.ifas.ufl.edu/>). [The EDIS Web site is a comprehensive, single-source repository of all current UF/IFAS numbered peer-reviewed publications. The database is searchable by topic, e.g., agriculture or lawn and garden, and by key words.]

Featured Creatures Website (<http://entnemdept.ifas.ufl.edu/creatures/>). [This is a set of in-depth profiles of insects, nematodes, arachnids and other organisms. The database

is searchable by common name, scientific name, crop or habitat, higher classification and recent additions.]

Flint, M. L., S. H. Dreistadt and J. K. Clark. 1998. *Natural Enemies Handbook*. University of California Integrated Pest Management Project. University of California Press, Los Angeles. 154 p. [This book can be used to identify and use many of the most common natural enemies. It contains a considerable amount of information about biological control, including the toxicity to natural enemies of selected insecticides and acaricides.]

Gerson, U., R. L. Smiley and R. Ochoa. 2003. *Mites (Acari) for Pest Control*. Wiley-Blackwell. 560 p. [This book describes 34 acarine families that contain mites useful for the control of pest mites, insects, nematodes and weeds. It also contains information on using the mites.]

Hoffman, M. P. and A. C. Frodsham. 1993. *Natural Enemies of Vegetable Insect Pests*. Cornell Cooperative Extension, Cornell University, Ithaca, N.Y. 63 p. [This book facilitates identification of the major parasites and predators of insect pests of vegetables. It also contains information on entomopathogenic nematodes and microbial insecticides.]

International Biocontrol Manufacturers Association (IBMA) Website (<http://www.ibma.ch>). [This is a global commercial biological control organization with members primarily in Europe. The website has an Invertebrate Biocontrol Agents (IBCA) Professional Group for producers of macroorganisms (insects, mites and entomopathogenic nematodes).]

IR-4. 2010. Searchable Database for Biopesticide and Organic Pest Management Solutions (<http://www.ir4.rutgers.edu/Biopesticides/Labeldatabase/index.cfm>). [Search categories include commercial crops, commercial turf and ornamentals, residential food crops, residential turf and ornamentals, pest problems (insects, diseases, weeds, nematodes, and animals), plant growth regulators and states.]

Malais, M. H. and W. J. Ravensberg. 1992. *Knowing and Recognizing* (Revised Edition). Koppert Biological Systems. Reed Business Information. 288 p. [This book describes major plant pests and their natural enemies. A newer edition is available from Koppert, (<http://www.koppert.com/>). This website also has information on the toxicity to natural enemies of selected pesticides.]

Natural Resources Canada, Insect Producer Database Website (<http://www.insect.glf.cfs.nrcan.gc.ca/>). [This database contains a listing of insects available from producers.]

The IPM Practitioner's 2015 Directory of Least-Toxic Pest Control Products (<http://www.birc.org/Final2015Directory.pdf>). [This publication contains more than 2000 products from more than 600 suppliers.]

Thomson, W. T. 1992. *A Worldwide Guide to Beneficial Animals used for Pest Control Purposes*. W. T. Thomson Publishing. Fresno, CA. 92 p. [This book is a practical guide to use of the 72 most common species of commercial beneficial insects, mites and nematodes for biological pest control. It includes an out of date list of companies that sell the natural enemies.]

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