

Epilogue

Controlling pests with natural enemies reduces pesticide use, stabilizes food supplies and ultimately benefits the public worldwide. The *Bemisia* program shared these objectives. Classical biological control practitioners often distribute natural enemies to researchers in other countries, subject to export and import regulations. Rather than reinventing the wheel, programs in one country can learn from the experiences of scientists in other countries, and biological control is often obtained with the same agents in various parts of the world. Foreign explorers from the USA were granted access to many countries throughout the world to collect natural enemies of *Bemisia*. In turn, natural enemies that performed well in the USA were shared with researchers in other nations affected by *Bemisia*.

Table 1 lists the dates, countries, cooperators, and natural enemies shipped. It is not yet known which species permanently established in most of the receiving countries, with the exception of Australia. Paul DeBarro (CSIRO Entomology), Indooroopilly, Queensland, Australia, conducted extensive research to determine if imported natural enemies were needed for control of *B. tabaci* biotype B that invaded Australia, causing problems starting in 1997. He concluded that *B. tabaci* did not have effective parasitoids despite the presence of parasitoids adapted to the indigenous *B. tabaci* 'Australasian' biotype. He then collaborated with US researchers to determine which single species should be the first to be imported and tested. The single release approach is required in Australia due to the extensive regulatory requirements for both insect and weed biological control agents. The decision was to import *Eretmocerus hayati*, originally from Pakistan, from field populations that had established in Texas. This was based on the fact that *Eret. hayati* had performed very well in the US program and was the most common exotic parasitoid in southern Texas, which is climatically similar to affected areas in Queensland, Australia. *Eretmocerus hayati* was imported in 2001. Host range testing of numerous related whitefly species that were indigenous to Australia showed that *Eret. hayati* posed little or no risk of unintended nontarget impacts. *Eretmocerus hayati* was released in Bundaberg, Queensland in late 2004 and has spread rapidly from the release sites. As of January 2005 it had been recovered far from release sites 300km to the south in the Lockyear Valley near Brisbane. Cotton and vegetable growers reported that 2004–2005 were the first years since 1995 that *B. tabaci* was not a significant pest in eastern Queensland (P. Debarro, personal communication).

Table 1 Shipments of *B. tabaci* parasitoids and predators to cooperators overseas.

Year	Country	Receiving scientist and institution	Species	M#	Origin	#'s released	
1995	Honduras	Ron Cave	<i>Eret. mundus</i>	M92014	Spain	1,000	
		Zamarano College	<i>Eret. mundus</i>	M92019	India	10,000	
		Colmar Serra	<i>Enc. sophia</i>	M93003	Spain	2,000	
1996	Dominican Republic	DR Department of Agriculture					
		Genaro Viggiani	<i>Enc. sophia</i>	M93003	Spain	100	
		Silvestri Institute					
		Leynska Wiscovitch					
Puerto Rico	Puerto Rico	USDA-APHIS-PPQ	<i>Enc. sophia</i>	M93003	Spain	18,650	
			<i>Enc. formosa</i>	M92030	Egypt	23,480	
			<i>Eret. mundus</i>	M92014	Spain	42,644	
			<i>Serangium parcestosum</i>	M93008	India	100	
			<i>Enc. sophia</i>	M95107	Pakistan	800	
1997	Israel	Dan Gerling					
		Tel Aviv University	<i>Eret. hayati</i>	M95012	Pakistan	33,000	
	Mexico	Jesus Vargas Camplis	<i>Eret. mundus</i>	M92014	Spain	33,000	
		National Institute of Forestry, Agricultural and Animal Research	<i>Eret. emiratus</i>	M95104	U.A.E.	33,000	
		Leynska Wiscovitch	<i>Eret. hayati</i>	M95012	Spain	128,508	
	Puerto Rico	Puerto Rico	USDA-APHIS-PPQ	<i>Eret. mundus</i>	M92014	Spain	11,000
				<i>Eret. emiratus</i>	M95104	U.A.E.	10,000
				<i>Enc. sophia</i>	M93003	Spain	8,000
				<i>Enc. formosa</i>	M92030	Egypt	10,000
	2001	Australia	Paul DeBarro	<i>Eret. hayati</i>	M95012	Pakistan	5,000
CSIRO Entomology							

Plans are presently being made to export *Eret. hayati* to China and *Eret. melanoscutus* to Colima, Mexico. Both countries have been affected by outbreaks of *B. tabaci* biotype B.

The recent discovery of *B. tabaci* biotype Q in Arizona and California has prompted calls for additional screenings of exotic *B. tabaci* parasitoids on this biotype. However, this may not be necessary, since many of the *Eretmocer* spp. imported and established in the US program were obtained from collections of *B. tabaci* biotypes other than B. At least three native North American *Eretmocer* species in Florida, Texas, Arizona and California readily adapted from *B. tabaci* biotype A to attack biotype B. It is likely that the already established native and introduced natural enemies will readily attack the Q biotype, as has been demonstrated for Spanish populations of *Eret. mundus* (Urbaneja and Stansly 2004).

Reference

- Urbaneja, A. and P.A. Stansly. 2004. Host suitability of different instars of the whitefly *Bemisia tabaci* 'biotype Q' for *Eretmocer* *mundus*. *BioControl* 49: 153–161.

Summary

The classical biological control program directed against *Bemisia tabaci* (Gennadius) biotype B (= *B. argentifolii* Bellows and Perring) in the 1990s was one of the largest and most comprehensive programs in the history of biological control. A team of scientists from USDA-APHIS, USDA-ARS, CDFA, and several universities contributed to the discovery, importation, evaluation, release, and colonization of a suite of imported natural enemies. Field entomologists were stationed in Arizona, California and Texas to carry out the research where the infestations were the most damaging. To support the foreign exploration for natural enemies for *B. tabaci* and other biological control projects, a new APHIS quarantine facility was built in Mission, Texas, which eventually coordinated with mass rearing facilities at the field locations to maximize the release efforts for the biological control program. The substantial level of commitment by USDA matched the level of damage caused to a wide range of crops by this 'super pest'. The national program leadership of ARS and APHIS produced a remarkable achievement in redirecting research programs, obtaining additional research and implementation funding from Congress, and developing a 5-Year National Research and Action Plan for Development of Management and Control Methodology for the Sweetpotato Whitefly (1992–1996), which was followed by the Silverleaf Whitefly 5-Year National Research, Action, and Technology Transfer Plan (1997–2001) to help organize research and track progress.

The foreign exploration program for natural enemies of *B. tabaci* was comprehensive, covering 28 countries, and more than 130 shipments of natural enemies were sent to quarantine facilities in the USA between 1991 and 1998. Climate matching was used to compare the affected areas in the USA with locations within the native distribution of *B. tabaci* and thereby prioritize foreign exploration. The ARS European Biological Control Laboratory in Montpellier, France was extremely valuable to the biological control program; its staff engaged in nearly year-round exploration, which led to the discovery of many parasitoids, predators and pathogens for evaluation by US researchers.

In the USDA APHIS Mission Biological Control Laboratory quarantine, 55 populations of natural enemies were established in culture, including 13 species of *Eretmocerus* and *Encarsia* parasitoids. Only parasitoids reared from *B. tabaci* (any biotype) and with a primary or autoparasitic biology were considered for release.

Predictive, prerelease studies were conducted in quarantine and in field cages to determine which species showed the most potential to impact whitefly populations. This information was used to prioritize species for mass rearing and field release. Low-performing parasitoid species were also released in substantial numbers at selected locations to validate the predictions.

The sweetpotato whitefly program was the first large-scale biological control program to use molecular genetic methods to characterize the imported natural enemies prior to their release. RAPD-PCR was used to screen the natural enemies reared in quarantine to identify cryptic species and maximize available genetic diversity from the exploration efforts. This was critical because many of the most valuable *Eretmocerus* species were extremely similar morphologically, but had unique biological traits such as host-plant preferences and climatic adaptations. The molecular methods were also used to assure colony purity and to identify exotic specimens recovered in the field programs. Taxonomic keys were developed to identify and describe the native and imported *Eretmocerus* and *Encarsia* parasitoids of *B. tabaci* in North America.

Mass rearing facilities were established in Tucson, Arizona; Imperial and Sacramento, California; and Mission, Texas. Hundreds of millions of *Eretmocerus* and *Encarsia* species were mass reared for several years for release and evaluation in the areas affected by sweetpotato whitefly, which included the subtropical agricultural areas of the USA and Mexico. Mass rearing techniques improved dramatically over the course of the program, beginning with laboratory rearing in environmental chambers on whitefly-infested hibiscus plants, to heated, outdoor field cages with large pots of kale and eggplant, to highly managed greenhouses that used large-leaf eggplants and mechanical removal of parasitoid pupae. The substantial number of parasitoids available for release enabled a large-scale field evaluation of biological control as an integrated component of management programs.

Field evaluation programs were conducted in Phoenix, Arizona; Brawley and Sacramento, California; and Mission, Texas. Candidate natural enemies were tested in field cages on multiple crops, including alfalfa, broccoli, cotton, and melons. The results showed strong tri-trophic interactions and the significance of climatic adaptation. Four species of Paelearctic *Eretmocerus* that established in the western USA were morphologically similar, representing a group of closely related taxa that appear to be specialist parasitoids of the *B. tabaci* complex that includes several known biotypes. Their ability to readily attack whiteflies in the *B. tabaci* complex may have given them an advantage in the field versus the native *Eret. tejanus* Rose and Zolnerowich and *Eret. eremicus* Rose and Zolnerowich, which have a broader host range that includes *Trialeurodes* species. To date no nontarget impacts have been detected from the exotic parasitoids, which is likely due to their narrow host range.

The climate in the native range of each of the four imported *Eretmocerus* spp. closely matched the climate in the areas of the USA where they established: *Eret. mundus* Mercet from Mediterranean Europe to San Joaquin Valley, California; *Eret. emiratus* Zolnerowich and Rose from the hot desert of the Arabian Peninsula to Imperial Valley, California; *Eret. sp. nr. emiratus* from the tropical desert of Ethiopia in equatorial Africa to Yuma and Phoenix, Arizona; and *Eret. hayati*

Zolnerowich and Rose from the subtropical desert of the Indus River Valley in Pakistan to the Rio Grande Valley, Texas. The exotic autoparasitoid *Enc. sophia* (Girault and Dodd) also established in the Imperial Valley of California, although several endemic autoparasitoids were previously present in this agroecosystem.

Several release methods were developed to enhance the likelihood of establishment of the parasitoids in the annual cropping systems. Refuge strips, home gardens, and commercial nurseries were used as release sites because they had stable year-round populations of *B. tabaci* and were free of broad spectrum pesticide use. In addition to inoculative release methods, a more efficient method for augmentation of parasitoids using seedling transplants as 'banker plants' was developed for cucurbit crops.

Field efforts to control *B. tabaci* were aided by the development of several narrow spectrum insecticides that were effective against *B. tabaci* while allowing substantial parasitoid activity. Biological control-intensive IPM strategies were developed to take advantage of the new selective insecticides. Banker plants were transplanted into imidacloprid treated fields, which reduced the cost of release and demonstrated how the BC-IPM could be integrated with current farming practices.

Trials with the entomopathogens *Beauveria bassiana* and *Paecilomyces fumosoroseus* showed they caused significant mortality to *B. tabaci* nymphs under high humidity conditions. Specialized spray equipment was developed and tested to apply the pathogens under commercial field conditions. Field trials showed that the biopesticides were effective during the early season and compatible with natural enemies. Two different formulations of *B. bassiana* (Mycotrol) and a formulation of *Paecilomyces fumosoroseus* were later commercialized.

The sweetpotato whitefly biological control program clearly demonstrated the potential benefits of classical biological control in annual row-crop agriculture. The program also demonstrated the utility of predictive evaluations, which showed that a multiple species release strategy was needed due the varied climates and crops that were impacted by *B. tabaci*. This strategy should be considered for future biological control programs directed at polyphagous invasive pests that become widely distributed in the USA.

Following their establishment, detailed quantitative studies are now needed to document the impact of the introduced species, which appeared to be substantial in the years immediately following establishment in areas such as the Lower Rio Grande Valley. Life table studies similar to those conducted for survivorship of *B. tabaci* on cotton in Maricopa, Arizona (Naranjo and Ellsworth 2005) are needed for all areas where the exotic parasitoids have become established. Only with such evaluations will we truly be able to accurately measure the impact and significance of benefits derived from the interagency sweetpotato whitefly biological control program.

Reference

- Naranjo, S.E. and P.C. Ellsworth. 2005. Mortality dynamics and population regulation in *Bemisia tabaci*. *Entomologia Experimentalis et Applicata* 116: 93–108.

Index

A

- A-biotype, *see* biotype A
A10 (primer) 122
Abelmoschus esculentus (*see also* okra) 194, 202, 209, 227, 246, 247, 311
abiotic factors 8, 35, 37, 55, 297
Acaudaleyrodes citri 108–109
accession(s) 20–22, 24, 114–117, 122–124, 182, 183, 207, 208
Acletoxenus formosus 20, 124, 127, 132
Admire (*see also* imidacloprid) 155, 156, 261, 267, 283
AFLP 73, 74
agricultural production 1, 19, 225, 319
agroecosystem 7, 19, 154, 230, 260, 287, 292, 295, 297, 299, 300, 302, 303, 313, 316, 331
agroecosystem structure 299
air freight 20
Albizia sinoensis 317, 318
Alcea 196, 202
Aleurocanthus 84, 90, 101, 108, 109
Aleurocanthus woglumi 84, 90, 108, 109
Aleurodiphilus 72, 76
Aleuropleurocelus 101, 102, 317–320
Aleuropleurocelus coachellensis 317–319
Aleurothrixus 93, 96, 101, 107–109
Aleurothrixus floccosus 96, 107–109
Aleurothrixus porteri 108
Aleyrodes inconspicua 1
Aleyrodes tabaci 1
Aleyrodidae 34, 72, 89–91, 96, 98, 101, 122, 192, 205, 288
alfalfa (*see also* *Medicago sativa*) 129, 130, 132, 133, 135, 137, 138, 168, 206, 210, 225, 244, 250, 251, 254, 255, 287–290, 292–300, 302, 303, 320, 330
allelochemicals 37, 40, 52
allozyme 5, 98
Amitus bennetti 25, 132, 207, 312
annual host 210, 246, 295, 297–299, 302, 303, 307, 318
antagonistic interaction 54, 55
antennal club 91, 92, 94, 96
antimicrobial compound 40
ants 140, 163, 212, 318
Aphelinidae 18, 26, 27, 71, 89, 91, 98, 121, 132, 163, 170, 192, 193, 201, 207, 230, 235, 290, 293, 309, 312, 318
Aphelinus gossypii 167
Arabian peninsula 27, 143, 330
arboreal habitat 144
Argentina 4, 33, 35
Argythamnia neomexicana 316, 317
Arizona 2–5, 9, 17, 19, 20, 26, 29, 83, 89, 91, 97, 99–101, 123, 124, 129, 131–133, 142, 143, 149, 162, 168, 170, 191–203, 207, 208, 253, 307, 309, 316–321, 327, 329–331
armored scale 71, 72, 75–77, 82, 98, 126
arrowweed 317, 319
ARSEF collection 35, 46, 57
artificial media 34, 40, 41, 46
Aschersonia 33, 34, 39, 43–46, 54–56
Aschersonia aleyrodis 36, 39, 44–46, 53–55
Aschersonia andropogonis 36
Aschersonia goldiana 36
Aschersonia placenta 44, 46
ash whitefly 72
Aspidiotiphagus 72, 76
attack rate(s) 121, 123, 124, 127, 151, 152, 179, 183, 188, 193, 203, 213, 227
aubergine (*see also* eggplant) 2
augmentation (*incl.* augmentation biological control) 8, 9, 56, 168, 186, 210, 221, 303, 331

Australia 2, 27, 74, 91, 93, 99, 100, 107, 147, 158, 185, 186, 325, 326
 autoparasitoid (*incl.* autoparasitic) 21, 22, 71, 82, 122, 133–137, 141, 166, 184, 261, 312, 329, 331

B

B-biotype, *see* biotype B
 bandedwing whitefly (see also *Trialeurodes abutiloneus*) 158
 banding pattern 25, 26, 111, 113–116, 158
 banker plant(s) 177, 179, 186, 187, 283, 331
Bauhinia variegata (see also orchid tree) 210, 319
 bayberry whitefly (see also *Parabemisia myricae*) 90
 bean(s) 2–4, 21, 38, 127, 132, 202, 214, 313, 314
Beauveria bassiana 33–36, 38–40, 47, 48, 50–53, 55–57, 331
Bemisia argentifolii 1, 5, 6, 17, 34, 40, 43, 89, 111, 112, 121, 129, 148, 192, 206, 244, 260, 288, 308, 329
 big-eyed bug, *see* *Geocoris*
 bioassay 35, 47, 49, 123
 biocontrol-based IPM 121
 Bioimage software 113, 114
 biosystematics 96–98, 122
 biotic factors 8, 35, 37, 55
 biotype A 5, 89, 206, 207, 308, 309, 320, 327
 biotype B 1, 5, 17, 18, 25, 33, 34, 37, 45, 48, 49, 51, 52, 55, 56, 89, 111, 112, 116, 121, 129, 148, 158, 168, 185, 191–193, 207, 226, 243, 244, 259, 260, 327
 biotype Q 327
 biotype(s) 1, 5, 6, 17, 18, 21, 25, 26, 33
 biparental 22–24, 98
 blackbean 3
 blastospore(s) 37, 39–41, 43, 49, 53
 boundary layer 37, 40, 50, 52
Brassica 154, 180, 192, 206, 208
 Brawley 29, 116, 132, 142, 143, 209, 245, 246, 249, 250, 255, 283, 294, 330
 Brazil 2, 4, 21, 33, 35, 36, 44, 83, 121, 124, 126, 135–138, 147, 149–151, 182, 228, 255
 broccoli 121, 123–125, 132, 135–138, 141–143, 147, 154, 155, 171, 183, 192, 195, 202, 203, 209, 227, 246, 253, 254, 287, 289, 292, 293, 295–300, 302, 303, 320, 330

C

C:N ratio 41
 cabbage 4, 18, 22, 38, 40, 51, 151, 157, 171, 186, 192, 202, 289
 California 2, 3, 5–7, 9, 17–20, 25, 26, 29, 83, 89, 91, 97–101, 116, 118, 123, 124, 129, 131–133, 140, 142, 143, 149, 162, 168, 171, 175, 186, 193, 205–209, 211, 225–231, 233, 243–246, 249, 250, 256, 259, 266, 283, 287–289, 291–294, 298, 301, 307–310, 316, 317, 319–321, 327, 329–331
 California Department of Food & Agriculture 29, 100, 132, 133, 142, 163, 168, 173, 175, 185, 187, 207, 208, 211–216, 226, 227, 230, 251, 297, 309, 329
 cantaloupe 38, 121, 123, 124, 129, 131–139, 141, 142, 147, 150, 155–158, 179, 184, 186, 192, 194, 206, 209, 210, 216–218, 221, 246, 250, 262, 263, 266, 269, 270, 287–290, 292, 293, 295–300, 302, 303, 314, 320
 cassava 2
 CDFA, *see* California Department of Food & Agriculture
 center of origin 20, 27, 28
Ceratonia siliqua 101, 317
Chamaesyce 83
 cheesebush, *see* *Hymenoclea salsola*
 China 4, 44, 74, 91, 327
Chrysoperla 130, 206
 Chrysopidae 207, 318
Cistus salvifolius 196
 citrus 4, 44, 45, 55, 56, 129, 132–134, 140, 180, 206, 225, 229–239, 244, 256
 citrus blackfly 72, 84, 90
 citrus-cotton interface 232, 235
 classical biological control 9, 28, 29, 90, 102, 129, 161, 168, 169, 175, 253, 259, 284, 288, 290, 291, 308, 325, 329, 331
 climate 8, 17, 19, 25–28, 40, 41, 45, 54, 129, 131, 138, 142–144, 148, 180, 188, 192, 205, 206, 211, 226, 243, 244, 254, 256, 288, 330, 331
 climate matching 19, 28, 144, 193, 329
 climatic adaptation 25, 179, 188, 330
 CLIMEX 19, 20, 28
Clitostethus arcuatus 20, 132
 CO4 primer 122
 Coccidae 43, 77, 82
 Coccinellidae 20, 55, 132, 144, 208, 318, 321

- COI primer 73
 COII primer 73
 cole crop(s) 18, 123, 144, 147, 149, 151, 154, 158, 171, 180, 192, 206, 209, 210, 217, 230, 252, 260, 288, 289, 292, 303, 315
 collection site 19, 113, 311
 colonization 90, 181, 225, 246, 253, 256, 268, 329
 Colorado River 194, 199, 320
 commercial nurseries 191, 194, 196, 199, 211, 331
 competitive advantage 188
 conidia 37, 39–53, 55
Conidiobolus 36
 Coniopyrgidae 318
 conservation (*incl.* conservation biological control) 7–9, 243, 244, 252
 conspecific 97, 312
 cotton (see also *Gossypium hirsutum*) 1–5, 7, 20–24, 26–28, 38–40, 50, 52, 57, 121, 123–125, 129–133, 135–138, 140–142, 147, 149–155, 163, 167, 168, 177, 180, 183, 184, 186, 188, 192, 202, 206, 207, 209–213, 215–218, 221, 222, 225, 229–233, 235, 238–240, 245, 246, 248, 250, 254, 269, 287–290, 292, 293, 295–300, 302, 303, 309, 314, 315, 320, 325, 330, 331
 country of origin 194, 196
 cowpea 3
 crop cycle 51, 57, 154
 crop losses 2–5, 17, 206
 crop sequence 130
 cropping patterns 288, 291
 crucifer 18, 130, 314
 cryptic species 1, 96, 111, 112, 116, 117, 122, 330
 cucumber (see also *Cucumis melo*) 24, 38–40, 44–46, 50, 51, 53, 55, 151, 157, 180, 202, 313–315
Cucumis melo 121, 123, 129, 150, 180, 184, 194, 206, 210, 246, 262, 308, 314
Curinus coeruleus 321
 Cyprus 4, 21, 24, 33, 35, 83, 116, 150, 182, 228
- D**
Datura discolor 316, 317
Datura innoxia 196
Delphastus 55, 208
Delphastus catalinae 55, 208
Delphastus pusillus 55
 demonstration project 161, 162, 168, 256, 259, 269
 desert agriculture 131
 desert climate 19, 25, 138, 244, 256
 desert lavender (see also *Hyptis emoryi*) 317, 319
 desert survey 215, 223, 318, 320
 desert valley 83, 129, 130, 143, 149, 205, 244, 254, 284, 309, 316
 destruxin 49
 Deuteromycetes 34
 development 5–8, 18, 20, 33, 34, 42, 44, 48, 49, 52, 53, 55–57, 89, 90, 99, 111, 112, 129, 131, 133, 134, 141, 148, 162, 168, 172, 173, 184, 212, 249, 252, 255, 283, 284, 294, 299, 313, 329, 331
Dialeurodes 44, 101, 107–109
Dialeurodes citri 44, 80, 108, 109
Dialeurodes citrifolii 44
Dicoria canescens 316, 317
 differential mortality 45
 dispersal 6, 7, 44, 45, 138, 191, 193, 195, 199, 200, 205, 219, 223, 230, 249, 266, 282
 DNA 18, 26, 79, 99, 111–117, 181, 185, 198, 213, 248, 251, 294
 DNA squash blot 99, 294
 DNA fingerprinting 41
 DNA hybridization 294
 DNA patterns 21, 22, 24, 112, 182, 227
 DNA sequence data 99
 Dominican Republic 3, 22, 83, 135, 137, 138, 186, 320
 Drosophilidae 20, 132
Dumbletoniella 91
 duplicate cultures 111, 115
- E**
 EA, *see* Environmental Assessment
 early season inoculation 187
 ecological studies 111, 112, 115
 economic impact 1, 188
 economic losses 5, 129
 ectoparasitism 82
 efficacy 7, 20, 35, 37–39, 42, 48, 49, 51–53, 57, 117, 121, 123, 127, 131, 152, 155, 200, 201, 256, 261, 292
 efficacy testing 49, 121
 eggplant 23, 24, 39, 162, 163, 166, 167, 169–174, 193, 194, 202, 211, 231, 246, 247, 253, 255, 312, 315, 330
 Egypt 2, 4, 7, 21, 23, 33, 35, 74, 83, 116, 126, 228, 326
 electrophoretic gel pattern 122

- emulsifiable oils 48, 49
- Encarsia aurantii* 76, 77, 79, 80, 82
- Encarsia bimaculata* 21, 25, 75, 80, 83, 115, 125, 126, 133, 135, 136, 141, 142, 150, 183, 207, 228, 255
- Encarsia brasiliensis* 311
- Encarsia clypealis* 72
- Encarsia coquilletti* 223, 316, 319, 320
- Encarsia cubensis* 74, 76, 77, 80, 313
- Encarsia flavoscutellum* 74, 75, 77, 82
- Encarsia formosa* 20, 21, 54, 55, 72–74, 79–84, 115, 135, 162, 183, 207, 228, 309, 312, 314, 315, 321, 326
- Encarsia haitiensis* 80, 311
- Encarsia hispida* 21, 80, 81, 83, 126, 135–138, 170, 182, 207, 211, 212, 216, 228, 311, 312, 315
- Encarsia inaron* 71–73, 76, 77, 79, 80, 82, 84, 235
- Encarsia lahorensis* 76, 77, 80
- Encarsia longicornis* 71, 82
- Encarsia lutea* 21, 25, 77, 80, 83, 126, 149, 150, 182, 228
- Encarsia luteola* 73, 74, 76–82, 182, 207, 215, 216, 223, 254, 307, 310, 312, 314–316, 319, 320
- Encarsia meritoria* 73, 80, 182, 207, 215, 223, 226, 235, 309, 311–316, 319, 320
- Encarsia nigricephala* 79, 80, 83, 312, 313, 321
- Encarsia opulenta* 72, 76, 77, 80, 82, 310
- Encarsia parvella* 22, 76, 77, 79, 80, 82, 83, 125, 135–137
- Encarsia pergandiella* 21, 80–84, 121, 124, 126, 135–138, 147–154, 157, 158, 181, 182, 184, 188, 207, 226, 228, 235, 255, 307, 310–315
- Encarsia porteri* 82, 319
- Encarsia protransvena* 74, 75, 80, 83
- Encarsia quaintancei* 312, 313, 317
- Encarsia sophia* 9, 21, 23, 73, 74, 80, 83, 115, 117, 126, 129, 131, 133, 135, 136, 141–144, 149, 150, 158, 166, 180, 182, 183, 186, 205, 207, 215, 216, 218–222, 225, 228, 231, 233, 235, 243, 248, 249, 251, 252, 255, 309, 312, 320, 321, 326, 331
- Encarsia strenua* 74, 76–80, 82–84, 115, 150, 310, 312–315
- Encarsia tabacivora* 307, 311, 312, 314, 315
- Encarsia transvena* 74, 83, 309, 312
- Encarsia* sp. 21, 22, 25, 71–74, 81–84, 115, 121, 124–126, 133, 135, 137, 138, 144, 151, 166, 186, 188, 216, 218, 221, 228, 249, 255, 261, 312, 314, 315, 318–321, 330
- Encarsia* spp. 8, 27, 112, 114, 115, 117, 121, 148, 149, 157, 158, 168, 170, 181, 182, 186, 227, 238, 321
- endoparasitic 71
- endoparasitoid 71, 82, 312
- entomopathogen 8, 54, 55, 57, 331
- entomopathogenic fungi 33–37
- Entomophthora* 36
- Entomophthorales 36
- Environmental Assessment 122, 180, 308
- environmental conditions 40, 45, 53, 56, 131, 150
- epizootic(s) 35, 39, 41–45, 47, 53, 55, 56
- Eretmocerus californicus* 90, 93, 108, 130, 137, 309, 314, 319
- Eretmocerus corni* 91, 93, 108
- Eretmocerus debachi* 90, 93, 108
- Eretmocerus emiratus* 9, 22, 24–26, 93, 99, 126, 129, 135–140, 143, 162, 174, 177, 186, 191–194, 196, 198–200, 202, 203, 205, 207, 211–213, 218, 221, 223, 228, 230, 233, 235, 243, 248, 251, 255, 259, 269–271, 274–282, 287, 300, 320, 326, 330
- Eretmocerus eremicus* 9, 93, 97–99, 108, 116, 123, 130, 135–140, 144, 149, 162, 168, 200, 202, 203, 207, 213, 216–218, 220, 221, 223, 226, 231, 238, 245, 248, 252, 254, 259, 260, 263, 264, 282, 284, 290, 300, 302, 307, 309, 316, 319, 320, 330
- Eretmocerus furuhashii* 22, 93, 108
- Eretmocerus haldemani* 93, 96, 108, 309
- Eretmocerus hayati* 9, 23, 25, 28, 93, 99, 100, 108, 116, 121, 124–126, 135–137, 139, 140, 143, 147, 149–153, 155–158, 162, 179, 182–188, 191–194, 196, 198–200, 202, 203, 207, 212, 216, 221, 225, 228, 229, 231, 233, 235, 255, 259, 266, 267, 300, 320, 325–327, 330
- Eretmocerus longicornis* 93, 108
- Eretmocerus melanoscutus* 23, 93, 99, 100, 108, 116, 126, 134–139, 150, 151, 183, 207, 212, 228, 327
- Eretmocerus mundus* 9, 20, 23–25, 27, 28, 93, 99, 100, 108, 116, 117, 121, 124–126, 129, 134–140, 147, 149–158, 162, 180, 182–186,

- 191–194, 196, 198–200, 202, 203, 208, 211, 218, 221, 223, 225, 228, 229, 231, 233, 235, 238, 240, 248, 251, 255, 259, 263–265, 284, 300, 309, 320, 326, 327, 330
- Eretmocerus picketti* 93, 98, 101, 102, 109
- Eretmocerus rui* 25, 93, 100, 109
- Eretmocerus serius* 90, 93, 109
- Eretmocerus* sp. 9, 24, 25, 55, 99, 126, 134, 193, 208, 221, 307, 313, 319
- Eretmocerus* spp. 8, 22, 112, 115–117, 121, 123, 142, 148, 149, 151, 155, 157, 158, 172, 178, 179, 181, 183–186, 188, 213, 215, 216, 218, 222, 227, 233, 238, 248, 249, 252, 312, 321, 327, 330
- Eretmocerus staufferi* 93, 99, 109, 116, 126, 135, 152, 153, 182, 208, 216, 228
- Eretmocerus tejanus* 93, 97, 99, 109, 116, 121, 124, 126, 147, 152–154, 157, 158, 181–186, 188, 208, 228, 307, 310, 314–316, 330
- Eritrea 26
- establishment 9, 25, 26, 42, 50, 55, 100, 131, 143, 144, 148, 151, 153, 161, 162, 179, 181–188, 193, 195, 197, 199, 205, 206, 209–211, 213–216, 221, 223, 225, 230–232, 238, 244–245, 247, 249, 253, 255, 256, 259, 260, 291, 292, 303, 308, 310, 320, 331
- establishment evaluation 181, 185
- Ethiopia 2, 19, 24–26, 28, 99, 100, 129, 135, 139, 140, 188, 191, 193, 196, 198, 203, 205, 218, 211, 230, 233, 248, 259, 287, 300, 330
- Eulophidae 318
- Euphorbia* 24, 83, 196, 232
- Euphorbia maculata* 232
- Euphorbia pulcherrima* 196
- European Biological Control Laboratory 8, 17, 18, 20, 27, 29, 33, 35, 45, 46, 55, 329
- evaluation 9, 17, 18, 29, 33, 83, 84, 90, 112, 117, 121, 122, 124, 127, 129, 131–135, 137–142, 147–149, 152, 157, 161, 166, 181, 185, 208, 329, 330
- evolutionary unit 75
- exotic species 8, 91, 99–102, 139, 152
- exploration 8, 9, 17, 18, 20, 27–29, 33, 35, 45, 46, 127, 161, 192, 310, 329, 330
- exuvia 149, 156, 173, 174, 212, 262, 293, 300
- F**
- F1 progeny 140
- factor analysis 295, 297, 298
- fecundity 8, 131, 148, 166, 231
- fermentation 46, 48, 53
- Ficus* 196, 202, 210, 252
- field cage evaluation(s) 83, 131–144
- field cage(s) 9, 122, 123, 129–144
- field crop(s) 9, 17, 28, 38, 50, 53, 56, 132, 144
- field evaluation 111, 112, 115, 117, 122, 123, 131, 134, 140, 142, 143, 147–158, 330
- field insectary 149, 152, 212, 243, 247, 248, 259, 260
- field parasitism 17, 27
- field recovery 99, 216
- field release 131, 132, 143, 147–149, 151, 162, 164, 166, 168, 179, 181, 182, 212, 259, 260, 269, 273, 303, 330
- field tests 47, 48, 52, 124, 179, 187, 229
- Florida 3, 5, 17, 18, 20, 25, 44, 83, 89, 91, 100, 129, 130, 132, 172, 208, 307–313, 321, 327
- FONSI (Finding of No Significant Impact) 180
- foreign exploration 8, 17–29, 33, 35, 46, 127, 161, 192, 310, 325, 329
- formulation 40, 42, 48–50, 163, 331
- France 4, 8, 18, 24, 33, 35, 132, 329
- fungi 33–43, 45–57, 164
- fungicide 51, 56, 171, 175
- G**
- garden plot 181–183, 209
- generation time 134, 168, 299
- genetic characterization 28, 29, 183
- genetic diagnostics 111, 117
- genetic diversity 43, 73, 80, 81, 144, 330
- genetic variability 41
- Geocoris* 130, 206, 318
- geographic population 83, 129, 131, 133, 141–143, 193, 228, 248
- geographic strain 148
- Georgia 4, 5, 18, 91, 132, 167, 310
- germination 37, 39–42, 44, 46, 47, 51, 56, 186
- global spread 18
- Gossypium hirsutum* (see also cotton) 121, 123, 129, 151, 206, 225, 246, 309
- Greece 1, 8, 21, 24, 33, 35, 36, 83, 115, 293

greenhouse 4, 7, 8, 34, 37–42, 44–57, 72, 83, 123, 132, 135, 161, 162, 164, 167–172, 174–177, 184, 208, 210, 214, 225, 226, 231, 234, 238, 247, 251, 253, 284, 330
 greenhouse crops 8, 47, 49, 52, 53, 55, 57
 greenhouse whitefly (see also *Trialeurodes vaporariorum*) 34, 42, 44–46, 51–53, 55, 56, 72, 83, 162, 163, 170, 238
 gregarious 91
 growth media 40

H

habitat 9, 18, 29, 35, 40, 45, 84, 144, 193, 209, 224, 243–246, 249, 252, 253, 256, 288, 292, 295, 298, 307, 308, 310
 Hemiptera 20, 82, 180, 192, 205, 206, 288, 318
Heterotheca subaxillaris 316, 317
 heterotrophic 82
Hibiscus 23, 25, 37, 38, 53, 123, 131, 162, 165, 166, 175, 176, 177, 194–197, 202, 210–212, 214, 220, 227, 231, 235, 244–247, 252, 253, 319, 330
Hibiscus rosa-sinensis 131, 162, 165, 175, 196, 210, 214, 231, 244, 319
 high priority agents 123
Hippodamia convergens 318
 home garden(s) 194–196, 198, 210, 211, 228, 243, 246, 252, 253, 331
 Hormaphididae 75, 77, 82
 Horn of Africa 27
 host acceptance 131
 host association(s) 75, 76, 83, 90, 96, 158
 host crop(s) 124, 129, 131, 135, 141, 142, 158, 244, 254, 288, 292, 293, 295–300, 302, 303, 315, 320
 host insect effect(s) 97
 host plant characteristic(s) 44, 45, 131
 host plant effect(s) 39, 48, 123, 142, 149
 host plant(s) 5, 6, 17, 18, 20–22, 24, 25, 28, 35, 37, 39, 40, 45, 51, 52, 54, 101, 113, 122, 124, 127, 130, 131, 140, 142, 148, 149, 151, 161, 169, 171, 176, 177, 181, 182, 188, 191–194, 196, 197, 203, 205–207, 209, 210, 214, 215, 218, 243, 244, 246, 250, 252, 253, 256, 288, 289, 307, 309–311, 313–320, 330
 host range 7, 44, 49, 127, 188, 288, 316, 330
 host range testing 126, 127, 325

host relationships 75, 82
 host specific (specificity) 71, 82, 83, 188, 308
 host-finding efficiency 138
 humiditron 181
 hybridization 100, 294
Hymenoclea salsola 101, 317–319
 hyperparasitoid 71, 311, 318
 hyphae 42
 hyphal body 42, 48
 Hypocreales 36, 37, 40, 49
Hyptis emoryi 317, 319

I

identification key(s) 74, 75, 94, 310
 imidacloprid (see also *Admire*) 7, 9, 49, 56, 129, 155, 157, 179, 187, 256, 259, 261–263, 265–273, 275–278, 283, 284, 289, 298, 331
 Imperial Valley 2, 3, 5, 9, 19, 25, 83, 100, 101, 129–133, 135, 137, 139, 140, 142, 143, 168–171, 205–211, 213–215, 218, 219, 221–223, 226, 230, 238, 243, 246, 248–252, 256, 259, 283, 287–293, 295–301, 303, 309, 316, 330, 331
 implementation 6, 9, 29, 33, 34, 49, 57, 117, 162, 261, 329
 import regulations 325
 importation 9, 18, 74, 89, 90, 99, 112, 121, 123, 130, 180, 230, 259, 260, 329
 incumbent advantage 147, 153, 154
 India 2, 3, 20, 21, 23, 25, 33, 35, 36, 44, 74, 83, 100, 115, 116, 126, 127, 130, 132, 134–136, 139–142, 144, 147, 149–152, 157, 182, 183, 208, 228, 248, 263, 326
 Indian subcontinent 8, 20, 28, 132
 indigenous natural enemies 192, 290
 indigenous species 8, 144, 300, 302, 308, 318
 Indonesia 19, 33, 35, 36, 73
 infection rate 44, 45
 infectivity 40, 42, 56
 insect pathogen 34, 54
 insectary 133, 149, 152, 168, 175, 193, 207, 208, 210–212, 216, 243, 246, 247, 249–253, 255, 256, 262
 insectary crop(s) 247
 insectary gardens 209, 213, 216–218, 248, 249, 252
 insecticide 7, 9, 28, 29, 34, 37, 50, 53, 54, 56, 57, 102, 150, 152, 154, 156, 180, 181, 187, 191, 193, 194, 210, 227, 230, 231,

- 244, 250, 252, 253, 255, 256, 259, 262,
287, 292, 294–300, 302–304, 331
- insecticide load(s) 287, 294–296, 298–300,
302, 303
- insecticide resistance 7
- integrated pest management 9, 38, 54, 56, 57,
121, 206, 261, 266, 331
- interaction 6, 7, 44, 45, 51, 52, 54–57, 99,
123, 124, 188, 330
- interaction with beneficial insects 54
- interaction with fungicides 54
- IPM, *see* integrated pest management
- irrigated crops 52
- isolate (fungal) 8, 33–35, 37, 39–44,
46–49, 55
- isozyme electrophoresis 112
- Israel 2, 7, 21, 24–26, 33, 35, 36, 83, 91,
116, 134–137, 139, 149–151,
164, 182, 193, 194, 228,
248, 326
- Italy 4, 23, 24, 33, 35, 116, 125, 126, 182,
228, 326
- ITS2 73
- ivermectin 49
- J**
- Jacaranda* 195, 202
- Jatropha cinerea* 317–319
- Justicia spicigera* 196
- K**
- kale 147, 149–151, 155, 166, 167, 192,
203, 330
- key crop 123, 129, 131, 144, 148, 192
- L**
- laboratory bioassays 47
- lacewing 130
- landscape 18, 130, 196, 199, 292, 295–298,
302
- landscape analysis 292, 295
- landscape characteristics 292
- Lantana* 21, 23, 24, 194, 196, 202, 210, 211,
214, 227, 252, 317
- leaf microclimate 45
- leaf samples 27, 134, 184, 191, 195, 197, 212,
215, 310, 314
- Lecanicillium* 33, 34, 36, 39, 41–43
- Lecanicillium lecanii* 33, 34, 36, 39, 41–43,
52, 53, 55, 56
- Lecanicillium longisporum* 34
- Lecanicillium muscarium* 34
- lepidopteran eggs 71, 82
- lettuce 2, 3, 192, 202, 206
- Levuana iridescens* 26
- lifespan 134
- liquid culture 42, 46
- liquid fermentation 48, 53
- lomboy (*see also Jatropha cinerea*) 318–320
- long-term evaluation 181
- long-term insectary 209, 213, 217, 243, 246,
249, 256
- Lower Rio Grande Valley 19, 25, 83, 100,
123, 130, 143, 144, 147, 148,
150–152, 154, 155, 157, 179–185,
187, 188, 309, 314–316, 331
- LRGV, *see* Lower Rio Grande Valley
- M**
- macro-characters 113, 122
- Macrolophus caliginosus* 20
- Malaysia 19, 22, 33, 35, 44, 83, 115, 126,
127, 135, 141, 142, 182, 228
- Malva neglecta* 232
- mass production 46, 48, 53, 168, 243, 256,
259, 260
- mass rearing 112, 121, 123, 127, 148, 149,
155, 157, 161, 162, 169, 174, 181, 193,
227, 261, 284, 329, 330
- maximizing species diversity 111, 115, 117, 121
- MBCL, *see* Mission Biological Control
Laboratory
- meconia 27, 184, 216, 218, 248
- Medicago sativa* (*see also* alfalfa) 129, 206,
225, 244, 288
- Mediterranean 4, 18, 27, 33–35, 101, 143,
226, 228, 230
- Metarhizium anisopliae* 39, 49
- Mexico 2, 3, 5, 36, 84, 91, 98, 179, 192, 207,
208, 219, 316, 317, 326, 327, 330
- microbial insecticide 34, 37, 56
- microclimate 45, 51
- migration 151, 154, 187, 218, 254, 260, 291
- Miridae 20
- Mission Biological Control Laboratory
17, 20–22, 24–27, 29, 83, 99, 100,
112, 121–123, 125–127, 131–133,
152–155, 157, 162, 165, 166, 182,
183, 192–194, 196, 198, 207, 208,
211, 226–228, 248, 263, 266, 269,
309, 314, 329
- Mississippi 44, 91, 162, 207, 307, 309,
310, 313
- molecular characterization 18, 28, 111–119

molecular diagnostics 112, 117
 molecular fingerprint 26
 molecular sequence data 73
 monophyletic (*incl.* monophyly) 79–81
 morphological characters 18, 26, 50, 72, 73,
 76, 78, 79, 89, 91, 94, 98–100, 112, 116,
 140, 166, 180, 183, 185, 198, 221, 318
 morphological taxonomy 18
 morphology 6, 51, 90, 97, 112, 116, 122, 185,
 186, 198, 223
 morphometrics 74
 mortality 7, 37, 43, 45–50, 55, 56, 130, 203,
 211, 252, 256, 287, 291, 293, 297,
 299–303, 312, 313, 321, 331
 Multan (Pakistan) 19, 22, 23, 25, 116, 135,
 142, 143, 205, 218, 221, 228, 248, 266
 multivariate analysis 287–305
 multivariate statistics 288
 mung bean 2, 3
 mycelial growth 40
 mycoinsecticide(s) 50, 53, 57

N

Nabis 55
 National Research and Action Plan 5, 6, 18,
 89, 329
 native parasitoid complex 181, 314, 316
 native parasitoid(s) 7, 8, 20, 72, 121, 124,
 131, 147, 152–158, 181, 198, 207,
 209, 215, 221, 226, 234, 238, 259,
 260, 307–309, 315, 316, 325, 327,
 329–331
 native plant(s) 215, 307, 309, 310
 native species 121, 123, 124, 144, 152, 153,
 168, 182, 186, 191, 203, 213, 235,
 245, 249, 254, 263, 308
 natural enemies 6–9, 17–29, 33–35, 45, 47,
 54, 56, 89, 90, 102, 112, 116, 117,
 121–123, 127, 129–144, 148, 162, 164,
 170, 192, 205, 223, 243–255, 287, 288,
 290–292, 294, 299, 302–304, 307–309,
 315, 316, 325, 327, 329–331
 natural habitat 45
 natural regulation 34
 navel orange 140, 141
Neopomphale 318, 319
Neoseiulus californicus 164
 Nepal 33, 35, 36
 Neuroptera 206, 207, 318
 no-choice testing 126
 non-crop host 130
 non-target 34, 55, 57, 89, 90, 99, 101, 102,
 126, 215, 307, 308, 316, 318, 325, 330
 northeastern Africa 143

O

obligate hyperparasitism 132
 okra (see also *Abelmoschus esculentus*) 3, 4,
 22, 25, 180, 194, 202, 209, 216–218,
 227, 229, 243, 246–253, 311, 315, 320
 open field evaluation 122, 152
 orchid tree (see also *Bauhinia variegata*) 210,
 211, 214, 244, 252, 319
 organic (crops) 152, 209, 210, 218, 231,
 246, 260–262, 269–271, 273, 276,
 278–283, 312
Orius 55, 164, 206, 318
 ornamental (plants) 4, 18, 20, 53, 130, 180,
 186, 206, 211, 214, 245, 252, 303, 307,
 309, 310, 313, 317, 319
 outbreaks 1, 5, 7, 8, 17, 33, 34, 44, 48, 84,
 123, 129, 165, 167, 185, 192, 206,
 226, 229, 249, 251, 259, 260, 288–290,
 308, 309, 327
 overwintering 9, 18, 123, 132, 140, 154, 193,
 219, 226, 229, 230, 235, 238, 244, 288
 overwintering host 129, 229, 315
 overwintering refuge 132, 244

P

Paecilomyces 33, 34, 36, 38
Paecilomyces farinosus 36, 38
Paecilomyces fumosoroseus 8, 33, 35–41,
 45, 47, 48, 50–53, 55, 56, 331
 Pakistan 2, 4, 19, 22, 23, 25, 33, 35, 36, 83,
 115, 116, 121, 124, 125, 129–131,
 135–143, 147, 150, 151, 156–158,
 179, 182, 183, 186–188, 193, 194,
 196, 205, 206, 218, 221, 228, 229,
 231, 233, 243, 248, 255, 259, 266,
 309, 325, 326, 331
Parabemisia myricae 90, 108
Paraleyrodes 101
 parasitic Hymenoptera 20, 21, 90, 99, 102,
 113, 122, 207
 parasitism 7, 17, 27, 28, 55, 82, 122, 123,
 130, 133, 137, 147, 149, 150, 151,
 153–158, 168, 173, 181, 184, 188, 207,
 212, 213, 215, 218–220, 225, 230,
 232–234, 238, 243–245, 249, 250, 252,
 254, 255, 259, 260, 262–265, 267, 272,
 274, 281, 283, 287, 292–294, 297,
 300–303, 307, 313, 314, 321
 parasitoid cultures 8, 20, 116, 134, 162, 166,
 167, 176, 177
 parasitoid inoculated seedling transplants 179
 pathogen(s) 8, 33, 34, 41, 47, 48, 50–54, 56,
 57, 121, 171, 329, 331
Pectinophora gossypiella 143

- pepper 4, 38, 180, 192
 percent(age) parasitism 28, 250, 263–265, 267, 270, 271, 287, 292, 294, 297, 302, 303
 perennial 130, 214, 227, 243–245, 252, 292, 294, 316
 Persian Gulf 25, 26
 pesticide 6, 18, 27, 51, 53–56, 102, 129, 130, 163, 170, 171, 210, 256, 259, 261, 262, 266, 283, 284, 287, 291, 292, 294, 297, 299, 303, 325, 331
 pesticide resistance 18, 170
 Phillipines 22, 33, 35, 36, 83, 126
 phyllosphere 48, 50, 51
 phylogenetic analysis 78, 82
 phylogeny 28, 43, 81, 83
Physalis minima 28
Phytophthora 164, 170
 phytoseiid mites 321
 pink bollworm (see also *Pectinophora gossypiella*) 143, 290
 plant architecture 232
 plant surface(s) 45
 plant-fungus interaction(s) 52
 Platygastridae 132, 312
Pluchea purpurascens 316, 317
Pluchea sericea 317, 319
 poinsettia (see also *Euphorbia pulcherrima*) 4, 5, 21, 22, 38, 39, 45, 46, 53, 73, 84, 196
Polygonum sp. 28
 polyphagous 44, 126, 130, 331
 population dynamics 6, 9, 130, 247, 309
 population management 6
 post-release monitoring 197
 precipitation 45, 226
 predation 7, 55, 140, 141, 143, 252, 293, 313
 predator(s) 8, 17, 20, 54, 55, 57, 121, 124, 126, 127, 129, 130, 132, 143, 144, 164, 165, 167, 170, 195, 206, 212, 292, 293, 297, 299, 318, 321, 326, 329
 predictive studies 181
 predictor of field efficacy 117, 121
 pre-release studies 127, 179, 183, 320, 330
 primary parasitoid 71, 82, 89, 133, 184
 primer(s) 111, 113–117, 122, 294
 production 1, 4, 5, 7, 8, 19, 29, 34, 35, 41–44, 46, 48, 53, 97, 98, 111, 113, 115, 117, 123, 130, 131, 133–137, 139–142, 152, 161, 162, 164, 166–170, 172, 174–177, 206, 209, 211, 225, 230, 243, 247–249, 251, 252, 254, 256, 259–262, 266, 269, 271, 283, 284, 288–290, 292, 295, 297–299, 308, 309, 319
 progeny 25, 125, 131, 133–142, 166, 221, 260, 265, 299
 propagule 37, 40, 50
Prospaltella 72
 Proteobacteria 81
 pubescence 45
 Puerto Rico 25, 132, 208, 307, 308, 311, 312, 326
 pure culture 116, 122, 123
 pycnidia 45
Pythium 164, 170
- Q**
 Q-biotype, see Biotype Q
 quality control 111, 112, 115
 quarantine 9, 18, 20, 24–26, 29, 111–117, 121–127, 131, 132, 135, 137, 139, 143, 148, 150, 152, 162, 179, 181, 186, 192, 193, 329, 330
 quarantine bioassay 123
 quarantine culture 135, 148, 181, 208
 quarantine performance 125
 quarantine processing 111, 115
 quarantine protocol 122
 quarantine screening 124, 131, 150, 155, 157
 Queensland (Australia) 91, 100, 185, 325
- R**
 rainfall 45, 180, 192, 226, 325
 RAPD-PCR 18, 26, 28, 41, 79, 99, 111–117, 121, 122, 139, 140, 153, 157, 158, 160, 179, 181–185, 198, 213, 218, 235, 330
 RAPD-PCR (banding) patterns 25–27, 99, 111, 113–116, 228–229, 272
 rate(s) of parasitism 122, 149, 154, 157, 243, 249, 259, 260, 263, 265, 275–281
 rearing 8, 26, 29, 83, 93, 99, 101, 112, 121, 123, 127, 148, 149, 152, 155, 157, 161–188, 193, 200, 211, 227, 261, 284, 309, 321, 329, 330
 recovery 100, 117, 132, 143, 147, 153, 179–188, 191–203, 205–223, 235
 recovery methods 200
 recovery survey(s) 143, 185
 Reduviidae 55
 reference collection 91
 refuge planting(s) 153, 247
 regional survey(s) 310
 relative humidity 37, 40, 45, 48, 51, 53, 180, 192
 release 8, 9, 17, 18, 20, 25, 29, 41, 89, 91, 101, 102, 117, 121, 122, 127, 131–134, 143, 147–149, 151–158, 162–164, 168, 169, 173, 176, 179–188, 191–203, 205–223, 225–239, 243–245, 247, 248, 251, 253, 255, 256, 259–284, 287, 288, 290–292, 303, 308, 309, 316, 318, 320, 321, 325, 326, 329–331

- release rate 143, 182, 261, 263, 269–273, 275–284
- release strategies 256, 259, 261, 262, 331
- reservoir(s) 18, 130, 193, 210, 227, 244, 254, 287, 303, 307, 315, 321
- resistance 6, 7, 9, 18, 53, 170
- Rio Grande Valley (*see also* Lower Rio Grande Valley) 3, 9, 19, 25, 83, 100, 123, 130, 143, 144, 148, 150, 151, 157, 179–185, 187, 188, 309, 314, 315, 331
- ROBO 123
- Rosa* spp. 196, 210, 244, 317
- Ruellia brittoniana* 196
- S**
- sampling 9, 50, 57, 101, 102, 134, 140, 152, 156, 184, 185, 197, 200, 203, 212, 218, 220, 221, 231–234, 236, 247, 249, 252, 262, 266, 292–299, 303, 308, 310, 311, 315
- San Joaquin Valley 19, 20, 132, 225–240, 244, 256, 320, 321, 330
- San Jose scale 72
- satellite DNA 112, 185
- screening 9, 33, 35, 39, 42, 44, 117, 123, 124, 131, 133, 150, 155, 157, 226, 327
- searching ability 188
- searching efficiency 130
- seasonal crop(s) 288, 320
- secondary parasitoid 133
- seedling transplant(s) 179, 186, 331
- selective pathogen 54
- Semidalis* sp. nr. *flinti* 318
- sentinel locations 184
- sentinel plants 184, 185, 191, 197, 200, 201, 214, 219
- Serangium* 20, 55, 124, 127, 132, 142, 144, 208, 326
- Serangium montazerii* 132
- Serangium parcesetosum* 20, 55, 124, 127, 132, 142–144, 208
- Sesamum* 83
- sex ratio 72, 81, 134, 184, 213, 221
- sex ratio distortion 71, 81
- sibling species 73
- Sida* 28
- Signiphora* sp. 313
- Signiphora aleyrodalis* 311, 312
- silverleaf 313
- silverleaf symptoms 5
- silverleaf whitefly (*see also Bemisia argentifolii*) 6, 17, 33, 111, 112, 121, 129, 148, 186, 187, 232, 308, 329
- sleeve cage evaluations 147–152, 155
- sleeve cage(s) 121, 123, 148–150
- smoketree 317, 319
- Solanum* spp. 202, 235
- solar radiation 37, 50
- Sonchus oleraceus* 27, 186, 314
- Sonoran desert 192
- Sonoran silktree 317, 318
- South Carolina 307, 309, 310, 313
- southern USA 18, 129, 230, 307, 313
- southwestern USA 26, 122, 129, 130, 144, 192, 205, 243, 244, 259–261, 307–309, 330
- sowthistle (*see also Sonchus oleraceus*) 27, 180, 186, 229, 232, 314, 315
- soybean(s) 3–5, 21, 22, 180, 188
- Spain 4, 8, 17, 19–21, 23, 27, 29, 33, 35, 36, 83, 115, 116, 121, 124–127, 134–137, 139–142, 147, 149–152, 154–158, 182, 183, 186, 188, 193, 196, 218, 221, 228, 231, 233, 248, 263, 326
- spatial scale(s) 292, 295
- species complex 1, 17, 27, 34, 90, 101, 122
- species diversity 111, 115, 117, 121, 130
- species groups 74, 76–79, 82–84
- species identification 125, 126, 198, 221, 234, 310, 311, 314, 319
- species relationships 75
- spiny blackfly 72
- spore 3, 41, 44–50, 53, 54, 56
- spore concentration 43
- spore dispersal 45
- spore germination 40, 41
- sporulation 37, 42, 44, 46
- spotted spurge, *see Euphorbia maculata*
- squash 3, 5, 38, 50, 202, 294, 313, 314
- squash blot 99, 294
- stable habitat 288
- sticky trap(s) (*see also* yellow sticky trap) 55, 191, 195, 197, 200, 201
- storage 20, 175, 178, 212
- subtropical 19, 20, 28, 43, 179, 180, 188, 309, 330, 331
- sugar beets 2, 206
- sugarcane 180
- sunflower 3, 158, 180, 194, 202, 209, 235, 246, 247, 315
- sunflower oil 40
- survey 29, 73, 83, 130, 143, 158, 184, 185, 203, 210, 214, 215, 218–223, 225, 226, 233, 238, 254, 255, 307–321
- survival 37, 44, 45, 140, 188, 211, 233, 247
- sweet potato 1, 130, 180, 186, 313, 320

- sweetpotato whitefly 1, 5, 6, 89, 111, 121, 129, 148, 307, 308, 329–331
- systematics 6, 75, 89, 90, 96, 98–100, 113, 116, 117, 122
- T**
- Taiwan 4, 22–24, 33, 35, 36, 83, 115, 116, 126, 134–138, 183, 186, 228
- Tamaulipas (Mexico) 179
- taxonomic key(s) 122, 330
- taxonomy 18, 29, 71, 72, 74, 89, 90, 111, 117, 121
- technology transfer 6, 329
- Tecoma capensis* 196, 210, 252
- Tecoma stans* 196, 202
- temperature 20, 37, 41–45, 48, 49, 51–53, 113, 130, 133, 137, 138, 141, 167–169, 171, 172, 174–178, 180, 188, 192, 206, 226, 244, 248, 254, 294
- Tetraleurodes* 91, 101, 108, 109, 317–319
- Tetraleurodes acaciae* 101
- Tetraleurodes caulicola* 317–319
- Texas 3, 5, 6, 8, 9, 17–20, 24–26, 28, 29, 33, 35, 44, 52, 55, 83, 89, 91, 97, 99–101, 112, 114, 116, 117, 121, 123, 124, 126, 130, 131, 133, 135, 143, 144, 147–158, 162, 165, 175, 179–188, 192, 193, 207, 208, 211, 213, 226, 228, 230, 307–310, 314–316, 321, 325, 327, 331
- Thailand 2, 17, 19, 21–23, 27, 29, 33, 35, 44, 83, 91, 100, 115, 116, 125, 126, 134–137, 141, 142, 150, 151, 183, 188, 228
- tobacco 1, 3, 317
- tomatoes 3–5, 22, 23, 38–40, 44, 50, 51, 57, 98, 135, 180, 192, 202, 214, 312–134, 320
- Trialeurodes* 101, 102, 108, 109, 307, 308, 313, 315–319, 321
- Trialeurodes abutiloneus* 108, 109, 158, 188, 238, 307, 308, 313, 315–319, 321
- Trialeurodes vaporariorum* 24, 34, 39–46, 49, 51–55, 80, 99, 108, 109, 162, 238, 284, 313
- tritrophic interactions 51, 123, 124, 188, 330
- U**
- UAE, *see* United Arab Emirates
- ultraviolet light 45, 53, 294
- uniparental 21, 23, 98, 100, 122, 133–138, 144, 216
- unique banding pattern(s) 26, 111
- United Arab Emirates 4, 19, 22, 25, 28, 29, 129, 135–140, 188, 193, 198, 205, 218, 221, 228, 230, 233, 248, 259, 269
- urban area 138, 192, 193, 206, 219, 220, 295–298, 317, 319, 320
- urban hosts 218
- urban releases 209, 214, 218
- UV-B 37
- V**
- vegetable(s) 3, 4, 25, 129, 180, 181, 186, 192, 196, 206, 209, 214, 227, 229, 230, 253, 254, 259–261, 308, 309, 312, 313, 325
- Verbena rigida* 196
- Verticillium* 33, 34, 41
- Vigna caracalla* 196, 210, 252, 319
- virulence 41, 42, 46, 47
- voucher (specimens) 27, 99, 112, 117, 123, 133, 138, 311, 314, 316
- W**
- watermelon(s) 3, 4, 179, 180, 186
- weeds 17, 20, 28, 130, 144, 180, 215, 225, 230, 232–238, 307, 309–311, 313–316
- Weslaco (Texas) 24, 29, 33, 35, 55
- wetting agents 49
- whitefly density 152, 154, 157, 172, 196, 197, 213, 215, 231, 232, 246, 250–252, 259, 260, 263, 266, 268–270, 272, 275, 277–281, 283, 314, 316
- whitefly host plant 113, 177, 191, 194, 196, 206, 209, 210, 252
- whitefly-fungus interaction 45
- wildlife refuge(s) 153, 210, 244, 255
- winter vegetables 129, 180, 254
- Wintergarden (Texas) 179–181, 185, 186
- Wolbachia* 71, 72, 81
- X**
- Xanthium spp.* 28
- Y**
- yellow sticky trap 195, 197, 200
- Yuma (Arizona) 143, 191, 194, 196, 199, 207, 316, 319, 330
- Z**
- Zoophthora radicans* 36