

Foreign Exploration for Natural Enemies of *Bemisia tabaci* from Southeast Asia

J. C. Legaspi¹, B. C. Legaspi, Jr.², R. I. Carruthers³, J. Goolsby⁴, W. A. Jones², A. A. Kirk⁵, C. Moomaw, T. J. Poprawski², R. A. Ruiz⁴, N. S. Talekar⁶ and D. Vacek⁴

¹Texas Agricultural Experiment Station, The Texas A&M University System, 2415 East Highway 83, Weslaco, TX 78596

²USDA-ARS Beneficial Insects Research Unit, 2413 East Highway 83, Weslaco, TX 78596

³National Program Staff, USDA-ARS-NPS, BARC-WEST, Beltsville, MD 20705

⁴Mission Biological Control Center, USDA-APHIS-PPQ, Mission, TX 78572

⁵USDA-ARS European Biological Control Laboratory, Montpellier, France

⁶Asian Vegetable Research and Development Center, PO Box 42, Shanhua, Tainan, Taiwan 74199

ABSTRACT

There is speculation that the sweetpotato whitefly *Bemisia tabaci* (Gennadius) (biotype 'B') (= *B. argentifolii*) may have originated in the orient because of the diversity of endemic *Bemisia* species, and effective natural enemies are likely to be found in the region. Parasitoids native to southeast Asia also may be adapted to intended areas of introduction in south Texas, because of climatic similarities. Accordingly, four separate explorations for natural enemies of *B. tabaci* were conducted in the Philippines, Taiwan, Malaysia, Thailand, and Indonesia over a period from November, 1993 to October, 1995. The collections resulted in the importation into the United States of 22 geographic strains of the aphelinid genera *Encarsia* spp. and *Eretmocerus* spp., 2 coccinellids, 1 unidentified syrphid, and several isolates of 3 species of entomopathogenic hyphomycetous fungi. One strain of *Eretmocerus* from Taiwan may represent an undescribed species; another strain of *Eretmocerus* from Thailand currently is being described as a new species. No natural enemy cultures were obtained from Malaysia. The aphelinids collected were classified according to DNA banding patterns using RAPD-PCR techniques. The classification revealed an interesting diversity of patterns in both genera from Taiwan. We discuss some possible implications of the DNA patterns, as well as efforts to evaluate the parasitoids as biological control agents of the sweetpotato whitefly in south Texas and other parts of the US.

RESUMEN

Se especula que la mosca blanca del camote *Bemisia tabaci* (Gennadius) (Biotipo 'B') (= *B. argentifolii*) pudo haberse originado en el oriente debido a la diversidad de especies de *Bemisia* endémicas, y que sus enemigos naturales efectivos se encuentren probablemente en esta región. Los parasitoides nativos del sureste de Asia también podrían adaptarse a áreas determinadas en el sur de Texas debido a las similitudes climáticas. De acuerdo a esto, se condujeron cuatro exploraciones separadas para buscar enemigos naturales de *B. tabaci* en Filipinas, Taiwán, Malasia, Tailandia e Indonesia por un período comprendido entre noviembre de 1993 a octubre de 1995. La colección resultó en la importación a los Estados Unidos de 22 variantes geográficas de los afelinidos *Encarsia* spp. y *Eretmocerus* spp., 2 coccinélidos, un sírfido no identificado y 3 especies de hongos entomopatógenos. Una de las variantes de *Eretmocerus* proveniente de Taiwán podría representar una especie no descrita; otra variante de *Eretmocerus* proveniente de Tailandia está actualmente siendo descrita como una especie nueva. Ningún cultivo de enemigos naturales se obtuvo de Malasia. Los afelinidos colectados se clasificaron de acuerdo a los patrones de bandeo del DNA usando técnicas de RAPD-PCR. La clasificación reveló una diversidad interesante de patrones en ambos géneros en Taiwán. Se discuten algunas posibles implicaciones de los patrones del DNA, también como los esfuerzos para evaluar a los parasitoides como agentes de control biológico de la mosca blanca del camote en el sur de Texas y otras partes de los Estados Unidos.

The sweetpotato whitefly (SPWF), *Bemisia tabaci* (Gennadius) (Homoptera: Aleyrodidae) is an extremely destructive pest of field, ornamental, and greenhouse crops throughout the world because of a combination of its wide geographical range (Cock, 1986; 1993), high fecundity, short life-cycle (Baumgartner and Yano, 1990), broad host range (Cock, 1986; Byrne et al., 1990), ability to serve as a vector for plant viruses (Brown et al., 1992), production of exudate which promotes growth of sooty mold and resurgence and resistance to conventional insecticides (Dittrich et al., 1990).

Taxonomic uncertainty regarding *B. tabaci* and the recently described *B. argentifolii* Bellows and Perring (Bellows et al., 1994) makes it difficult to assess the global distribution of the whitefly as well as the relevance and accuracy of the literature purported to be on *B. tabaci* (see Brown et al., 1995). As a result, the geographical origin of *B. argentifolii* (= *B. tabaci* biotype "B") has been a matter of debate among taxonomists. Lopez-Avila (1986) (citing Mound 1965a,b; 1983) suggests that *B. tabaci* originated in the orient because of the presence of related indigenous species, and that human action resulted

Table 1. Insect natural enemies collected in Southeast Asia. Collections are tabulated by species identification, assigned identification number, DNA banding pattern, collection site, names of collector(s), date of collection, and original host plant

Species	ID	DNA	Collection site	Collectors ¹	Date	Host plant
<i>En. transvena</i> ²	M94014	EN-11	Benguet, Philippines	L, C, P	3-94	white potato
<i>En. transvena</i>	M95073		Los Baños, Philippines	L	6-95	cassava
Syrphidae	M94015		Benguet, Philippines	L, C, P	3-94	<i>Alcea rosea</i>
<i>En. transvena</i>	M94016	EN-11	Shanhua, Taiwan	L, C, P	3-94	tomato
<i>En. transvena</i>	M94017	EN-3	Shanhua, Taiwan	L, C, P	3-94	poinsettia
<i>En. transvena</i>	M94019	EN-4	Shanhua, Taiwan	L, C, P	3-94	soybean
<i>Eretmocerus</i> sp. nov. (?)	M93055	ERET-3	Tainan, Taiwan	M	12-93	poinsettia
<i>Eretmocerus</i> sp.	M93058	ERET-1	Tainan, Taiwan	M	12-93	tomato
<i>Eretmocerus</i> sp.	M94020	ERET-3	Shanhua, Taiwan	L, C, P	3-94	soybean, tomato
<i>Eretmocerus</i> sp.	M95097	ERET-3, 11	Tainan, Taiwan	J, T	10-95	tomato
<i>Er. nr. furuhashii</i>	M95098	ERET-11	Tainan, Taiwan	J, T	10-95	tomato
<i>Eretmocerus</i> sp.	M94022		Tainan, Taiwan	L, C, P	3-94	soybean
<i>Cheilomenes sexmaculata</i> ³	M94018		Shanhua, Taiwan	L, C, P	3-94	eggplant
<i>Illeis koebelei</i> ³	M94021		Shanhua, Taiwan	L, C, P	3-94	soybean
<i>En. transvena</i>	M95049		Hua Hin, Thailand	L, C	5-95	lantana
<i>En. transvena</i>	M95051		Hua Hin, Thailand	L, C	5-95	unknown
<i>En. transvena</i>	M95053		Hua Hin, Thailand	L, C	5-95	cassava
<i>En. transvena</i>	M95055		Hua Hin, Thailand	L, C	5-95	unknown
<i>En. transvena</i>	M95059		Krabi, Thailand	L, C	5-95	cassava
<i>Eretmocerus</i> sp. nov.	M95054	ERET-3	Him Mui, Thailand	L, C	5-95	unknown
<i>Encarsia</i> sp. ⁴	M95074		Medan, Indonesia	L, C, K	5-95	jasmine
<i>En. nr. strenua</i>	M95061		Cirebon, Indonesia	L, C, K	5-95	pumpkin
<i>En. nr. strenua</i>	M95063		Magelang, Indonesia	L, C, K	5-95	pumpkin
<i>Encarsia</i> sp.	M95070		Medan, Indonesia	L, C, K	5-95	jasmine
<i>Encarsia</i> sp.	M95075		Magelang, Indonesia	L, C, K	5-95	pumpkin

¹Collectors' identifications: L = Jesusa C. Legaspi; C = Raymond I. Carruthers; P = Tadeusz J. Poprawski; M = Charles Moomaw; K = Alan A. Kirk; J = Walker A. Jones; T = Narayan S. Talekar

² Collected from host insect *Trialeurodes* (Homoptera: Aleyrodidae) spp.

³ Coccinellidae

⁴ Collected from unknown species of whitefly host

in subsequent dispersal to India, America, and Africa. Greathead and Bennett (1981) (using the data of Mound and Halsey, 1978) found greatest diversity of *Bemisia* species, excluding *tabaci*, in the Palearctic and adjoining oriental regions. They argue that these regions constitute the center of diversity for the genus *Bemisia* and areas where effective natural enemies are likely to be found. Furthermore, parasitoids native to southeast Asia may be adapted to intended areas of introduction in south Texas, because of climatic similarities. Accordingly, four separate explorations for natural enemies of *B. tabaci* were conducted in the Philippines, Taiwan, Malaysia, Thailand, and Indonesia over a period from November, 1993 to October, 1995. We cite the natural enemies imported into the US against the whitefly which resulted from these explorations.

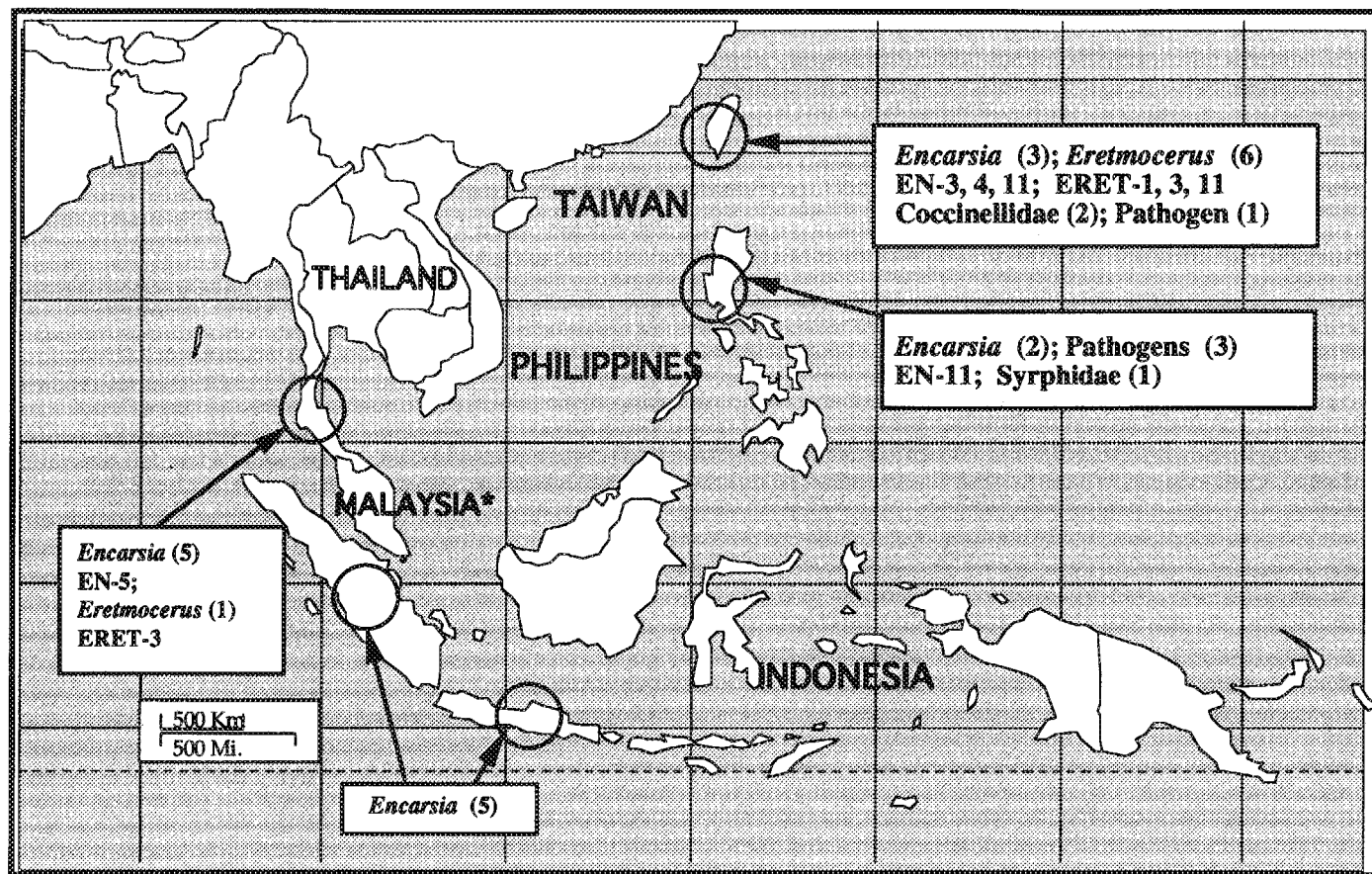
MATERIALS AND METHODS

Collections site and dates. Four trips were made to southeast Asian countries, over a period from November 1993 - October 1995: 1) November - December 1993: Philippines and Taiwan; 2) March 1994: Philippines and Taiwan; 3) May - June 1995: Philippines, Malaysia, Thailand and Indonesia;

4) September - October 1995: Taiwan.

In the first trip to Taiwan and the Philippines, collections were made from 4 Taiwanese provinces: Tao-Yuan (north; ~24° 50' N, 121° 30' E), Tai-Chung (central; ~24° 10' N, 120° 50' E), Tainan (south; ~22° 50' N, 120° 30' E) and Ping-Tung (south; ~22° 45' N, 120° 35' E). Host plants were predominantly greenhouse poinsettia (*Euphorbia pulcherrima* Willd. ex Klotzsch) and field eggplant (*Solanum melongena* L.), although some collections were also made from field tomato (*Lycopersicon esculentum* Miller) and soybean (*Glycine max* (L.) Merr.), as well as greenhouse soybean. In the Philippines, collections were taken from the provinces of Cavite (~14°28' N, 120° 50' E) and Quezon (~14° 25' N, 121° 30' E), situated in the southern parts of island of Luzon.

In the second series of collections from the Philippines parasites of *B. tabaci* were collected from cassava (*Manihot esculenta* Crantz) in the towns of Puypoy, Bay and Los Baños in the province of Laguna (~14° 10' N, 121° 15' E). Collections were also made in the provinces of Pangasinan (~16°N, 120° 25' E), Tarlac (~15° 40' N, 120° 30' E) and Benguet (~15° 30' N, 120° 45' E). The climate in Pangasinan and Tarlac is usually hot and dry in March (mean temperature ~27° C). Benguet is often cooler and more humid (mean tem-



* Collections made, but no natural enemies were obtained

Fig. 1. Map of natural enemies collected in Southeast Asia. Where appropriate, DNA banding pattern is indicated.

perature $\approx 21^{\circ}$ C) during the day because of its high elevation (~ 1800 m.).

In the third trip, a single collection was made from the Philippines (Los Baños, Laguna). A single collection was also made from Kuala Lumpur, Malaysia ($\sim 30^{\circ}$ N, 102° E) on cassava. Thirteen collections were made in Indonesia ($\sim 7^{\circ}$ S, 107° E), mostly in Cirebon, Magelang, central and western Java, and northern Sumatra. Whitefly parasites were collected on pumpkin (*Cucurbita pepo* L.), cassava, cucumber (*Cucumis sativus* L.), and jasmine (*Jasminum* sp. L.).

The fourth trip consisted of more collections from tomato host plants taken in Tainan, Taiwan.

Collection protocol. Collections for parasites were made following the methods described by Rose and DeBach (1990). Immature whiteflies, especially parasitized individuals, were excised from leaves in groups of ≈ 5 -10 whiteflies. The leaf cuttings were then placed into 0.25 dram glass vials. A thin streak of honey was applied to the inside of each vial using a camel hair brush. The vials were sealed with cotton and placed into a plastic container containing individual cells, similar to those used to hold bullet cartridges. Leaves with very high whitefly densities were placed in paper or plastic containers and separated using thin tissue. The samples were sorted by location, host plant and genera. Predators were kept individually in vials with leaves infested with whiteflies. Collections for entomopathogens were made only in the

Philippines and Taiwan. To collect entomopathogens, host cadavers were transferred individually using sterile techniques onto Sabouraud dextrose agar, supplemented with 1% yeast extract (SDAY) and 0.1% of the antibiotic, gentiain.

All samples collected were placed in homemade humidity controlled packages together with detailed collection notes and then transported to the Beneficial Insects Research Unit, USDA-ARS Subtropical Agricultural Research Center, Weslaco, Texas or APHIS-MBCC.

Insect identifications. Voucher specimens of the parasites collected were sent to M. Rose (currently at Montana State Univ.), G. Zolnerowich, and J. Woolley (Texas A&M, College Station, TX) and to M. Shauff (USDA Systematics Lab.) for identification. A coccinellid was sent to N. van den Berg (USDA Systematics Lab.) for identification. Samples of the whiteflies collected were sent to J. Brown (U. Arizona) and R. Gill (Univ. California) for genetic, enzymatic, and morphological identification and comparison to populations found in the US.

RAPD-PCR DNA analysis. The parasites quarantined at MBCC were assayed for their randomly amplified polymorphic DNA (RAPD) patterns using the techniques described in Black et al. (1992) to assist in taxonomic determinations. Individual insects are assigned to DNA pattern types (Vacek et al., 1996, 1997). The DNA of individual insects was amplified in a GeneAmp™ PCR System 9600 thermal cycler with

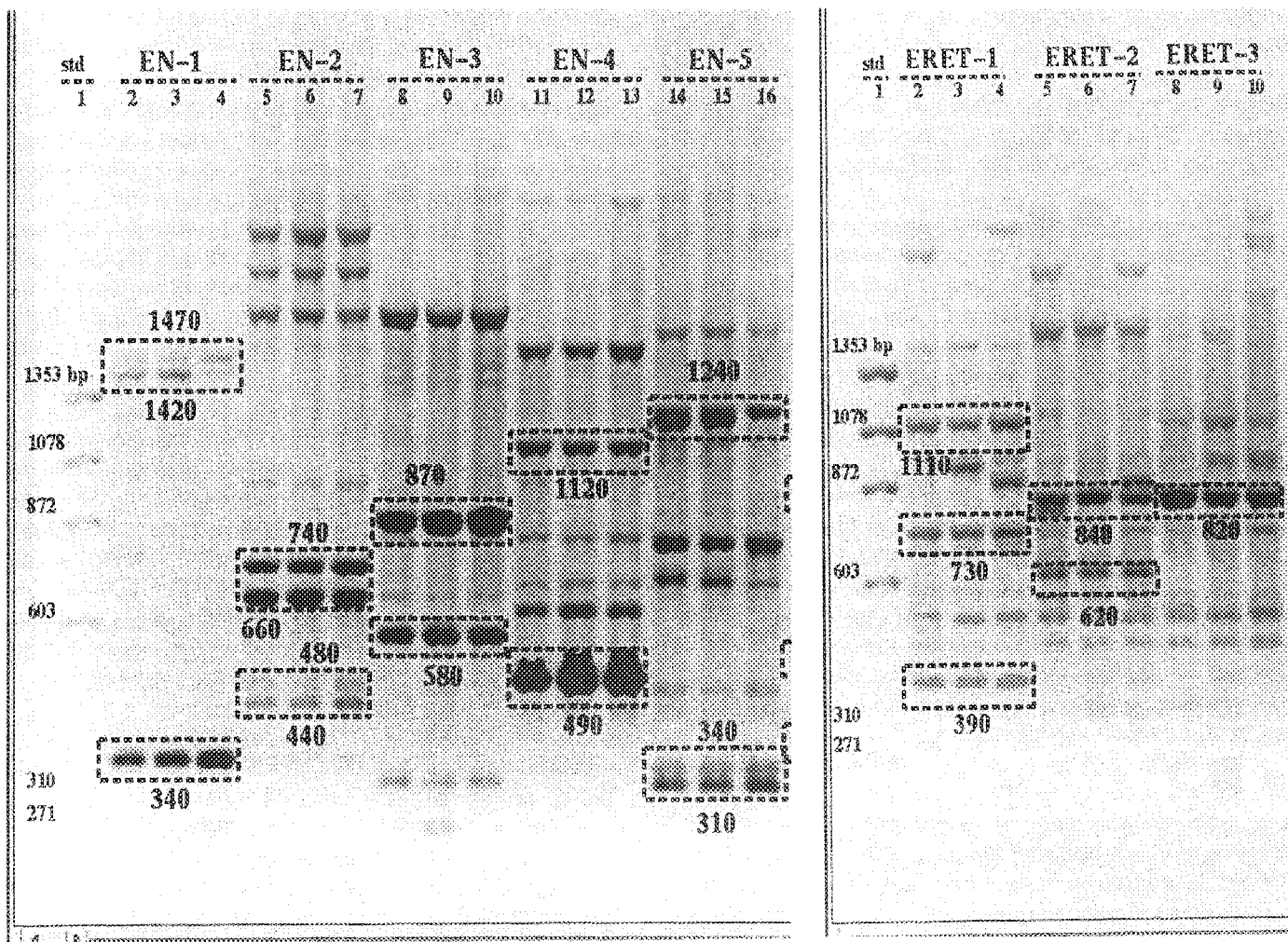


Fig. 2. Genetic fingerprints for selected *Encarsia* and *Eretmocerus* patterns. Each genetic pattern is represented by 3 insects, numbered across the top. Key diagnostic markers are indicated by the boxes, where the adjacent numbers represent the numbers of base pairs contained. The patterns EN-1 (India), EN-2 (Africa, Egypt, Greece, Thailand, USA), and ERET-2 (India) were obtained from studies independent to those described in this paper. The banding patterns for EN-11 showed key markers for 1450, 505, and 350 base pairs (figure not shown); and the pattern for ERET-11 showed key markers at 1250, 1110, 870, and 800 base pairs (figure not shown) (see text for details).

AmpliQ[®] DNA polymerase. Insect DNA preparation, specific DNA primers, PCR reaction mixtures, thermal cycler program, and electrophoresis followed those of Black et al. (1992), who identified discrete genetic markers in aphids and 2 micro-hymenopterans. The following primers were synthesized by Operon Technologies Inc. for use in this study: C04: 5'-CCGCATCTAC-3', C01: 5'-TTCGAGCCAG-3', BAM: 5'-ATGGATCCGC-3', and ECO: 5'-ATGAATTCGC-3'. The primers bind randomly to sections of insect DNA which are amplified and separated by electrophoresis according to numbers of base pairs amplified. In conjunction with classical taxonomic methods, these genetic "fingerprints" are used as key diagnostic tools for identification and classification of insects.

RESULTS AND DISCUSSION

Collection results. The collections from southeast Asia resulted in 22 geographic strains of parasites belonging to the

genera *Encarsia* or *Eretmocerus*, 2 coccinellids, 1 unidentified syrphid and 3 entomopathogenic fungi (Table 1 and Fig. 1). In Table 1, collections are tabulated by species identification, identification number, DNA banding pattern, collection site, names of collector(s), date of collection, and original host plant. Taiwan yielded 3 collections of *Encarsia*, representing 3 DNA banding patterns (EN-3, 4, 11), 6 collections of *Eretmocerus*, representing 3 banding patterns (ERET-1, 3, 11), and 2 predatory coccinellids, *Cheilomenes sexmaculata* (F.) and *Illeis koebelei* Timberlake obtained from eggplant and soybean, respectively. In the Philippines, 2 collections of *Encarsia* were obtained, 1 possessed EN-11 pattern and no DNA analysis was performed on the other. In addition, an unidentified syrphid was collected, as well as the entomopathogenic fungi *Paecilomyces fumosoroseus* (Wize) Brown & Smith, *Fusarium coccophilum* (Desmazieres) Wollenweber and Reinking, and *Beauveria bassiana* (Balsamo) Vuillemin (Fig. 1). An isolate of *Paecilomyces* was

also recovered from *Bemisia* on greenhouse cabbage, *Brassica* sp. L., in Shanhua, Taiwan. Isolates of the latter are being maintained at the USDA-ARS Plant Protection Research Unit (PPRU), Ithaca, NY, the USDA-ARS European Biological Control Laboratory (EBCL) in Montpellier, France, and the Beneficial Insects Research Unit, in Weslaco, TX.

In Thailand, 5 collections of *Encarsia* were obtained (no DNA analyses), as well as 1 species of *Eretmocerus* (ÉRET-3). Indonesia yielded 5 collections of *Encarsia*, although no DNA analyses were performed. The collections from Malaysia did not result in any insect natural enemies.

Sweetpotato whitefly was not a pest in Taiwan at the time of the first visit, except in greenhouse vegetables and poinsettia. The dominant whitefly problem was the spiraling whitefly, *Aleurodicus dispersus* Russell, which is found on a variety of hosts including guava (*Psidium guajava* L.), plumaria, poinsettia, papaya (*Carica papaya* L.) and a number of vegetable crops. A similar situation existed in the Philippines, where the sweetpotato whitefly was less of a problem, but the spiraling whitefly was ubiquitous. Although *B. tabaci* does not appear to be a pest of economic significance in these countries at the time of this writing, continued routine and indiscriminate applications of insecticides may eventually elevate *B. tabaci* to pest status.

Most of the *B. tabaci* during the second trip to Taiwan were found on poinsettias. The numbers of SPWF attained such high densities that scientists at the Asian Vegetable Research and Development Center (AVRDC) banned the use of poinsettias as ornamentals at the center. The tomato plants used for demonstration were also highly infested with SPWF. Many of the commercial fields were sprayed with insecticides although some field crops such as soybean were found to have parasitized whiteflies. Most of the plant hosts with parasitized whiteflies came from plants in the greenhouses that were not sprayed with insecticides. According to researchers at Taiwan Agricultural Research Institute, *B. tabaci* attacks at least 16 known host plants in Taiwan: florist's chrysanthemum (*Chrysanthemum morifolium* Ramat.), poinsettia, sunflower (*Helianthus annuus* L.), gerbera (*Gerbera jamesonii*), sweet potato (*Ipomoea batatas* (L.) Lam.), Indian lettuce (*Lactuca indica* L.), *Leonurus sibiricus*, eggplant, *Ludwigia octovalvis*, white mulberry (*Morus alba* L.), guava, *Pueraria lobata* (Willd.) Ohwi (Kudzu), an herb (*Rhinacanthus nasutus*), Cuba jute (*Sida rhombifolia* L.), *Solanum capsicastrum*, and *Tithonia diversifolia*.

In the Philippines, parasite larvae were observed in *B. tabaci* collected in Quezon on eggplant, sweet potato and non-cultivated squash (*Cucurbita* spp.). Whitefly were collected in Cavite from sweet potato and cultivated squash, but no parasites were observed. Collecting was hampered because of excessive rainfall during typhoon season in the Philippines. The cassava plants are usually not treated with insecticides and were grown mainly for subsistence rather than commercial production. Commercial plots which were sprayed were not good collection sites. The collections yielded 2 cultures which may represent undescribed species of *Eretmocerus*.

One strain of *Eretmocerus* sp. from Taiwan (M93055) may be undescribed. However, the culture was lost before it could be described. *Eretmocerus* M95054 from Thailand will be described as a new species (M. Rose, personal communication). Many of the parasitoids collected from southeast Asia and reported in this paper, together with others collected from other parts of the world have been evaluated while in quarantine, as well as in cage experiments, prior to field releases throughout the Lower Rio Grande Valley (Goolsby et al., 1996, 1997; J.A.G., W.A.J. unpublished data). Many of the exotics which have been permitted for release are also being evaluated by the Mission Biological Control Center and its cooperators in field cages in California and Arizona (Hoelmer, 1997).

Entomopathogens from the Philippines. Upon arrival at the BIRU in Weslaco, Texas, most of the plates containing the pathogen collections were found to be covered with saprophytic and/or phytopathogenic fungi belonging to the genera: *Cladosporium*, *Fusarium*, *Aspergillus*, *Penicillium*, *Fumago*, *Scorias* and *Capnodium*. However, after 3 to 5 subsequent transfers onto fresh SDAY, we were able to obtain pure cultures of 16 isolates of *B. bassiana*, 5 of *P. fumosoroseus* and 1 of *F. coccophilum*, all from adult *Bemisia* except for *F. coccophilum*.

RAPD-PCR analysis. Examples of the electrophoreses are illustrated in Fig. 2, for both *Encarsia* (Fig. 2A) and *Eretmocerus* species (Fig. 2B). Each number along the top axis indicates a separate insect sample; thus, each genetic pattern is represented by 3 insects. Key diagnostic markers are indicated by the boxes, where the adjacent numbers represent the numbers of base pairs contained. Generally, the darker the mark, the more reliable the fingerprint. The patterns EN-1 (India), EN-2 (Africa, Egypt, Greece, Thailand, USA), and ÉRET-2 (India) were obtained from studies independent to those described in this paper. The banding patterns for EN-11 showed key markers for 1450, 505, and 350 base pairs (figure not shown); and the pattern for ÉRET-11 showed key markers at 1250, 1110, 870, and 800 base pairs (figure not shown).

When the collections reported in this paper are pooled with those of other workers, RAPD-PCR genetic analyses revealed an interesting abundance of distinct DNA banding patterns in Taiwan. Only 1 pattern for *Encarsia* (EN-11) was found in the Philippines, whereas 4 each for *Encarsia* (EN-3, 4, 5, 11) and *Eretmocerus* (ÉRET-1, 3, 9, 11) were found in Taiwan. The *Encarsia* pattern found in the Philippines was found also only in Taiwan. *Encarsia* banding patterns EN-3 and EN-4 are currently unique to Taiwan. The *Eretmocerus* patterns ÉRET-9 and ÉRET-11 are currently unique to Taiwan, and ÉRET-3 has also been found in Thailand. In contrast, the pattern ÉRET-1 is widely distributed, having also been found in populations collected from: Egypt, India, Spain, Italy, and Israel. It is interesting to speculate whether the diversity of genetic patterns discovered in a given country or geographical area simply reflects greater collection efforts relative to other localities or suggests an underlying evolutionary diversification.

ACKNOWLEDGEMENT

This research was truly an exercise in international collaboration. We thank the following people for facilitating our collections in their respective countries: R. Morakot (Thailand); B. Legaspi, Sr. (Philippines); L. Wei Hong (Malaysia); I. Nimbi, M. and E. Shepard (Indonesia); F. C. Su and S. F. Chung (Taiwan). Taxonomic expertise was kindly provided by M. Rose (Montana State University), G. Zolnerowich, and J. Woolley (Texas A&M, College Station, TX), N. van den Berg (USDA Systematics Lab.), M. Shauff (USDA Systematics Lab.), J. Brown (Univ. Arizona) and R. Gill (Univ. California). The manuscript was improved through reviews kindly provided by K. R. Summy (USDA-ARS Crop Insects Research Unit) and G. J. Hallman (USDA-ARS Crop Quality and Fruit Insects Research Unit). We acknowledge the excellent technical assistance of J. Hadman (APHIS-MBCC). G. Mercadier (USDA-ARS-EBCL) isolated the *Paecilomyces* collected from Taiwan. This research was supported in part by grant no. 58-319R-1-028 from the NCISE-IARC Pilot Linkage Program. Approved for publication by the director of the Texas Agricultural Experiment Station.

LITERATURE CITED

- Baumgartner, J. and E. Yano, E. 1990. Whitefly population dynamics and modelling. pp. 123-146. In D. Gerling (ed.), *Whiteflies: their bionomics, pest status and management*. Intercept. Andover, Hants., UK.
- Bellows, T. S. Jr., T. M. Perring, R. J. Gill and D. H. Headrick. 1994. Description of a species of *Bemisia* (Homoptera: Aleyrodidae). *Ann. Entomol. Soc. Am.* 87, 195-206.
- Black, W. C. IV, N. M. DuTeau, G. J. Puterka, J. R. Nechols and J. N. Pettorini. 1992. Use of the random amplified polymorphic DNA polymerase chain reaction (RAPD-PCR) to detect DNA polymorphisms in aphids (Homoptera: Aphididae). *Bull. Entomol. Res.* 82: 151-159.
- Brown, J. K., H. S. Costa and F. Laemmlen. 1992. First report of whitefly-associated squash silverleaf disorder of *Cucurbita* in Arizona and of white streaking disorder of Brassica species in Arizona and California. *Plant Dis.* 76: 426.
- Brown, J. K., D. R. Frohlich and R. C. Rosell. 1995. The sweetpotato or silverleaf whiteflies: Biotypes of *Bemisia tabaci* or a species complex? *Annu. Rev. Entomol.* 40: 511-534.
- Byrne, D. N., T. S. Bellows and M. P. Parrella. 1990. Whiteflies in agricultural systems. pp. 227-262. In D. Gerling (ed.), *Whiteflies: their bionomics, pest status and management*. Intercept. Andover, Hants., UK.
- Cock, M. J. W. (ed.). 1986. *Bemisia tabaci*- A Literature Survey on the Cotton Whitefly with an Annotated Bibliography - FAO, CAB IIBC. 121 pp.
- Cock, M. J. W. (ed.). 1993. *Bemisia tabaci*- An Update on the Cotton Whitefly with an Annotated Bibliography - IIBC, CSC, FAO, IICA. 78 pp.
- Dittrich, V., S. Uk, and G. H. Ernst. 1990. Chemical control and insecticide resistance of whiteflies. pp. 263-285 In D. Gerling [ed.] *Whiteflies: Their Bionomics, Pest Status and Management*. Intercept Ltd.
- Goolsby, J., J. C. Legaspi and B. C. Legaspi, Jr. 1996. Quarantine evaluation of exotic parasites of the sweetpotato whitefly, *Bemisia tabaci* (Gennadius). *Southwest. Entomol.* 21: 13-21.
- Goolsby, J. G., B. C. Legaspi, Jr. and W. Jones. 1997. Quarantine screening of natural enemies. p. 71 In T. J. Henneberry, N. C. Toscano, R. M. Faust, and D. Kopp (eds.). *Silverleaf whitefly supplement to the 5-year National Research and Action Plan: progress review, technology transfer and new research and action plan (1997-2001)*, San Diego, CA, 28-30 Jan. 1997. USDA.
- Greathead, D. J and F. D. Bennett. 1981. Possibilities for the use of biotic agents in the control of the white fly, *Bemisia tabaci*. *Biocontrol News Info.* 2, 7-13.
- Hoelmer, K. 1997. 1996 field cage evaluations of non-indigenous parasitoids in desert crops p. 75 In T. J. Henneberry, N. C. Toscano, R. M. Faust, and D. Kopp (eds.). *Silverleaf whitefly supplement to the 5-year National Research and Action Plan: progress review, technology transfer and new research and action plan (1997-2001)*, San Diego, CA, 28-30 Jan. 1997. USDA.
- Lopez-Avila. A. 1986. Taxonomy and biology. In: *Bemisia tabaci*- A Literature Survey on the Cotton Whitefly with an Annotated Bibliography (M. J. W. Cock, ed) - FAO, CAB IIBC, 3-11.
- Mound, L. A. 1965a. Effect of leaf hair on cotton whitefly populations in the Sudan Gezira. *Emp. Cotton Grow. Rev.*, 42, 33-40.
- Mound, L. A. 1965b. Effect of whitefly (*Bemisia tabaci*) on cotton in the Sudan Gezira. *Emp. Cotton Grow. Rev.*, 42, 290-294.
- Mound, L. A. 1983. Biology and identity of whitefly vectors of plant pathogens. pp. 305-313 In R. T. Plumb and J. M. Thresh (eds.). *Plant Virus Epidemiology: The Spread and Control of Insect-Borne Viruses*. Blackwell.
- Mound, L. A. and S. M. Halsey. 1978. *Whitefly of the World*. British Museum.
- Rose, M. and P. DeBach. 1990. Foreign exploration and importation of natural enemies. pp. 417-431 In D. Rosen (ed.). *The armored scale insects. Their biology, natural enemies and control*. Vol B. Elsevier.
- Vacek, D. C., R. A. Ruiz, and L. E. Wendel. 1996. RAPD-PCR identification of natural enemies of SPWF. p. 149 In T. J. Henneberry, N. C. Toscano, R. M. Faust, and J. R. Coppedge (eds.). *Silverleaf whitefly (formerly sweetpotato whitefly, strain B): 1996 supplement to the 5-year National Research and Action Plan - 4th Ann. Rev.* San Antonio, TX, 4-6 Feb, 1996. USDA.
- Vacek, D. C., R. A. Ruiz, and L. E. Wendel. 1997. RAPD-PCR identification of natural enemies of SPWF. p. 94 In T. J. Henneberry, N. C. Toscano, R. M. Faust, and D. Kopp (eds.). *Silverleaf whitefly supplement to the 5-year National Research and Action Plan: progress review, technology transfer and new research and action plan (1997-2001)*, San Diego, CA, 28-30 Jan. 1997. USDA.