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Authors: Hernández-Ortiz, Vicente, Delfín-González, Hugo, Escalante-Tio, Andrés, and Manrique-Saide, Pablo

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HYMENOPTERAN PARASITOIDS OF *ANASTREPHA* FRUIT FLIES (DIPTERA: TEPHRITIDAE) REARED FROM DIFFERENT HOSTS IN YUCATAN, MEXICO

VICENTE HERNÁNDEZ-ORTIZ [1], HUGO DELFÍN-GONZÁLEZ [2], ANDRÉS ESCALANTE-TIO [2] AND PABLO MANRIQUE-SAIDE [2]
[1]Instituto de Ecología A.C., Km 2.5 carretera antigua a Coatepec No. 351, Congregación El Haya
Apartado Postal 63, C.P. 91000, Xalapa, Veracruz, México

[2]Universidad Autónoma de Yucatán, Facultad de Medicina Veterinaria y Zootecnia, Depto. de Zoología
Apartado Postal 4-116, Mérida, Yucatan, Mexico

ABSTRACT

In order to carry on the detection and species inventory of hymenopteran parasitoids associated with fruit flies, we examined various tropical fruits growing at the Southern region of Yucatan. During a yearly cycle (Jun 2000 to Jun 2001), 9 host fruit species (including some varieties) were collected by 2 different methods. The first method involved weekly collection of ripened fruits that were transported to the laboratory ("Fruit-Lab"); and the second method was collection of fruits placed on the ground below the tree canopy ("Fruit-Beds"), and which remained in the field for two weeks, after which they were transported to the laboratory. Fruits obtained were counted and weighed, and the recovered pupae were quantified for each sample. As a whole, we sampled 4,470 fruits (850.8 Kg) from the 9 host plant species and varieties, which were infested by 5 fruit fly species: *Anastrepha ludens* (Loew), *A. obliqua* (Macquart), *A. serpentina* (Wiedemann), *A. striata* Schiner, and *A. fraterculus* (Wiedemann). The average parasitism in all samples was 3.69% represented by 11 hymenopteran species as follows: Braconidae, *Doryctobracon areolatus* (Szépligeti), and *Opius bellus* (Gahan); Figitidae, *Aganaspis pelleranoi* (Brethes), *Aganaspis* sp., *Odontosema anastrephae* Borgmeier and *Odontosema* sp.; Diapriidae, *Coptera haywardi* (Oglobin); Chalcididae, *Dirhinus* sp.; Pteromalidae, *Spalangia endius* Walker; Eurytomidae, *Sycophila* sp.; and Perilampidae, *Euperilampus* sp. On the basis of results in differences among samples for parasitism rates, fruit fly parasitoid, and fruit fly host plant, parasitoid assemblages are analyzed and discussed.

Key Words: parasitism, fruit flies, host plants, natural enemies

RESUMEN

Con el propósito de realizar la detección e inventario de especies de parasitoides asociados con moscas de la fruta, se examinaron diversos frutos tropicales cultivados en la región Sur del estado de Yucatán. Durante el ciclo anual comprendido entre junio de 2000 a junio de 2001, se estudiaron nueve especies y variedades de frutos de la región, empleando dos métodos de colecta: el primero se realizó por medio de la colecta semanal de frutos maduros transportados al laboratorio ("Fruit-Lab"); y el segundo mediante la recolección de camas de frutos ("Fruit-Beds") colocados en el suelo bajo la cobertura de los árboles, los cuales permanecieron por dos semanas, y posteriormente trasladados al laboratorio. En ambos casos, los frutos fueron contados y pesados, además de la cuantificación de pupas recuperadas en cada muestra. En total se recolectaron 4,470 frutos (850.8 Kg) de las nueve especies y variedades de plantas hospederas, las cuales resultaron infestadas por cinco especies de moscas de la fruta: *Anastrepha ludens* (Loew), *A. obliqua* (Macquart), *A. serpentina* (Wiedemann), *A. striata* Schiner, y *A. fraterculus* (Wiedemann). La proporción de parasitismo en todas las muestras fue de 3.69% representado por 11 especies de himenópteros de las siguientes familias: Braconidae, *Doryctobracon areolatus* (Szépligeti), y *Opius bellus* (Gahan); Figitidae, *Aganaspis pelleranoi* (Brethes), *Aganaspis* sp., *Odontosema anastrephae* Borgmeier, and *Odontosema* sp.; Diapriidae, *Coptera haywardi* (Oglobin)); Chalcididae, *Dirhinus* sp.; Pteromalidae, *Spalangia endius* Walker; Eurytomidae, *Sycophila* sp.; and Perilampidae, *Euperilampus* sp.. Con base en estos resultados, se analizan y discuten las diferencias entre los índices de parasitismo, así como entre los ensambles mosca- parasitoide y planta hospedera-parasitoide.

Translation provided by the authors.

Diverse regional studies in Latin America have addressed the incidence of native parasitoids of the genus *Anastrepha* in countries such as Guatemala (Eskafi 1990), Costa Rica (Jirón & Mexzon 1989), Colombia (Yepes & Vélez 1989; Carrejo & González 1999), Venezuela (Katiyar et

al. 1995; Boscán & Godoy 1996; García & Montilla 2001), Brazil (Canal et al. 1995; Leonel et al. 1995; Guimarâes et al. 1999; Aguiar-Menezes et al. 2001), and Argentina (Ovruski 1995; Ovruski et al. 2004, 2005).

Previous studies have stated that as many as 18 parasitoid species of *Anastrepha* have been recorded in Mexico, including the exotic species *Diachasmimorpha longicaudata* (Ashmead) and *Aceratoneuromyia indica* (Silvestri), both of which have been considered as established (Ovruski et al. 2000). However, at least 6 other exotic species have been introduced into Mexico for control of *A. ludens* and *A. obliqua* (Jiménez-Jiménez 1955, 1956, 1963).

Inventories of native parasitoids of *Anastrepha* fruit flies have been conducted in commercial orchards at Morelos and Chiapas (McPhail & Bliss 1933; Baker et al. 1944; Aluja et al. 1990), but also in wild environments associated with native fruit fly hosts in Nuevo León (Plummer & McPhail 1941; González-Hernández & Tejada 1979), Veracruz (Hernández-Ortiz et al. 1994; López et al. 1999), and Chiapas (Aluja et al. 2003). Inventories have not been done in many other fruit growing regions of Mexico.

Anastrepha ludens (Loew), *A. obliqua* (Macquart), *A. serpentina* (Wiedemann), *A. striata* Schiner, *A. fraterculus* (Wiedemann), *A. ampliata* Hernández-Ortiz, and *A. pallens* (Coquillett) have been recorded from the state of Yucatan (Hernández-Ortiz et al. 2002). The first 4 species are significant pests in fruit crops in Mexico and most of the Neotropics (Hernández-Ortiz & Aluja 1993). Fruit fly control in Yucatan has generally involved use of pesticides (CESVY 2000), and very little is known of the native hymenopteran parasitoid communities. An earlier regional study showed the presence in Yucatan of certain Opiinae (Braconidae) that potentially parasitize *Anastrepha* species, including *Doryctobracon* Ender, *Utetes* Foerster, and *Opius* Wesmael (Delfín-González & León 1997), although sampling methods in that study were not focused on host collection. Thus, specific relationships between *Anastrepha* and braconid species remain unknown.

The present study focuses on the search for and inventory of parasitoids that attack *Anastrepha* species, as well as determination of the relationships between fruit flies, host plants, and parasitoids in the fruit growing region of southern Yucatan, which mainly consists of mixed orchards of citrus, mango, sapodilla, guava, and red mombin.

Materials and Methods

The study was carried out in mixed commercial orchards in the Yaax-Hom Fruit Unit, 5 km from the Lol-Tun archaeological site, Oxkutzcab municipality, in southern Yucatan (20°18'N, 89°42'W). Surrounding native vegetation is semi-evergreen tropical forest (Flores & Espejel 1994). Collection of fruit samples occurred from Jun 2000 to Jun 2001, and included 9 host plant species during their fruit-growing seasons: sour orange, *Citrus aurantium* L. (Aug 2000 to Jan 2001); Valencia orange, *C. sinensis* (L.) Osbeck var. valenciana (Oct 2000 to Mar 2001); Ruby grapefruit, *C. paradisi* MacFad (Jul 2000 to Jan 2001); star apple, *Chrysophyllum cainito* L. (Jan to Mar 2001); mango, *Mangifera indica* L. c.v. cordoba, criollo, pico de loro, and manglova (Mar to Jul 2001); sapodilla, *Manilkara zapota* (L.) P. Royen (Sept to Dec 2000); mamey sapote, *Pouteria sapota* (Jacq.) H. Moore & Stearn (Apr to Jul 2001); guava, *Psidium guajava* L. (Jun to Sep 2000; Febr , April to Jun 2001); and red mombin, *Spondias purpurea* L. c.v. San Juan, tuxpana, and chi-abal (Apr to May 2001).

Fruits were sampled during the fruiting season of each host plant, according to availability of mature fallen fruits under the trees by means of 2 different methods as follows:

(1) Fruit-Lab Samples. Fruits were weekly sampled, placed in 20-liter containers with a substrate of soil from the collection site, covered with wire mesh and topped with a fine-mesh screen to prevent contamination. Samples were taken to the laboratory where they were counted, weighed, and reviewed daily. The recovered pupae were separated in small plastic containers for adult fly and parasitoid emergence.

(2) Fruit-Bed samples. This method was implemented once a sufficient amount of fruits were available. Collected fruits were arranged in "fruit-beds" under the tree canopy, consisting of a plastic tarp covered with soil, containing a known number of fruits previously weighed. "Fruit-beds" remained in the field for 2 weeks and were observed. All pupae recovered were taken to the laboratory in small plastic containers for adult fly and parasitoid emergence.

Percent of parasitism (PP) was recorded as PP = a/(a + b) 100, where a = Number of recovered parasitoids; and b = Number of emerged adult flies in each sample (Steck et al. 1986). Correlation analysis (Statistica 1999) was used to compare mean fruit weight of host sampled (calculated as the $Log_{(10)}$ of fruit weight), infestation index (calculated as the number of larvae/Kg fruit), and percentage of parasitoids recovered in each sample.

Specimens of fruit flies and parasitoids were determined by VHO and HDG, respectively. Voucher specimens are deposited in the Insect Collections (IEXA) of the Instituto de Ecologia (Xal-

apa, Veracruz), and in the Regional Entomological Collections (CERUY) of the Universidad Autónoma de Yucatán (Mérida, Yucatán). Botanical samples were identified by personnel of the Botanical Department of the UADY and deposited in the Herbarium of this institution. Botanical nomenclature is based on Terrel et al. (1986), and parasitoid nomenclature follows Ovruski et al. (2000).

Results

Altogether, 4,470 fruits (850.8 kg) from 9 host species (including 4 mango varieties and 3 red mombin varieties) were examined and found to be infested by 5 *Anastrepha* species. All the citrus hosts (*C. aurantium*, *C. sinensis*, and *C. paradisi*) were infested by *A. ludens*, and 1 specimen of *A. serpentina* was recovered from ruby grapefruit and 2 from sour orange. A single specimen of *A. fraterculus* was found in sour orange. The hosts of the family Sapotaceae (*C. cainito*, *P. sapota* and *M. zapota*) were only infested by *A. serpentina*, and all *S. purpurea* varieties were infested by *A. obliqua*. The mango varieties (*M. indica*) were infested by *A. ludens* (53.4%) and *A. obliqua* (45.9%), and 2 specimens of *A. serpentina* were recovered. The guava fruits (*Psidium guajava*) were infested by *A. fraterculus* (84.2%) and *A. striata* (15.8%).

In total, 12,929 larvae and pupae were recovered from the sampled fruits. Although the number of fruits collected by each sampling method were equivalent, the "Fruit-Lab" samples exhibited a higher degree of infestation (2,227 fruits, with 8,511 recovered pupae), than that left in the "Fruit-Bed" samples (2,243 fruits, with 4,418 recovered pupae). The highest infestation indices per host were observed in *P. guajava* (103.2 larvae/Kg), *S. pupurea* (all varieties with 83.3 to 44 larvae/Kg), *C. cainito* (40.4 larvae/Kg), *P. sapota* (29.6 larvae/Kg), and *C. aurantium* (22.5 larvae/Kg). The lowest infestation rates occurred in *M. indica* (all varieties with 15.9 to 0.3 larvae/Kg), *M. zapota* (15.7 larvae/Kg), *C. sinensis* (4.2 larvae/Kg), and *C. paradisi* (3.1 larvae/Kg). Sample sizes in some of these low-infestation hosts were relatively small. In total, 9,223 fruit fly viable pupae were recovered during the study, which produced 8,883 adult flies and 340 parasitoid specimens. Average parasitism of all fruit flies was 3.69% (Table 1).

The recovered parasitoids included the following 11 species: the larval-pupal parasitoids *D. areolatus* (Szépligeti) and *Opius bellus* (Gahan) (Braconidae); *Aganaspis pelleranoi* (Brethes), *Aganaspis* sp., *Odontosema anastrephae* Borgmeier and *Odontosema* sp. (Figitidae); and the pupal parasitoids *Coptera haywardi* (Oglobin) (Diapriidae), *Dirhinus* sp. (Chalcididae), and *Spalangia endius* Walker (Pteromalidae). In addition, 2 other parasitoid species in the genera *Sycophila* sp. (Eurytomidae) and *Euperilampus* sp. (Perilampidae) were recorded for the first time in *Anastrepha*.

Relationships between fruit fly-parasitoids among samples showed that *A. ludens* was attacked in *Citrus* spp. by 5 parasitoids, which accounted for 29.3% of overall species, while in *M. indica* only 2 parasitoid species were recorded with 0.6%. In this sense, *A. obliqua* was parasitized in *Spondias purpurea* by 5 parasitoid species (16.7%); *A. serpentina* was attacked by 5 parasitoids (25.6%) infesting 3 hosts of the family Sapotaceae; and the *Psidium guajava* fruits infested by *A. striata*/*A. fraterculus* were parasitized by 8 species (27.8%).

Odontosema anastrephae was found in 7 host plant species representing 43.2% of all recovered parasitoids with highest proportions in *Psidium guajava* and *Citrus aurantium*. *Coptera haywardi* represented by 16.2% of parasitoids was found in 6 hosts; *Doryctobracon areolatus* (14.2%) was present in 4 hosts, particularly in *C. cainito*; and *Spalangia endius* only accounted for 6.5% of the overall recorded parasitism, but it was found in 4 different fruit hosts (Table 2).

Parasitism observed between 2 sampled collections revealed that specimens recovered from "Fruit-Bed" samples were higher than those recovered from the "Fruit-Lab" samples with 68.5% and 31.5%, respectively. In this sense, species as *C. haywardi*, *O. anastrephae*, *S. endius*, and *Dirhinus* sp. were dominant in "Fruit-Beds" accounting for 65% of all parasitoid specimens. On the contrary, the dominant species observed in "Fruit-Lab" samples were *D. areolatus*, *Sycophila* sp. and *Euperilampus* sp., which accounted for 21.2%. Table 3 shows the proportions of parasitoids by hosts obtained from each sampling method.

Correlation analysis between average fruit weight (Log Fruit Weight) and the infestation index (Mean Larvae/kg Fruit) were significant (r = -0.695; P = 0.005), indicating that as average weight increased in the different fruit species, the degree of infestation in the sample decreased. In contrast, there was not a significant correlation between the average fruit weight and the percentage of parasitism (r = -0.090; P = 0.758), and no correlation between infestation index and the percentage of parasitism among samples (r = 0.270; P = 0.350).

Discussion

All parasitoid species reported here are first records for *Anastrepha* in Yucatan. No previous published records exist in literature of the genera *Sycophila* sp. (Eurytomidae) and *Euperilampus* sp. (Perilampidae) as parasitoids in *Anastrepha* (Ovruski et al. 2000). In this sense, *Eurytoma sivinskii* Gates & Grissell (Eurytomidae) was recently described attacking field populations of

TABLE 1. HOST PLANT SAMPLED AND RECOVERED FRUIT FLY PUPAE AND PARASITOIDS OF *ANASTREPHA* SPECIES IN YUCATAN MEXICO. *MANGIFERA INDICA*: 1 = VAR. CORDOBA; 2 = VAR. CRIOLLO; 3 = VAR. PICO DE LORO; 4 = VAR. MANGLOVA; *SPONDIAS PURPUREA*: 1 = VAR. SAN JUAN; 2 = VAR. TUXPANA, 3 = VAR. CHI-ABAL.

Host plant	Fruit sampled	Total fruit weight (Kg)	Mean fruit weight (Kg)	Infestation (larvae/Kg)	Total pupae recovered	Pupae viable	Flies emerged	Parasitoids emerged	Parasitism %
C. aurantium	558	90.40	0.162	22.50	2037	1630	1578	52	3.19
C. sinensis	732	138.60	0.189	4.24	587	438	414	24	5.48
C. paradisi	251	124.40	0.496	3.15	392	269	245	24	8.92
Ch. cainito	200	22.80	0.114	40.40	918	514	447	67	13.04
M. indica 1	325	64.70	0.199	2.80	179	110	108	2	1.82
M. indica 2	29	4.60	0.159	15.90	73	67	67	0	0.00
M. indica 3	225	87.00	0.387	0.33	29	23	23	0	0.00
M. indica 4	234	105.90	0.453	1.20	127	81	81	0	0.00
Ma. zapota	454	83.60	0.184	15.70	1310	1084	1072	12	1.11
Po. sapota	92	72.80	0.791	29.60	2157	1940	1932	8	0.41
Ps. guajava	442	26.80	0.061	103.20	2765	1773	1679	94	5.30
S. purpurea 1	716	26.80	0.037	83.30	2232	1188	1133	55	4.63
S. purpurea 2	138	1.75	0.013	44.00	77	73	72	1	1.36
S. purpurea 3	74	0.65	0.009	70.80	46	33	32	1	3.03
All samples	4470	850.8	0.232	31.2	12929	9223	8883	340	3.69

TABLE 2. PARASITOID SPECIES EMERGED BY HOST FRUIT SPECIES UNDER 2 DIFFERENT SYSTEMS OF COLLECTION. *M. INDICA*; 1 = VAR. CORDOBA; *S. PURPUREA*; 1 = VAR. SAN JUAN; 2 = VAR. TUXPANA; 3 = VAR. CHI-ABAL. ACRONYMS FOR PARASITOID SPECIES ARE AS FOLLOWS: DAR = *D. AREOLATUS*; OBEL = *O. BELLUS*; CHAY = *C. HAYWARDI*; APELL = *A. PELLERANOI*; ASP = *AGANASPIS* SP.; OANAS = *O. ANASTREPHAE*; OSP = *ODONTOSERNA* SP.; SPEND = *S. ENDIUS*; DSP = *DIRHINUS* SP.; SYSP = *SYCOPHILA* SP.; ESP = *EUPERILAMPUS* SP.

Hosts	Parasitoids	Oar	Obel	Chay	Apell	Asp	Oanas	Osp	Spend	Dsp	Sysp	Esp	Totals	% by sample
C. aurantium	Fruit Lab	0	0	0	1	0	1	1	0	0	0	0	3	0.9
	Fruit beds	0	0	8	0	0	38	0	3	0	0	0	49	14.4
C. sinensis	Fruit Lab	0	0	0	0	0	1	0	0	0	0	0	1	0.3
	Fruit beds	0	0	6	0	0	10	0	7	0	0	0	23	6.8
C. paradisi	Fruit Lab	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Fruit beds	0	0	1	0	0	23	0	0	0	0	0	24	7.1
Ch. cainito	Fruit Lab	30	0	0	0	0	12	0	0	0	0	0	42	12.4
	Fruit beds	5	0	7	0	0	13	0	0	0	0	0	25	7.3
M. indica 1	Fruit Lab	0	0	0	0	0	1	0	0	0	1	0	2	0.6
	Fruit beds	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Ma. zapota	Fruit Lab	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Fruit beds	0	0	9	0	0	3	0	0	0	0	0	12	3.5
S. purpurea 1	Fruit Lab	5	0	0	0	0	0	0	0	0	8	16	29	8.5
	Fruit beds	0	0	0	0	0	0	0	10	15	1	0	26	7.7
S. purpurea 2	Fruit Lab	0	0	0	0	0	0	0	0	0	1	0	1	0.3
	Fruit beds	0	0	0	0	0	0	0	0	0	0	0	0	0.0
S. purpurea 3	Fruit Lab	1	0	0	0	0	0	0	0	0	0	0	1	0.3
	Fruit beds	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Po. sapota	Fruit Lab	0	0	0	0	0	0	0	0	4	0	4	8	2.3
	Fruit beds	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Ps. guajava	Fruit Lab	6	2	0	7	1	3	1	0	0	0	0	20	5.9
	Fruit beds	1	0	24	5	0	42	0	2	0	0	0	74	21.7
Total specimens	Fruit Lab	42	2	0	8	1	18	2	0	4	10	20	107	31.5
	Fruit beds	6	0	55	5	0	129	0	22	15	1	0	233	68.5
% parasitism	FLab + FBeds	14.1	0.6	16.2	3.8	0.3	43.2	0.6	6.5	5.6	3.2	5.9	340	100

TABLE 3. RELATIONSHIP FRUIT FLY-PARASITOID SPECIES RECOVERED FROM ALL SAMPLED HOSTS EXPRESSED IN PERCENTAGES.

Fruit fly	*A. ludens*	*A. ludens* / *A. obliqua*	*A. obliqua*	*A. serpentina*	*A. striata*/ *A. fraterculus*	Parasitism %
Hosts	*Citrus* spp.	*M. indica*	*Spondias purpurea*	*Ch. cainito, P. sapota, M. zapota*	*P. guajava*	All hosts
Parasitoids						
Odontosema anastrephae	21.4	0.3	0.0	8.2	13.3	43.2
Odontosema sp.	0.3	0.0	0.0	0.0	0.3	0.6
Aganaspis pelleranoi	0.3	0.0	0.0	0.0	3.5	3.8
Aganaspis sp.	0.0	0.0	0.0	0.0	0.3	0.3
Doryctobracon areolatus	0.0	0.0	1.8	10.3	2.1	14.2
Opius bellus	0.0	0.0	0.0	0.0	0.6	0.6
Coptera haywardi	4.4	0.0	0.0	4.7	7.1	16.2
Spalangia endius	2.9	0.0	2.9	0.0	0.6	6.4
Dirhinus sp.	0.0	0.0	4.4	1.2	0.0	5.6
Sycophila sp.	0.0	0.3	2.9	0.0	0.0	3.2
Euperilampus sp.	0.0	0.0	4.7	1.2	0.0	5.9
Parasitism %	29.3	0.6	16.7	25.6	27.8	100.0

A. obliqua in Mexico (Gates & Grissell 2004). The eurytomids also occur as parasites in Cynipidae, Pteromalidae, Eurytomidae, Tanaostigmatidae, and Agaonidae (Grisell & Schauff 1990; DiGiulio 1997), and members of the family Perilampidae are hyperparasitoids of Ichneumonidae (Darling 1997). However, since the tephritid pupae were separated from the fruit and counted before adult emergence, these may be cases of hyperparasitism. These results should be further investigated.

The genus *Dirhinus* (Chalcididae) has been reported as a pupal parasite in Brachycerous Diptera widely distributed throughout the world tropics, with 3 known species in the USA (Burks 1947), and about 15 native species yet to be studied in regions ranging from Indiana (USA) to central Argentina (Boucek 1992). Unpublished data for Mexico indicate the presence of at least *D. buscki* (Crawford), *D. schwarzi* (Crawford), *D. texanus* (Ashmead), and *D. giffardii* (Silvestri) (data provided by Alejandro González-Hernández and Serguei Triapitsyn), although there are probably 1 or 2 more species with cosmopolitan distribution (Robert A. Wharton, Texas A & M University, personal communication).

Dirhinus giffardi is the unique species reported attacking fruit flies in the Neotropics, a native western African species introduced in Israel around 1950 (Podoler & Mazor 1981), and in Latin American countries of Puerto Rico (1935-1937), Costa Rica (1955), Peru (1960), Colombia (1970), and Bolivia (1971), and in Florida, USA (1977-1979) (Ovruski et al. 2000). In Mexico, it has been introduced in the states of Morelos and Oaxaca (Jiménez-Jiménez 1956), however there is no evidence that it is established in these regions. The *Dirhinus* species reported in this paper is very similar to *D. schwarzi* and *D. giffardii*, representing an undescribed species, and a new record of a native parasitoid for *A. obliqua* and *A. serpentina*.

The exotic species *Diachasmimorpha longicaudata* and *Aceratoneuromyia indica* were not recorded during the present study, but both have been documented as established and as having significant parasitism indices in Costa Rica (Wharton et al. 1981) and Mexico (Aluja et al. 1990) respectively, though both these studies were only concerned with coffee and mango orchards. *Spalangia endius* is a remarkable record, since it has been recorded from *Anastrepha* in Florida, though rarely reared from tephritids (Ovruski et al. 2000).

The majority of the published papers on *Anastrepha* parasitoids indicate that *D. areolatus* (Braconidae) is the most important native parasitoid species, having the highest parasitism indices in the Neotropical region in countries such as Mexico (Hernández-Ortiz et al. 1994; López et al. 1999), Guatemala (Eskafi 1990), Costa Rica (Jirón & Mexzon 1989), Colombia (Yepes & Velez 1989; Carrejo & González 1999), Venezuela (Katiyar et al. 1995), Brazil (Canal et al. 1995; Leonel et al. 1995; Aguiar-Menezes & Menezes 1997; Aguiar-Menezes et al. 2001), and Argentina (Ovruski et al. 2004, 2005).

On the basis of our results, *O. anastrephae* (Figitidae) is the dominant species occurring in 7 host plants attacked by 5 *Anastrepha* species. This species is considered a koinobiont parasitoid of *Anastrepha* larvae (Ovruski et al. 2000),

though most of the recovered specimens were found in the Fruit-Bed samples, particularly from *Citrus* species and guava accounting for 87.7%. Such differences in the parasitism indices may be related to parasitoid biological factors, such as the ability of *O. anastrephae* to reach their host larvae by entering wounds in fruit located on the ground (Sivinski et al. 1997, 2000).

Comparisons between fruit weight and infestation rates among different hosts showed that the number of larvae was larger in small fruits but decreased as fruit size increased. This coincides with results observed for *A. suspensa* in Florida (USA), when fruit sizes and infestation indices were compared for 6 host species (Sivinski 1991).

Previous hypothesis on parasitism levels have been attributed in part to physical difficulties in locating immature stages within large fruits (Sivinski 1991). However, our comparisons between fruit weight of 14 hosts and the parasitism rates of the 11 parasitoid species showed no correlation. This may be due to the fact that more sample sizes are needed in order to test this hypothesis, or that the native parasitoid community has only become recently adapted to certain exotic fruit species included in our analysis, such as *Citrus* spp. and *M. indica*.

The low level of parasitism (3.69%) observed in this study is probably due to orchard management practices, in which destruction of fallen fruit and periodic pesticide use (CESVY 2000), could have a negative impact on parasitoid populations. Similar studies carried out in Brazil reported similar species diversity and levels of parasitism (Uchôa-Fernandes et al. 2003). Based on the parasitoid species diversity that attack the *Anastrepha* fruit flies in Yucatan, further studies need to be focused on the biology and ecology of certain native parasitoids such as *O. anastrephae*, *C. haywardi*, and *D. areolatus* as promising biological control agents.

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