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A Review of Hymenopterous Parasitoid Guilds Attacking *Anastrepha* spp. and *Ceratitis capitata* (Diptera: Tephritidae) in Argentina

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ABSTRACT: This study provides detailed information on the diversity, abundance, guilds, host plant and host fly ranges, distribution, and taxonomic status of hymenopterous parasitoid species associated with *Ceratitis capitata* (Wiedemann) and *Anastrepha* spp. (*A. fraterculus* (Wiedemann) and *A. schultzi* Blanchard) in Argentina. Moreover, the article also argues future needs regarding the use of some parasitoid species as an alternative tool in fruit fly management programs of the National Fruit Fly Control and Eradication Program (PROCEM-Argentina). Data used for this work were obtained from numerous old and recent published articles on fruit fly parasitoids in Argentina.

Key Words: Medfly, South American fruit fly, ecology, natural enemies, biocontrol

INTRODUCTION

Over the past 30 years, there has been noteworthy attention in the utilization of hymenopterous parasitoids in integrated fruit fly pest management in tropical and subtropical regions (Wharton 1989, Aluja 1996, Sivinski 1996, Purcell 1998, Montoya and Liedo 2000, Sivinski and Aluja 2003,). Thus, the employment of new Afrotropical and Neotropical parasitoid species is a valid and applicable strategy for the suppression of *Ceratitis capitata* (Wiedemann) and *Anastrepha* spp. in Latin America, respectively (Aluja 1999, Ovruski et al. 2000, Wharton et al. 2000, Lopez et al. 2003, Sivinski and Aluja 2003).

In Argentina, *C. capitata* and *A. fraterculus* (Wiedemann) are two economically important fruit fly species, and their control is currently kept, within certain limits, through insecticidal bait-spray applications and cultural practices. In the case of the Medfly, the sterile insect technique is applied (Aruani et al. 1996; Spinetta 2004). However, there were also some isolated efforts throughout last century to implement biological control programs by using some native parasitoids that were collected in wild vegetation and released in commercial fruit orchards, as well as by using of exotic parasitoids introduced into Argentina from Hawaii, Costa Rica, and Mexico (Ovruski et al. 1999). The introduced parasitoid species were: *Fopius arisanus* Sonan (reported as *Opius oophilus* Fullaway), *Doryctobracon crawfordi* (Viereck) (reported as *Opius crawfordi*), *Diachasmimorpha longicaudata* (Ashmead) (reported as *Opius* or *Biosteres longicaudatus*) (Braconidae), *Aceratoneuromyia indica* (Silvestri) (reported as *Syntomosphyrum indicum*), *Tetrastichus giffardianus* Silvestri (Eulophidae), and *Pachycrepoideus vindemmiae* (Rondani) (Pteromalidae) (Ovruski and Fidalgo 1994). From these species, *P. vindemmiae*, *A. indica* and *D. longicaudata* were released in limited numbers in some provinces (Turica 1968). Unfortunately, the effectiveness of all these biological control efforts in reducing *C. capitata* and *A. fraterculus* populations to an economically significant level was never ascertained due to absence of follow-up studies (Ovruski et al. 1999).

At least 18 and 22 hymenopterous parasitoid species have been recorded from *C.*

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capitata and *A. fraterculus* in the Neotropical region, respectively (Ovruski et al. 2000). Surveys of the parasitoid species attacking cryptic *A. fraterculus* species and *C. capitata* have been published in Mexico (Aluja et al. 2003, López et al. 1999, Sivinski et al. 2000), Colombia (Yépes and Vélez 1989, Carrejo and González 1999), Guatemala (Eskafi 1990), Costa Rica (Wharton et al. 1981), Venezuela (Katiyar et al. 1995), Peru (Cruz 1995), Brazil (Leonel et al. 1995, 1996; Salles 1996; Aguiar-Menezes and Menezes 1997, 2001; Canal et al. 1995; Canal and Zucchi 2000; Guimarães et al. 2000, 2003; Carvalho et al. 2000; Carvalho 2001; Aguiar-Menezes et al. 2001), and Argentina (Nasca 1973; Ovruski 1995, 2003; Wharton et al. 1998; Schliserman et al. 2003; Ovruski et al. 2004, 2005, 2006). These articles mainly show that the Neotropical region undoubtedly represents a valuable source of additional parasitoid species which could be employed in order to abate the populations of *Anastrepha* pest species. In addition to *A. fraterculus* parasitoids, a recent article published by Schliserman et al. (2004) informs on a parasitoid guild associated with *A. shultzi* Blanchard in Northwestern Argentina.

The purpose of this study, is to provide detailed information on the diversity, abundance, biology, host range, distribution, and taxonomic status of hymenopterous parasitoid species associated with *C. capitata* and *Anastrepha* spp. in Argentina, and discuss future needs regarding the use of some neotropical parasitoid species as an alternative tool in fruit fly management programs of the National Fruit Fly Control and Eradication Program (PROCEM-Argentina).

METHODS

Data used for this work were obtained from numerous old and recent published articles on fruit fly parasitoids in Argentina. The vast majority of these publications involved parasitoid surveys of economically important fruit flies, such as *C. capitata* and *A. fraterculus*. Most records of parasitoid come from bulk samples of fruit, from which several species of flies and parasitoids emerge. Parasitoids reared under these conditions are often considered as coming from prevailing tephritid in the samples (Wharton et al. 1998). Therefore, there are various published records on fruit fly host-parasitoid association that need to be verified (see Table 1). Moreover, various parasitoid species previously reported in the literature had never been formally described or had been misidentified (Ovruski et al. 2005). In addition, all the literature on tephritid parasitoids of the Neotropical region was also checked, which provided information on parasitoids species occurring in Argentina.

Parasitoid nomenclature follows Johnson (1992) for Diapriidae, Wharton (1997) for Braconidae, Gibson et al. (1997) for Eulophidae and Pteromalidae, and Wharton et al. (1998) for Figitidae.

RESULTS

Diversity. There are two regions within Argentina in which fruit fly native parasitoids are common: the region which comprises Catamarca, Tucumán, Salta, and Jujuy (NW) and the region that covers Misiones, Corrientes and Entre Rios (NE). The original native vegetation in both areas was a subtropical rain forest, locally known as "Las Yungas" or "Selva Tucumano-Boliviana" in the Northwest and "Selva Paranaense y de Galería" in the Northeast (Cabrera, 1976). As a result of several fruit fly parasitoid surveys made over the past 69 years in these two Argentinean regions, a total of 11 neotropical parasitoid species (5 belong to Braconidae, 4 to Figitidae, and 2 to Diapriidae), 2 indopacific parasitoid species (1 Braconidae and 1 Eulophidae), 1 cosmopolitan parasitoid species (Pteromalidae), and 2 pteromalid parasitoid spe-

Table 1. Native and exotic parasitoid species associated with *Anastrepha fraterculus*, *A. schultzi* and *Ceratitis capitata* in Argentina and some biological characteristics. [1] 1° = primary; 2° = secondary; K = koinobiont; I = idiobiont. [2] In = IndoPacific, Ne = Neotropical, Co = Cosmopolitan. [3] S = solitary; G = gregarious; En = endoparasitoid; Ec = ectoparasitoid; L-P = larval-pupal parasitoid; P = pupal parasitoid. [4] Host fly-parasitoid association should be verified.

	Parasitism Modes[1]	Species origin[2]	Host Interaction[3]	Host fruit fly species
Braconidae				
Diachasmimorpha longicaudata (Ashmead)	1°, K	In	S, En, L-P	*A. fraterculus* *C. capitata*
Doryctobracon areolatus (Szépligeti)	1°, K	Ne	S, En, L-P	*A. fraterculus* *A. schultzi* *C. capitata* [4]
Doryctobracon brasiliensis (Szépligeti)	1°, K	Ne	S, En, L-P	*A. fraterculus* *A. schultzi* *C. capitata* [4]
Doryctobracon crawfordi (Viereck)	1°, K	Ne	S, En, L-P	*A. fraterculus*
Opius (Bellopius) bellus Gahan	1°, K	Ne	S, En, L-P	*A. fraterculus*
Utetes (Bracanastrepha) anastrephae (Viereck)	1°, K	Ne	S, En, L-P	*A. fraterculus* *A. schultzi* *C. capitata* [4]
Figitidae				
Aganaspis pelleranoi (Brèthes)	1°, K	Ne	S, En, L-P	*A. fraterculus* *A. schultzi* *C. capitata*
Dicerataspis grenadensis Ashmead	1°, K	Ne	S, En, L-P	*A. fraterculus* [4]
Lopheucoila anastrephae (Rohwer)	1°, K	Ne	S, En, L-P	*A. fraterculus* [4]
Rhoptromeris haywardi (Blanchard)	1°, K	Ne	S, En, L-P	*A. fraterculus* [4] *C. capitata* [4]
Diapriidae				
Coptera haywardi Loiácono (Ogloblin i.l.)	1°, I	Ne	S, En, P	*A. fraterculus*
Tricopria anastrephae Costa Lima	1°, I	Ne	S, En, P	*A. fraterculus* *C. capitata* [4]
Eulophidae				
Aceratoneuromyia indica (Silvestri)	1°, K	In	G, En, L-P	*A. fraterculus* *C. capitata*
Pteromalidae				
Pachycrepoideus vindemmiae (Rondani)	1°- 2°, I	Co	G, Ec, P	*A. fraterculus* *C. capitata*
Pachyneuron sp.	1°- 2°, I	?	?, ?, P	*A. fraterculus* *C. capitata*
Spalangia sp.	1°, I	?	S-G, Ec, P	*A. fraterculus* *C. capitata*

cies from unclear origin (Table 1) were reared from *A. fraterculus* and *C. capitata* puparia. Although the *Pachyneuron* sp. and *Spalangia* sp. records still need verification, rearings from isolated puparia clearly demonstrate that these species are capable of successfully attacking *C. capitata* pupae. These parasitoids were recovered from different host plant species in the Northeastern provinces (Ogloblin 1937; Turica and Mallo 1961; DeSantis 1965; Ovruski and Schliserman 2003b), and mainly in the Northwestern provinces (Schultz 1938; Hayward 1940, 1941, 1943; Nasca 1973; Fernández de Araoz and Nasca 1984; Loiácono 1981; Ovruski 1995; Ovruski and Schliserman 2003a; Ovruski et al. 2004; Oroño et al. 2005) (Table 2). However, significant results have been achieved during the last 12 years (1994/2006) since the implementation of exhaustive taxonomic, biological, ethological and ecological studies on neotropical parasitoid species occurring in Argentina (Ovruski 1994a, Ovruski 1994b, Ovruski and Wharton 1996, Wharton 1997, Wharton et al. 1998, Ovruski et al. 2000, Ovruski 2002, Ovruski and Aluja 2002, Ovruski et al. 2004, Ovruski et al. 2005). Also, detailed information on the distribution, host range, diversity, abundance variation, diapause schedules, effect of microclimate, and different biological aspects below rearing conditions of several parasitoid species occurring in Argentina was reported by Sivinski et al. (1997, 1998, 2000, 2001), Aluja et al. (1988, 2003), López et al. (1999), and Guillén et al. (2002) studying these species in Mexico, and by Leonal Jr. et al. (1995), Canal and Zucchi (2000), Guimarães et al. (2000, 2003), and Aguiar-Menezes and Menezes (1997, 2001) studying them in Brazil. Four larval-pupal parasitoid species were also recorded by Schliserman et al. (2004) from *A. shultzi* pupae (Table 1). *Anastrepha shultzi* is a common tephritid species associated with fruits of *Juglans australis* Grisebach (locally known as "nogal criollo") in Tucumán (Schliserman et al. 2004).

The available data (Ovruski 1995; Wharton et al. 1998; Ovruski et al. 2004, Ovruski et al. 2005) suggests that the figitid *Aganaspis pelleranoi* (Brèthes) is better adapted to *C. capitata* larvae than any of the indigenous braconid parasitoids common in Argentina. Although the braconids *Utetes anastrephae* (Viereck) [reported as *Opius argentinus* (Brèthes)] (Nasca 1973), *Doryctobracon areolatus* (Szépligeti) [reported as *Doryctobracon tucumanus* (Turica and Mallo)], and *D. brasiliensis* (Szépligeti) (Fernández de Araoz and Nasca 1984), have been supposedly reared from *C. capitata* larvae, none of these records provide adequate evidence to conclude that the larvae were indeed *C. capitata* instead of *A. fraterculus*, which were very abundant in the study areas. In the same way, the host flies associations of the diapriid *Trichopria anastrephae* Costa Lima and the figitid *Rhoptromeris haywardi* (Blanchard) need to be verified. Earlier reports, such as Turica and Mallo (1961) and Wharton et al. (1998), suggest that both *T. anastrephae* and *R. haywardi* can multiply more easily on drosophilid puparia and larvae, respectively. The figitids *Lopheucoila anastrephae* (Rohwer) and *Dicerataspis grenadensis* Ashmead were recorded supposedly in association with *A. fraterculus* (Wharton et al. 1998), but the same authors indicated that lonchaeids and drosophilids seem to be the common hosts of *L. anastrephae* and *D. grenadensis*, respectively. However, in Brazil *L. anastrephae* has recently recovered from *Anastrepha amita* Zucchi and *A. pseudoparalella* (Loew) puparia, and the figitid *Dicerataspis flavipes* (Kieffer) from *A. amita* puparia (Guimarães et al. 2000).

In the case of those parasitoids species introduced into Argentina in the 1960's, four species (*D. crawfordi*, *P. vindemmiae*, *D. longicaudata*, and *A. indica*) are shown in Table 1 as species currently present in Argentina. *Doryctobracon crawfordi* was released in Jujuy and also in Misiones between 1961 and 1968. However, the permanent establishment of

Table 2. Fruit fly host plants throughout Argentina in which native and exotic larval parasitoids were recovered from *C. capitata* and *Anastrepha* spp., mainly *A. fraterculus*. Source: [1] Host plant – parasitoid associations recorded by Turica and Mallo (1961) have not been verified yet. [2] Host plant – parasitoid associations recorded by Nasca (1973) and Fernández de Araoz and Nasca (1984) have not been verified yet. [3] *Ai*, *Aceratoneuromyia indica*; *Da*, *Doryctobracon areolatus*; *Db*, *Doryctobracon brasiliensis*; *Dc*, *Doryctobracon crawfordi*; *Dl*, *Diachamimorpha* longicaudata; Ua, *Utetes anastrephae*; *Ob*, *Opius bellus*; *Ap*, *Aganaspis pelleranoi*; *La*, *Lopheucoila anastrephae*; *Dg*, *Dicerataspis grenadensis*; *Rh*, *Rhoptromeris haywardi*.

Plant	Common	Species	Larval parasitoid species [3]										
species and families	name	origen	A.i.	D.a	D.b	D.c	D.l	U.a.	O.b	A.p	L.a	D.g	R.h
Fabaceae													
Inga marginata Willd.	Pacay	Native			X					X			
Myrtaceae													
Myrcianthes pungens (Berg) Legrand	Mato	Native		X				X	X	X			
Eugenia uniflora L.	Surinam Cherry	Native		X				X	X	X			
Psidium guajava L.	Guava	Exotic	X	X	X	X		X	X	X	X	X	X[1]
Feijoa sellowiana (Berg) Berg	Feijoa	Native		X	X		X	X		X			
Hexachlamys edulis (Berg) Krausel et Legrand	Ubajay	Native		X[1]					X[1]				
Campomanesia crenata Berg [1]	Guabirá	Native							X[1]				
Blepharocalyx gigantea Lillo [1]	Horco Molle	Native		X[1]									
Moraceae													
Ficus carica L. [1]	Fig	Exotic		X					X[1]	X			X[1]
Rosaceae													
Cydonia oblonga Mill.	Quince	Exotic								X			
Prunus persica (L.) Batsch	Peach	Exotic	X	X	X			X	X	X			X[1]
P. domestica L.	Cultivated Plum	Exotic		X	X					X			
P. armeniaca L.	Apricot	Exotic		X	X					X			
Pyrus communis L.[1]	Pear	Exotic								X[1]			
Juglandaceae													
Juglans australis Grisebach	Wild walnut	Native		X	X			X		X			

Table 2. Continuation

Plant species and families	Common name	Species origen	Larval parasitoid species [3] A.i.	D.a	D.b	D.c	D.l	U.a.	O.b	A.p	L.a	D.g	R.h
Caricaceae													
***Carica quercifolia* Hill.** [1]	Sacha higuera	Native											X[1]
Rutaceae													
***Citrus paradisi* Macfadyn** [2]	Grapefruit	Exotic		X[2]	X[2]								
***C. sinensis* (L.) Osbeck** [2]	Sweet Orange	Exotic		X[2]									
C. aurantium L.	Sour Orange	Exotic								X			
Sapotaceae													
***Chrysophyllum gonocarpum* (Mart et Eich.) Egler**	Aguay	Native								X			

D. crawfordi was recently confirmed in Salta (Ovruski et al. 2005).

According to Ovruski et al. (2005) two probable interpretations are equally reasonable regarding the discovery of *D. crawfordi*: (1) since *D. crawfordi* was introduced in Argentina and released in Jujuy (approximately 43 years ago), this parasitoid species may have been successfully established on *A. fraterculus* in the release area, and it could have spread to other neighboring areas of northwest Argentina; (2) considering that *D. crawfordi* is a widespread neotropical braconid species (Ovruski et al. 2000), and that it was recovered in the Yungas forest of southern Bolivia (Escalante 1995), it is equally likely that the natural distribution range of this braconid includes northwestern Argentina.

Pachycreopoideus vindemmiae cannot be recognized as an exotic parasitoid established in Argentina. This pupal parasitoid is a poliphagous and cosmopolitan species but was also extensively cultured and widely released against various tephritid pests (Wharton 1989) and synanthropic flies (Morgan 1986). Originally, *P. vindemmiae* was introduced from West Africa and India to the Hawaiian Islands, and then it was redistributed in Latin America (Clausen 1978). *Pachycrepoideus vindemmiae* was previously reported in Tucumán under other scientific names of *Pachycrepoideus tucumanus* Blanchard (Hayward 1943; Turica and Mallo 1961), and in Mendoza and in Buenos Aires as *Pachycrepoideus dubius* Ashmead (DeSantis 1941; DeSantis 1967). Both scientific names are synonyms of *P. vindemmiae* at present (DeSantis 1979; DeSantis and Fidalgo 1994). Therofore, *P. vindemmiae* was already present in Argentina before 1961.

Recent fruit fly parasitoid surveys made in NE Argentina included specimens of *D. longicaudata* (Schliserman et al. 2003) and *A. indica* (Ovruski et al. 2006). The first record of *D. longicaudata* dates from March 2000 attacking *A. fraterculus* larvae from *Feijoa sellowiana* L. (Myrtaceae), and *A. indica* was recorded by first time in January 1998 from *Prunus persica* (L.) Batsch (Rosaceae) infested with *C. capitata* larvae, so that these parasitoid species were recovered approximately 40 years after its first release in Misiones. Also, in very small numbers, *A. indica* was recently found in Córdoba and Jujuy (Ovruski et al. 2006). Both *D. longicaudata* and *A. indica*, natives of Southeast Asia, are the only exotic parasitoids currently established in Argentina.

Parasitoid guilds. The biological peculiarities and host fruit flies of native and exotic parasitoid species occurring in Argentina are shown in Table 1. The larval-pupal parasitoids (figitids, eulophids and braconids) are more abundant (69%) than the pupal parasitoids (diapriids and pteromalids) (31%). No egg-larval parasitoids were found during fruit collection s in Argentina.

The two most important groups of native parasitoid attacking *A. fraterculus* natural population in Argentina are Braconidae, subfamily Opiinae, and Figitidae, subfamily Eucoilinae (Table 1). All these species are solitary, koinobiont endoparasitoid that oviposit in the *Anastrepha* larvae and emerge from the puparium [parasitoid guild number 2, which was defined by Ovruski et al. (2000)]. Based on the foraging behaviour, figitid and braconid parasitoid species were separated into two ecological groups (Sivinski et al. 1997). The figitids *A. pelleranoi*, *D. grenadensis*, *L. anastrephae*, and *Odontosema anastrephae* Borgmeier [a parasitoid recorded from *A. fraterculus* in Brazil by Guimarães et al. (2000)] attack mainly larvae in fallen fruit by penetrating fruit through previously existing holes (Sivinski et al. 1997; Wharton et al. 1998; Ovruski et al. 2004). On the contrary, the braconids *D. areolatus*, *D. brasiliensis*, *D. crawfordi*, *U. anastrephae*, and *Opius bellus* Gahan remain searching the host larvae on the fruit surface (Sivinski et al. 1997; Ovruski et al. 2004).

The idiobiont pupal parasitoids belonging to guilds 3 and 4 (Ovruski et al. 2000), are not well documented in Argentina mainly due to the difficulties in sampling fruit fly pupae. A small number of *T. anastrephae* specimens were recovered from *C. capitata* pupae (Turica and Mallo 1961) and *Coptera haywardi* Loiácono from *A. fraterculus* and *A. shultzi* Blanchard (Loiácono 1981). Both diapriid species belong to guild number 3, which include idiobiont endoparasitoids. The three pteromalid species cited in Table 1 belong to guild number 4, which include idiobiont ectoparasitoids.

Abundance. Based on parasitoid surveys in the NW and NE, areas of Argentina reported to date (Turica and Mallo 1961; DeSantis 1965; Nasca 1973; Fernández de Araoz and Nasca 1984; Ovruski 1995; Wharton et al. 1998; Ovruski 2002; Ovruski 2003; Ovruski and Schliserman 2003a, Ovruski and Schliserman 2003b; Ovruski et al. 2004; Schliserman et al. 2004; Schliserman and Ovruski 2004; Ovruski et al. 2005; Oroño et al. 2005), it is possible to make preliminary comparisons concerning parasitoid abundance of *A. fraterculus* for these two Argentinean regions. For example, considering the relative abundance of larval-pupal parasitoid species, *Doryctobracon areolatus* is the more abundant parasitoid of all species in NW (61%) and also in NE (45%); *A. pelleranoi* is the second more abundant in NW (28%), but *U. anastrephae* is the second more abundant in NE (28%); *D. brasiliensis* is the third more abundant in NW (9%), whereas *A. pelleranoi* is the third more abundant in NE (14%); *U. anastrephae* is the fourth more abundant in NW (1.2%), but in NE is *D. brasiliensis* (12%); *O. bellus* is the fifth more abundant species in NE (1%) and also in NW (0.3%). All other larval-pupal parasitoid species only occurring in NW (*D. crawfordi*, *L. anastrephae*, and *D. grenadensis*) are rarely encountered (0.06% - 0.1%). Pupal parasitoid species were barely sampled, and there are very few data on abundance of these parasitoid guilds. Some data on relative abundance (0.1% – 1.5%) were recorded for *P. vindemmiae* attacking *C. capitata* pupae in Tucumán (Ovruski 1995).

Distribution. *Doryctobracon areolatus*, *D. crawfordi*, *U. anastrephae* and *A. pelleranoi* are widespread species that occur from Mexico to Argentina. *Doryctobracon areolatus* has been established in Florida (Sivinski and Aluja 2003), and throughout its distribution in the Neotropic it is often the dominant member of *Anastrepha*-parasitoid guilds (Sivinski et al. 2000). *Opius bellus* is another widespread opiine, ranging from Costa Rica to northern Argentina, whereas *D. brasiliensis* has a more regional distribution pattern, including only Brazil, Bolivia, and Argentina. *Lopheucoila anastrephae* is another native figitid which occurs naturally from México to NW Argentina, whereas *D. grenadensis* would be distributed in few countries, such as Grenada, Brazil (Guimarães et al. 2003), and Argentina (Wharton et al. 1998). However, Wharton et al. (1998) pointed out that the genus *Diceratas-pis* is known from Mexico and south Florida through the Caribbean to Argentina. *Rhoptromeris haywardi* is only known in Argentina and Uruguay. According to Wharton et al. (1998), the generic placement of *R. haywardi* needs verification following Nordlander's (1978) revision of *Rhoptromeris* Förster, a Holartic genus. The Diapriid *Coptera haywardi* occurs in Argentina, Brazil, Venezuela and Mexico, while *Trichopria anastrepha* is present only in Brazil and Argentina (Ovruski et al. 2000). *Coptera haywardi* was originally recorded in NW Argentina attacking *A. fraterculus* and *A. shultzi* Blanchard (Loiácono 1981). The exotic parasitoids *D. longicaudata* and *A. indica*, and the cosmopolitan *P. vindemmiae* have been released in almost 12 American countries (Ovruski et al. 2000).

Host plant – parasitoid associations. The diversity of host fruit species has a significant effect on the proportion of fruit fly parasitism by several fruit fly parasitoid species (Sivinski et al. 2000). In Argentina, parasitoids reared from *A. fraterculus* larvae have mainly been recovered from fleshy fruit in the families Myrtaceae, Rosaceae, and Juglandaceae (Table 2). These host plants have a great number of fruit characteristics that may enhance parasitoid success, either by increasing attractiveness to the parasitoids or by facilitating detection of an oviposition in the host larvae (Sivinski et al 1997; Ovruski et al. 2004). Among the factors believed to be responsible for this attraction are thin pericarp, soft endocarp, type of volatiles emitted, color, and fruit size (Ovruski et al. 2000). Moreover, the high parasitoid diversity reflects the fact that these plant families contain some of the most commonly sampled fruits, such as guavas, peaches, and plums, the three of them being medium-sized fruit species. On the other hand, large-sized species such as the exotic *Citrus* spp, *Mangifera indica* L., and *Annona cherimola* Mill yield few or no parasitoids (Ovruski et al. 2004).

Aganaspis pelleranoi was recovered from 15 fruit species (representing 75% of all host fruit species in which *Anastrepha* parasitoids were reared, Table 2) and seven plant families, *D. areolatus* from 13 fruit (65%) species and five plant families, *D. brasiliensis* from eight fruit species (40%) and five plant families, *O. bellus* from seven fruit species (35%) and three plant families, *U. anastrephae* from five fruit species (25%) and two plant families, *R. haywardi* from four fruit species (20%) and four plant families, and *D. crawfordi*, *D. grenadensis* and *L. anastrephae* from one fruit species (5%) and one plant family, respectively. Both *D. areolatus* and *A. pelleranoi* are particularly common in several wild exotic and native, as opposed to introduced and cultivated commercial, fruit species (Sivinski et al. 2000; Ovruski et al. 2004).

The highest parasitism levels (ranging from 10% to 28% range), calculated as the number of parasitoids divided by the total number of parasitoids and host flies emerging from a particular fruit species were recorded in the medium-sized, exotic species *Psidium guajava* L., *P. persica*, and *P. domestica* L., and in the small-sized, native species *Eugenia uniflora* L., *Feijoa sellowiana* (Berg) Berg, and *Hexachlamys edulis* (Berg) Krausel et Legrand. The lower parasitization rates (ranging from

7% to 9%) were found in *Ficus carica* L. and *P. armeniaca* L., both exotic species, the former being small-sized, and the latter medium-sized, and in *Campomanesia crenata* Berg, *Myrcianthes pungens* (Berg) Legrand, *Juglans australis* grisebach, all small-sized, native species. *Doryctobracon areolatus* and *A. pelleranoi* were the most important mortality factors throughout NW (Ovruski and Schliserman 2003a; Ovruski et al. 2004; Ovruski et al. 2005) and NE (Ovruski and Schliserman 2003b) Argentina attacking *A. fraterculus*. Moreover, *A. pelleranoi* was a natural mortality factor of *C. capitata* in the large-sized, introduced fruit species *C. aurantium* (Schliserman and Ovruski 2004).

DISCUSSION

Most parasitoid surveys made in Argentina (90%) included ripe fruit collected from the field and kept in plastic or wooden boxes until full-grown fly larvae emerged from host fruit. In this way, host larvae fall to the bottom of the boxes where they pupate in sand. Then, fly pupae are sifted from the sand and kept in other cages until flies and parasitoids emerge. This sampling methodology is mainly aimed to obtain endoparasitoids species that oviposit in the host larva and emerge from the puparium. However, because this method seeks to obtain adult parasitoids, the knowledge of fruit fly parasitoid diversity in Argentina is limited. Surveys for detection of egg and pupal parasitoids associated with fruit flies have been largely neglected in Argentina. For this, ensuing surveys need to be focused on parasitoids that attack egg stage (guild number 1, Ovruski et al. 2000) and parasitoids that attack pupa stage (guilds number 3 and 4). Also, some fly-parasitoid species associations, such as *A. fraterculus* - *L. anastrephae* and *D. grenadensis*, and *A. fraterculus* and *C. capitata* - *T. anastrephae* need to be verified in future studies.

In the NW and NE regions of Argentina, in which a high diversity of indigenous parasitoids of *A. fraterculus* are well established in all native fruit species and in small, wild exotic fruits, management strategies should be used to conserve their natural populations. In these regions, there are patches of pristine forest and areas with perturbed wild vegetation adjacent to commercial orchards, where it is possible to find numerous native and exotic fruit fly host plants. Precisely, it is in these areas where *A. fraterculus* populations increase and from which they move to attack commercially grown fruit. Instead of removing native hosts, and following Aluja (1996, 1999), Aluja et al. (2003), and Ovruski et al. (2004), it is better to enhance natural parasitoid reservoirs such as *E. uniflora* (Myrtaceae), *F. sellowiana* (Myrtaceae), *J. australis* (Juglandaceae), and *Myrcianthes pungens* (Myrtaceae). In addition, a conservation biological control program could be combined with massive releases of native parasitoids such as *D. areolatus* and *A. pelleranoi* (Aluja 1996, 1999) against *A. fraterculus* in NW and NE Argentina. Although *D. crawfordi* is a rare species in NW Argentina, this larval-pupal parasitoid species represents a potential candidate for mass releases against *A. fraterculus* because it has a longer ovipositor than *D. areolatus* y *D. brasiliensis*, and it could attack fly larvae in large, exotic commercial fruit, such as citrus and mango (López et al. 1999). Additionally, pupal parasitoid such as the diapriid *Coptera haywardi* (Ogloblin) could also be released to attack the particularly susceptible pupal stage (Sivinski et al. 1998).

It is noteworthy, with the clear exception of *A. pelleranoi*, that Neotropical parasitoid species recorded in Argentina appear to be poorly adapted to the exotic *C. capitata*. Therefore, it is possible to consider that mass releases of the exotic parasitoid *D. longicaudata* in abandoned citrus orchards could also suppress *C. capitata* and also *A. fraterculus* populations in NW and NE Argentina.

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REFERENCES

Aguiar-Menezes, E. L., and E. B. Menezes. 1997. Natural occurrence of parasitoids of *Anastrepha* spp. Schiner, 1868 (Diptera: Tephritidae) in different host plants, in Itaguai (RJ), Brasil. Biological Control 8: 1-6.

Aguiar-Menezes, E. L., and E. B. Menezes. 2001. Parasitismo sazonal e fluctuação populacional de Opiinae (Hymenoptera: Braconidae), parasitóides de espécies de *Anastrepha* (Diptera: Tephritidae), em Seropédica, RJ. Neotropical Entomology. 30: 613-623.

Aguiar-Menezes, E. L., E. B. Menezes, P. S. Silva, A. C. Bittar, and P. C. R. Cassino. 2001. Native Hymenoptera parasitoids associated with *Anastrepha* spp. (Diptera: Tephritidae) in Seropedica city, Rio de Janeiro, Brazil. Florida Entomologist 84: 706-711.

Aluja, M. 1996. Future trends in fruit fly management, pp. 309-320. In B.A. McPheron and G.J. Steck. (eds.), Fruit fly pests: a world assessment of their biology and management. Delray Beach, Florida, St. Lucie Press, USA.

Aluja, M. 1999. Fruit fly (Diptera: Tephritidae) research in Latin America: myths, realities and dreams. Anais da Sociedade Entomologica do Brasil 28: 565-594.

Aluja, M., M. López, and J. Sivinski. 1998. Ecological evidence for diapause in four native and one exotic species of larval-pupal fruit fly (Diptera: Tephritidae) parasitoids in tropical environments. Annals of the Entomological Society of America 91: 821-833.

Aluja, M., J. Rull, J. Sivinski, A. L. Norrbom, R. Wharton, R. Macías-Ordoñez, F. Díaz-Fleischer, and M. López. 2003. Fruit flies of the genus *Anastrepha* (Diptera: Tephritidae) and associated native parasitoids (Hymenoptera) in the tropical rainforest biosphere reserve of Montes Azules, Chiapas, México. Environmental Entomology 32: 1377-1385.

Aruani, R., A. Ceresa, J. C. Granados, G. Taret, P. Peruzzotti, and G. Ortiz. 1996. Advances in the national fruit fly control and eradication program in Argentina, pp. 521-530. In B.A. McPheron and G.J. Steck. (eds.), Fruit fly pests: a world assessment of their biology and management. Delray Beach, Florida, St. Lucie Press, USA.

Cabrera, A. 1976. Regiones fitogeográficas argentinas. Enciclopedia Agricultura y Jardinería. ACME S.A.C.I., Buenos Aires, Argentina.

Canal, N. A., and R. A. Zucchi. 2000. Parasitóides – Braconidae, pp. 119-126. In A. Malavasi and R. A. Zucchi (eds.), Moscas-das-frutas de Importância Econômica no Brasil. Conhecimento Básico e Aplicado. Holos Editora, Riberão Preto, Brasil.

Canal, N. A., R. A. Zucchi, N. M. da Silva, and S. Silveira Neto. 1995. Análisis faunistico dos parasitóides (Hymenoptera: Braconidae) de Anastrepha spp. (Diptera: Tephritidae) em Manaus e Iranduba, Estado do Amazonas. Acta Amazónica 25 (3/4): 235-246.

Carrejo, N. S., and R. González, R. 1999. Parasitoids reared from species of *Anastrepha* (Diptera: Tephritidae) in Valle de Cauca, Colombia. Florida Entomologist 82: 113-118.

Carvalho, R. S. 2001. Primeira evidencia no Brasil de Diapausa em parasitoides de moscas-das-frutas (Diptera: Tephritidae) em ambiente tropical. EMBRAPA-Brasil, Com. Técnico 72: 1-4.

Carvalho, R. S., A. S. Nascimento, and W. J. R. Matrangolo. 2000. Controle Biologico, pp. 113-117. In A. Malavasi and R. A. Zucchi (eds.), Moscas-das-frutas de Importância Econômica no Brasil. Conhecimento Básico e Aplicado. Holos Editora, Riberão Preto, Brasil.

Clausen, C. P. 1978. Introduced parasites and predators of arthropod pests and weeds: a world review. USDA, Agriculture Handbook no 480, Washington, DC, USA.

Cruz, G. A. 1995. La “mosca sudamericana de la fruta” *Anastrepha fraterculus* Wiedemann y su control natural en Chanchamayo y Satipo. Revista de la Universidad de La Molina 7: 1-8.

DeSantis, L. 1941. Lista de himenópteros parásitos y predadores de los insectos de la República Argentina. Boletim da Sociedade do Brasil 4(1): 1-66.

DeSantis, L. 1965. Nota sobre un parásito de la mosca sudamericana de la fruta (Hymenoptera: Cynipidae). Revista de la Sociedad Entomológica Argentina 27: 73-74.

DeSantis, L. 1967. Catálogo de los himenópteros argentinos de la serie Parasitica, incluyendo Bethyloidea. Publ. Comis. Invest. Cient. Prov. Bs. As., Buenos Aires, Argentina.

DeSantis, L. 1979. Catálogo de los himenópteros calcidoideos de América al sur de los Estados Unidos. Publ. Esp. Comis. Invest. Cient. Prov. Bs. As., Buenos Aires, Argentina.

DeSantis, L., and P. Fidalgo. 1994. Catálogo de los himenópteros calcidoideos de América al sur de los Estados Unidos. Tercer Suplemento Academia Nacional de Agronomía y Veterinaria de Bs. As. 13: 1-154.

Eskafi, F. M. 1990. Parasitism of fruit flies *Ceratitis capitata* and *Anastrepha* spp. (Diptera: Tephritidae) en Guatemala. Entomophaga 35: 355-362.

Escalante, E. S. 1995. Evaluación de métodos para el control de moscas de la fruta en durazneros, localidad: El torno (Provincia Andrés Ibañez, Santa Cruz- Bolivia), años 1993-94. Graduation Thesis, Universidad Autónoma "Gabriel René Moreno", Santa Cruz, Bolivia, p. 95.

Fernández de Araoz, D., and A. J. Nasca. 1984. Especies de Braconidae (Hymenoptera: Ichneumonoidea) parasitoides de moscas de los frutos (Diptera: Tephritidae) colectados en la provincia de Tucumán. CIRPON, Revista de Investigaciones 2: 37-46.

Gibson, G. A. P., J. T. Huber, and J. B. Woolley. 1997. Annotated keys to the genera of the Neartic Chalcidoidea (Hymenoptera). NRC Research Press, Ottawa, Ontario, Canadá.

Guillén, L., M. Aluja, M. Equihua, and J. Sivinski. 2002. Performance of two fruit fly (Diptera: Tephritidae) pupal parasitoids (*Coptera haywardi* (Hymenoptera: Diapriidae) and *Pachycrepoideus vindemmiae* (Hymenoptera: Pteromalidae)) under different environmental soil conditions. Biological Control 23: 219-227.

Guimarães, J. A., Diaz, N. B. and Zucchi, R. A. 2000. Parasitoides – Figitidae (Eucoilinae), pp. 127-134. In A. Malavasi and R. A. Zucchi (eds.), Moscas-das-frutas de Importância Econômica no Brasil. Conhecimento básico e aplicado. Holos Editora, Riberão Preto, Brasil.

Guimarães, J. A., F. E. Gallardo, N. B. Diaz, and R. A. Zucchi. 2003. Eucoiline species parasitoid of fruit-infesting dipterous larvae in Brazil: identity, geographical distribution, and host associations. Zootaxa 278: 1-23.

Hayward, K. J. 1940. Lucha biológica contra las moscas de las frutas. Dispositivo que permite la salida de los parásitos beneficiosos del pozo donde se arroja la fruta atacada. Revista Industrial y Agrícola de Tucumán 30: 230-233.

Hayward, K. J. 1941. La lucha contra las moscas de las frutas. Revista Industrial y Agrícola de Tucumán 31: 331-349.

Hayward, K. J. 1943. Memoria Anual Departamento de Entomología. Revista Industrial y Agrícola de Tucumán 33: 68-70.

Jonson, N. F. 1992. Catalog of World species of Proctotrupoidea, exclusive of Playgastridae (Hymenoptera). Memoirs American Entomological Institute 51: 1-825.

Katiyar, K.P., J. Camacho, F. Geraud, and R. Matheus. 1995. Parasitoides hymenópteros de moscas de las frutas (Diptera: Tephritidae) en la región occidenatl de Venezuela. Revista de la Facultad de Agronomía 12: 303-312.

Leonel Jr., F.L., R. A. Zucchi, and R. A. Wharton. 1995. Distribution and tephritid hosts (Diptera) of braconid parasitoids (Hymenoptera) in Brazil. International Journal of Pest Management 41: 208-213.

Leonel Jr., F.L., R. A. Zucchi, and N. A. Canal Daza. 1996. Parasitismo de moscas-das-frutas (Diptera: Tephritidae) por Braconidae (Hymenoptera) en duas localidades do Estado de São Paulo. Anais da Sociedade Entomologica do Brasil 25: 199–205.

Loiácono, M. 1981. Notas sobre Diapriidae neotropicales (Hymenoptera: Diapriidae). Revista de la Sociedad Entomológica Argentina 40: 237-241.

López, M., M. Aluja, and J. Sivinski. 1999. Hymenopterous larval-pupal and pupal parasitoids of *Anastrepha* flies (Diptera: Tephritidae) in Mexico. Biological Control 15: 119-129.

López, M., J. Sivinski, P. Rendón, T. Holler, K. Bloem, R. Copeland, M. Trostle, and M. Aluja. 2003. Colonization of *Fopius ceratitivorus*, a newly discovered african eggpupal parasitoid (Hymenoptera: Braconidae) of *Ceratitis capitata* (Diptera: Tephritidae). Florida Entomologist 86(1): 53-60.

Montoya, P., and P. Liedo. 2000. Biological Control of fruit flies (Diptera: Tephritidae) through parasitoid augmentative releases: current status, pp. 719-723. In K. H. Tam (ed.), Area-wide control of fruit flies and other insect pests. Penerbit Universiti Sains Malaysia, Penang.

Morgan, P. B. 1986. Mass culturing microhymenopteran pupal parasites (Hymenoptera: Pteromalidae) of filth breeding flies. Misc. Publ. Entomol. Soc. Am. 61: 77-87.

Nasca, A. J. 1973. Parásitos de "moscas de los frutos" establecidos en algunas zonas de Tucumán. Revista Agronómica del Noroeste Argentino 10: 31-43.

Nordlander, G. 1978. Revision of the genus *Rhoptromeris* Förster, 1869, with references to north-western European species. Studies on Eucoilidae (Hym.: Cynipoidea) II. Entomologica Scandinavica 9: 47-62.

Ogloblin, A. 1937. La protección de los enemigos naturales de la mosca de la fruta (*Anastrepha fraterculus* Wied.). Almanaque del Ministerio de Agricultura: 177-179.

Oroño, E. L., S. M. Ovruski, A. L. Norrbom, P. Schliserman, C. Colin, C. B. Martin. 2005. Two new native host plant records for *Anastrepha fraterculus* (Diptera: Tephritidae) in Argentina. Florida Entomologist 88(2): 228-232.

Ovruski, S. M. 1994a. Immature stages of *Aganaspis pelleranoi* (Brèthes) (Hymenoptera: Cynipoidea: Eucoilidae), a parasitoid of *Ceratitis capitata* (Wied.) and *Anastrepha* spp. (Diptera: Tephritidae). Journal of Hymenptera Research 3: 233-239.

Ovruski, S. M. 1994b. Comportamiento en la detección del huésped de *Aganaspis pelleranoi* (Hymenoptera: Eucoilidae) parasitoide de larvas de *Ceratitis capitata* (Diptera: Tephritidae). Revista de la Sociedad Entomológica Argentina 53: 121-127.

Ovruski, S. M. 1995. Pupal and larval-pupal parasitoids (Hymenoptera) obtained from *Anastrepha* spp and *Ceratitis capitata* (Dipt: Tephritidae) pupae collected in four localities of Tucumán province, Argentina. Entomophaga 40: 367-370.

Ovruski, S. M. 2002. New records of fruit fly parasitoids from La Rioja province Northwestern Argentina. Proceeding of the Entomological Society of Washington 104 (4): 1054-1056.

Ovruski, S. M. 2003. Nuevos aportes a la taxonomía de las especies de Opiinae (Hymenoptera: Braconidae) parasitoides de *Anastrepha fraterculus* (Wiedemann) (Diptera: Tephritidae) en la provincia de Tucumán. Acta Zoológica Lilloana 47 (1): 39-68.

Ovruski, S. M. and P. Fidalgo. 1994. Use of parasitoids (Hymenoptera) in the control of fruit flies (Dip.: Tephritidae) in Argentina: bibliographic review (1937-1991). IOBC/WPRS Bulletin 17: 84 - 92.

Ovruski, S. M. and R. A. Wharton. 1996. On the identify of *Doryctobracon tucumanus* (Blanchard, 1966) (Hymenoptera, Braconidae: Opiinae). Proceeding of the Entomological Society of Washington 98 (1): 162-163.

Ovruski, S. M. and M. Aluja. 2002. Mating behavior of *Aganaspis pelleranoi* (Brèthes) (Hymenoptera: Figitidae, Eucoilinae), a fruit fly (Diptera: Tephritidae) larval-parasitoid. Journal of Insect Behavior 15 (1): 139-151.

Ovruski, S.M. and P. Schliserman. 2003a. First records of hymenopterous larval-pupal parasitoids of *Anastrepha fraterculus* (Diptera: Tephritidae) in the northwestern province of Catamarca, Argentina. Proceeding of the Entomological Society of Washington 105(4): 1056-1059.

Ovruski, S. M. and P. Schliserman. 2003b. Opiine and eucoiline parasitoids (Hymenoptera: Braconidae, Figitidae) of *Anastrepha fraterculus* (Diptera: Tephritidae) in the citrus orchard areas in Corrientes, northeastern Argentina. Canadian Entomologist 135(6): 863-865.

Ovruski, S. M., P. Schliserman, and M. Aluja. 2004. Indigenous parasitoids (Hymenoptera) attacking *Anastrepha fraterculus* and *Ceratitis capitata* (Diptera: Tephritidae) in native and exotic host plants in Northwestern Argentina. Biological Control 29: 43-57.

Ovruski, S. M., J. L. Cancino, P. Fidalgo, and P. Liedo. 1999. Nuevas perspectivas para la aplicación del control biológico contra moscas de la fruta (Diptera: Tephritidae) en Argentina. Revista Manejo Integrado de Plagas 54: 1-12.

Ovruski, S. M., M. Aluja, L. Sivinski, and R. A. Wharton. 2000. Hymenopteran parasitoids on fruit – infesting tephritidae (Diptera) in Latin America and the southern United States: diversity, distribution, taxonomic status and their use in fruit fly biological control. Integrated Pest Management Review 5: 81-107.

Ovruski, S. M., R. A. Wharton, P. Schliserman, and M. Aluja. 2005. Abundance of *Anastrepha fraterculus* (Diptera: Tephritidae) its associated native parasitoids (Hymenoptera) in "feral" guavas growing in the endangered northernmost Yungas forests of Argentina with and update on the taxonomic status of Opiine parasitoids previously reported in this country. Environmental Entomology 34 (4): 807-818.

Ovruski, S. M., P. Schliserman, O. R. DeColl, C. Peñaloza, L. Oroño, and C. Colin. 2006. The establishment of *Aceratoneuromyia indica* (Hymenoptera: Eulophidae) in three biogeographical regions of Argentina. Florida Entomologist. 89(2): 270-273.

Purcell, M. F. 1998. Contribution of biological control to integrated pest management of tephritid fruit flies in the tropics and subtropics. Integrated Pest Management Review 3: 63-83.

Salles, L. A. B. 1996. Parasitismo de *Anastrepha fraterculus* (Wied.) (Diptera: Tephritidae) por Hymenoptera, na região de Pelotas, RS. Pesquisa Agropecuaria Brasileira 31: 769-774.

Schliserman, P. and S. M. Ovruski. 2004. Incidencia de moscas de la fruta de importancia económica sobre *Citrus aurantium* (Rutaceae) en Tucumán, Argentina. Revista Manejo Integrado de Plagas y Agroecología (Costa Rica) 72: 52-61.

Schliserman, P., S. M. Ovruski, and O. R. DeColl. 2003. The recovery and permanent establishment of *Diachasmimorpha longicaudata* (Hymenoptera: Braconidae) in Misiones, northeastern Argentina. Florida Entomologist 86(4): 491-492.

Schliserman, P., S. M. Ovruski, C. Colin, A. L. Norrbom, and M. Aluja. 2004. First report of *Juglans australis* (Juglandaceae) as a natural host plant for *Anastrepha* schultzi (Diptera: Tephritidae) with notes on probable parasitism by *Doryctobracon areolatus*, *D. brasiliensis*, *Opius bellus* (Braconidae) and *Aganaspis pelleranoi* (Figitidae). Florida Entomologist 87(4): 597-599.

Schultz, E. F. 1938. La lucha contra las moscas de las frutas en Tucumán. Revista Industrial Agronómica de Tucumán 28 (7-9): 171-172.

Sivinski, J. 1996. The past and potential of biological control of fruit flies. In: McPheron, pp. 369-375. In B. A. McPheron and Steck, G. J. (eds.), Fruit fly pests: A World Assessment of Their Biology and Management. St. Lucie Press, DelRay Beach, Florida, USA.

Sivinski, J. and M. Aluja. 2003. The evolution of ovipositor length in the Parasitic Hymenoptera and the search for predictability in biological control. Florida Entomologist 86 (2): 143-150.

Sivinski, J., M. Aluja, and M. López. 1997. The spatial and temporal distributions of parasitoids of mexican *Anastrepha* species (Diptera: Tephritidae) within the canopies of fruit trees. Annals of the Entomological Society of America 90: 604-618.

Sivinski, J., J. Piñero and M. Aluja, M. 2000. The distributions of parasitoids (Hymenoptera) of *Anastrepha* fruit flies (Diptera: Tephritidae) along an altitudinal gradient in Veracruz, Mexico. Biological Control 18: 258-269.

Sivinski, J., K. Vulinec, E. Menezes, and M. Aluja. 1998. The bionomics of *Coptera haywardi* (Ogloblin) (Hymenoptera: Diapriidae) and other pupal parasitoid of tephritid fruit flies. Biological Control 11: 193-202.

Sivinski, J., K. Vulinec, and M. Aluja. 2001. Ovipositor length in a guild of parasitoids (Hymenoptera: Braconidae) attacking *Anastrepha* spp. fruit flies (Diptera: Tephritidae) in southern Mexico. Annals of Entomological Society of America. 94: 886-895.

Spinetta, M. 2004. National Fruit Fly Control and Eradication Program in Argentina, p. 144. In Proceedings of the 5th WGFFWH meeting, University of Florida-IFAS, Fl., USA.

Turica, A. 1968. Lucha biológica como medio de control de las moscas de los frutos. Revista IDIA: 241: 29-38.

Turica, A., and R. G. Mallo. 1961. Observaciones sobre la población de las "Tephritidae" y sus endoparásitos en algunas regiones citrícolas argentinas. Revista IDIA, Suplemento No. 6: 145-161.

Wharton, R. A. 1989. Classical Biological Control of fruit-infesting Tephritidae, pp. 303-313. In A. S. Robinson and G. Hooper (eds), World crop pests. Fruit flies, their biology, natural enemies and control, vol 3B. Elsevier Science, Amsterdam, The Netherlands.

Wharton, R. A. 1997. Generic relationships of opiine braconidae (Hymenoptera) parasitic on fruit-infesting Tephritidae (Diptera). Contributions of the American Entomological Institute 30: 1-53.

Wharton, R. A., S. M. Ovruski, and F. E. Gilstrap. 1998. Neotropical Eucoilidae (Cynipoidea) associated with fruit infesting Tephritidae, with new records from Argentina, Bolivia and Costa Rica. Journal of Hymenoptera Research 7: 102-115.

Wharton, R. A., F. E. Gilstrap, R. H. Rhodei, M. Fischel-M, and W. G. Hart. 1981. Hymenopterous egg-pupal and larval-pupal parasitoids of *Ceratitis capitata* and *Anastrepha* spp. (Diptera: Tephritidae) in Costa Rica. Entomophaga 26, 285-290.

Wharton, R. A., M. K. Trostle, R. H. Messing, R. S. Copeland, S. W. Kimani-Njogu, S. Lux, W. A. Overholt, S. Mohamed, and J. Sivinski. 2000. Parasitoids of medfly, *Ceratitis capitata* and related tephritids in Kenyan coffee: a predominantly koinobiont assemblage. Bulletin of the Entomological Research 90: 517-526.

Yépes, R. F., and R. Vélez. 1989. Contribución al conocimiento de las moscas de las frutas (Tephritidae) y sus parasitoides en el departamento de Antioquia. Revista Facultad Nacional de Agronomía de Medellín (Colombia) 42: 73-98.