

CROP PROTECTION

Faunistic Analysis of *Anastrepha* spp. (Diptera: Tephritidae) on a Guava Orchard under Organic Management in the Municipality of Una, Bahia, BrazilVIVIAN S DUTRA¹, MÍRIAN S SANTOS¹, ZILTON A SOUZA FILHO¹, ELTON L ARAUJO², JANISETE G SILVA¹¹Depto. de Ciências Biológicas, Univ. Estadual de Santa Cruz, Rod. Ilhéus/Itabuna, km 16, 45650-000, Ilhéus, BA
²Depto. de Ciências Vegetais, Univ. Federal Rural do Semi-Árido, BR 110 km47, Costa e Silva, 59625-900, Mossoró, RN

Edited by Roberto Antônio Zucchi – ESALQ/USP

Neotropical Entomology 38(1):133-138 (2009)Análise Faunística de *Anastrepha* spp. (Diptera: Tephritidae) em um Pomar de Goiaba sob Manejo Orgânico, no Município de Una, BA

RESUMO - Foi realizado estudo para caracterizar as populações de moscas-das-frutas em pomar orgânico de goiaba (*Psidium guajava* cv. Paluma) no município de Una, Sul da Bahia, por meio da análise faunística dos espécimes capturados em armadilhas McPhail de janeiro de 2004 a março de 2007. Foram capturados 22.673 espécimes de *Anastrepha* (15.306 fêmeas e 7.367 machos). Treze espécies de *Anastrepha* foram registradas. *A. fraterculus* e *A. obliqua* foram as mais frequentes e dominantes, perfazendo 90,1% de todos as fêmeas capturadas nas armadilhas. *A. fraterculus* foi a espécie predominante (mais frequente, constante e dominante). O alto valor do índice de Simpson (0,62) e os baixos valores dos índices de Shannon-Wiener (0,83) e equitabilidade (0,49) indicaram a dominância e a alta frequência de *A. fraterculus* e *A. obliqua* no pomar de goiaba, mesmo na presença de outras espécies frutíferas potencialmente hospedeiras de moscas-das-frutas.

PALAVRAS-CHAVE: Insecta, mosca-das-frutas, diversidade, armadilha McPhail, fruticultura orgânica

ABSTRACT - We carried out a study to characterize fruit fly populations on an organic guava orchard (*Psidium guajava* cv. Paluma) in the municipality of Una, southern region of the state of Bahia, Brazil, using faunistic analysis of the adult fruit fly specimens captured in McPhail traps from January 2004 through March 2007. A total of 22,673 specimens of *Anastrepha* (15,306 females and 7,367 males) were captured. Thirteen species of *Anastrepha* were recorded. *A. fraterculus* and *A. obliqua* were the more frequent and dominant species, accounting for 90.1% of all females captured in the traps. *A. fraterculus* was the predominant species (more frequent, constant and dominant). The high value of the Simpson index (0.62) and the low values of Shannon-Wiener (0.83) and equitability (0.49) indices indicated the dominance and high frequency of *A. fraterculus* and *A. obliqua* on the guava orchard despite the presence of other fruit species as potential hosts of fruit flies.

KEY WORDS: Insecta, fruit fly, diversity, McPhail trap, organic fruit crop

The genus *Anastrepha* Schiner comprises over 200 species and represents the most diverse genus of Tephritidae in the Americas (Norrbom *et al* 1999, Norrbom & Korytkowski 2007). These species are endemic to the Neotropical region and are restricted to tropical and subtropical areas, ranging from the southern United States to northern Argentina and most of the Caribbean Islands (Aluja 1994).

In Brazil, 101 *Anastrepha* species have been registered, seven of which are considered economically important infesting hosts in 35 families (Zucchi 2008). Many Myrtaceae species are important fruit fly hosts, especially

in the genera *Psidium*, *Eugenia* and *Syzygium* (Zucchi 2000, 2007, Jesus *et al* 2008).

Guava (*Psidium guajava*) is endemic to the Neotropical region (Thaipong, Boonprakob 2005) and is one of the preferred fruit fly hosts in Brazil (Araujo, Zucchi 2003, Raga *et al* 2006). Brazil is responsible for the largest production of guava in the world, most of which is concentrated in the states of São Paulo, Pernambuco and Bahia (Ministério da Agricultura, Pecuária e Abastecimento 2002). Despite its increasing importance regarding fruit production, few studies on faunistic analysis of fruit flies have been carried out in the

state of Bahia. There is only one previous study that focused on the eastern region, Recôncavo Baiano (between 38°30' and 40°09'S latitude and 12°18' and 13°36'W longitude) (Nascimento *et al* 1983).

Fruit fly species diversity and dominance can be affected by ecological background such as abundance and diversity of host plant species, composition of orchards and surrounding ecosystems or agroecosystems, as well as by altitudinal gradients (Aluja 1994, Aluja *et al* 1996). These analyses provide important information to determine the target species and locations for future programs of fruit fly control in a given region (Uramoto *et al* 2005).

In the current study, we examine population dynamics of fruit flies on a guava orchard under organic management in southern Bahia, Brazil, focusing on faunistic analysis over a three-year period. Our results offer insight into the diversity, dominance, and frequency of fruit fly species, which allows for the improved characterization of this insect community.

Material and Methods

The study site was an organic guava orchard of 0.5 ha within a 30 ha farm located in the municipality of Una, BA (15°17'S, 39°04'W, and 71 m above sea level). The farm is surrounded by mature coastal rainforest. The native vegetation is classified as tropical lowland rainforest. Climate is defined as Af (tropical wet) with a mean annual temperature of 24.7°C and 1,827 mm of rainfall, with no distinct rainy season. The orchard is comprised of 100 trees of *Psidium guajava* cv. Paluma and has been free of any pesticide applications for over 10 years. The guava trees are interspersed with banana (*Musa* sp., Musaceae), cacao (*Theobroma cacao*, Malvaceae), cassava (*Manihot esculenta*, Euphorbiaceae) and rubber trees (*Hevea brasiliensis*, Euphorbiaceae). The farm also has smaller areas planted with other potential fruit fly hosts in the families Anacardiaceae (*Spondias cytherea*, *S. purpurea* and *S. mombin*), Annonaceae (*Annona muricata*), Ebenaceae (*Diospyros kaki*), Malpighiaceae (*Malpighia puniceifolia*), Mimosaceae (*Inga edulis*), Moraceae (*Morus nigra*), Myrtaceae (*Psidium guineense*, *Eugenia stipitata*, *Eugenia uniflora* and *Syzygium malaccensis*), Oxalidaceae (*Averrhoa carambola*) and Sapotaceae (*Achras sapota*).

Fruit flies were captured using 10 plastic McPhail traps with a yellow bottom set up in guava trees on the orchard. Traps were placed in the central part of the tree canopy at 1.5 m from the ground surface and distributed within the orchard as follows: two traps in the central part of the orchard (18 m of distance from each other) and eight traps in the periphery of the orchard (5 m of distance from the orchard edge and at 12 m of distance from the central traps). Traps were baited with 700 ml of 5% hydrolyzed protein and serviced on a weekly basis. All captured insects were transferred to plastic vials filled with 70% ethanol and taken to the laboratory for identification. The sampling was carried out from January 2004 to March 2007.

All captured females of the genus *Anastrepha* were individually identified to species. Voucher specimens were deposited at the Laboratório de Entomologia, Universidade

Estadual de Santa Cruz (UESC), Ilhéus, BA and at the Laboratório de Moscas-das-frutas, Universidade Federal Rural do Semi-Árido (UFERSA), Mossoró, RN, Brazil.

Faunistic analysis was performed based on the indices of frequency, dominance, constancy, species richness, and the diversity indices of Simpson, Shannon-Wiener (H'), and equitability (modified Hill index). These indices were determinate as described by Silveira Neto *et al* (1976) and Uramoto *et al* (2005).

Results and Discussion

A total of 22,673 specimens of *Anastrepha* (15,306 females and 7,367 males) were captured in the three-year sampling period. The number of specimens varied with the year of collection. In 2004, 6,425 specimens of *Anastrepha* (4,396 females and 2,029 males) were captured. In 2005, the traps caught the highest number of *Anastrepha* (6,954 females and 3,487 males, totaling 10,441). In 2006/2007, there was a decrease of specimen number captured: 5,806 specimens of *Anastrepha* (3,955 females and 1,851 males). The increase on the number of flies trapped in 2005 was probably due to a markedly larger number of available fruits in the orchard and surrounding area, as well as to the higher temperatures observed in that year. These factors could have favored a higher emergence of adults, resulting in a high population peak observed in April 2005 (Dutra *et al*, unpublished data).

Thirteen *Anastrepha* species were recorded (Table 1), and this species richness is within the range reported in other inventories carried out in the state of Bahia. In a previous study carried out in the municipality of Una, Bittencourt *et al* (2006) reported only six species during a sampling period of three months. Nascimento *et al* (1983) carried out a three-year study in six locations in the Recôncavo Baiano, and reported a total of 20 species, ranging from seven to 17 species in Nova Soure (11°11'S; 38°26'W) and in Cruz das Almas (12°41'S; 39°03'W), respectively. In the municipalities of Juazeiro, BA (9°26'S; 40°26'W) and Petrolina, PE (9°26'S; 40°33'W), nine species were registered (Nascimento & Carvalho 2000).

In our study, most of the species captured presented low frequency of occurrence. This result suggests that adults of the low frequent species were not resident on the guava orchard, but they came from other hosts nearby the farm and/or the surrounding forest area. The study area is surrounded by one of the few and largest remnants of the highly endangered mature coastal rainforest in Brazil (Faria *et al* 2006). The Brazilian Atlantic rainforest is considered one of the richest biomes on earth, and southern Bahia harbors high species richness, high levels of endemism and local sites of diversity of trees in families that comprise species which are known hosts of *Anastrepha*, such as Fabaceae, Malpighiaceae, Myrtaceae, Rutaceae, and Sapotaceae (Thomas *et al* 1998, Faria *et al* 2006, Martini *et al* 2007). Thus, the forest areas surrounding the guava orchard can provide an important reservoir for tephritid populations that probably migrate to the orchard. The movement of fruit flies from the adjacent native vegetation, particularly forest fragments, into orchards

Table 1 Characterization of *Anastrepha* specimens on an organic guava orchard by faunistic indices in the municipality of Una, BA, from January 2004 to March 2007.

Species	N ¹				Frequency (%)			
	Total	Year 1	Year 2	Year 3	Total	Year 1	Year 2	Year 3
<i>A. fraterculus</i> (Wiedemann)	11,803	3,745	5,135	2,923	77.1	85.2	73.8	73.9
<i>A. obliqua</i> (Macquart)	1,991	434	1,068	489	13.0	9.9	15.4	12.4
<i>A. sororcula</i> Zucchi	828	8	394	426	5.4	0.2	5.7	10.8
<i>A. zenildae</i> Zuchi	276	97	131	48	1.8	2.2	1.9	1.2
<i>A. distincta</i> Greene	226	109	73	44	1.5	2.5	1.0	1.1
<i>A. montei</i> Lima	76	0	63	13	0.5	0	0.9	0.3
<i>A. pickeli</i> Lima	52	0	46	6	0.3	0	0.7	0.2
<i>A. manihoti</i> Lima	17	0	14	2	0.1	0	0.2	0.05
<i>A. serpentina</i> (Wiedemann)	15	0	14	1	0.1	0	0.2	0.02
<i>A. bahiensis</i> Lima	9	0	8	1	0.06	0	0.1	0.02
<i>A. dissimilis</i> Stone	7	0	7	0	0.05	0	0.1	0
<i>A. leptozona</i> Hendel	5	2	1	2	0.03	0.04	0.01	0.05
<i>A. antunesi</i> Lima	1	1	0	0	0.006	0.02	0	0
Species richness (S)	13	7	12	11				
Simpson index	0.62	0.74	0.57	0.57				
Shannon-Wiener index	0.83	0.56	0.91	0.87				
Equitability (Modified Hill)	0.49	0.48	0.50	0.54				

Species	Dominance ²				Constancy ³			
	Total	Year 1	Year 2	Year 3	Total	Year 1	Year 2	Year 3
<i>A. fraterculus</i>	d	d	d	d	87.0 (w)	80.7 (w)	85.2 (w)	98.2 (w)
<i>A. obliqua</i>	d	n	d	d	47.6 (y)	36.8 (y)	51.9 (w)	57.9 (w)
<i>A. sororcula</i>	n	n	n	d	21.2 (z)	10.5 (z)	31.5 (y)	21.0 (y)
<i>A. zenildae</i>	n	n	n	n	27.1 (y)	29.8 (y)	27.8 (y)	24.5 (y)
<i>A. distincta</i>	n	n	n	n	37.0 (y)	36.8 (y)	42.6 (y)	29.8 (y)
<i>A. montei</i>	n	n	n	n	17.6 (z)	--	38.9 (y)	15.8 (z)
<i>A. pickeli</i>	n	n	n	n	14.7 (z)	--	40.7 (y)	5.3 (z)
<i>A. manihoti</i>	n	n	n	n	5.3 (z)	--	13.0 (z)	3.5 (z)
<i>A. serpentina</i>	n	n	n	n	3.5 (z)	--	9.3 (z)	1.8 (z)
<i>A. bahiensis</i>	n	n	n	n	4.1 (z)	--	11.1 (z)	1.8 (z)
<i>A. dissimilis</i>	n	n	n	n	4.2 (z)	--	11.1 (z)	--
<i>A. leptozona</i>	n	n	n	n	2.3 (z)	1.7 (z)	1.8 (z)	3.5 (z)
<i>A. antunesi</i>	n	n	n	n	0.6 (z)	1.7 (z)	--	--

¹N = total of captured females; ²d: dominant; n: non-dominant; ³w: constant; y: accessory; z: accidental; Total: 2004-2007; Year 1: 2004-2005; Year 2: 2005-2006; Year 3: 2006-2007

was demonstrated by Vargas *et al* (1990), Aluja (1996) and Kovaleski *et al* (1999).

Only two, out of the 13 *Anastrepha* species captured, were dominant: *A. fraterculus* (Wiedemann) and *A. obliqua* (Macquart) (Table 1). The former was the most frequent species. Eight species showed a frequency lower than 1% and were

responsible for 1.2% of all females captured. *A. fraterculus* was the only species characterized as constant, occurring in 87.0% of the collections. Three species (*A. obliqua*, *A. zenildae* Zucchi and *A. distincta* Greene) were accessory, and the remaining species were accidental (Table 1).

The high value of the Simpson index and the low values

of Shannon and equitability indices were a result of the dominance and high frequency of *A. fraterculus* and *A. obliqua*, which accounted for 90.1% of all flies captured. Interestingly, of the 13 species captured in traps on the guava orchard, only *A. fraterculus*, *A. sororcula*, and *A. zenildae* actually use guava as a preferred host in this region of Bahia (Souza-Filho et al 2007).

Previous studies carried out in the state of Bahia, more precisely in the Recôncavo Baiano region, also registered the dominance of *A. fraterculus* and *A. obliqua* in most localities regardless of the species richness reported ($S = 20$) (Nascimento et al 1983). Studies conducted on guava orchards in northern Minas Gerais (Corsato 2004) reported 18 species of *Anastrepha*, however, the dominance of only two species, *A. zenildae* and *A. sororcula*, was observed. Two recent studies on guava orchards in the state of Rio de Janeiro also revealed the dominance of *A. fraterculus*, despite the species richness reported ($S = 16$) in the northwestern region (Ferrara et al 2005) as well as in the northern region ($S = 14$) (Aguar-Menezes et al 2008).

The dominance of certain species of *Anastrepha* on commercial fruit orchards, when one or two species account for more than 90% of all adults trapped even though other *Anastrepha* species may be captured, was already reported in studies conducted in Mexico and Costa Rica (Aluja et al. 1996), as well as in different regions of Brazil (Nascimento & Zucchi 1981, Araujo & Zucchi 2003, Silva et al 2006).

Aluja et al (1996) demonstrated that an association between the most common single species trapped on a particular orchard and the fruit crop cultivated on the orchard in question can indicate the fruits of this crop as a suitable host for oviposition and larval development. The high frequency, dominance and constancy of *A. fraterculus* on the guava orchard in our study are probably due to its preference for guava (Katiyar et al 2000, Raga et al 2006, Souza-Filho et al 2007). The higher frequency of *A. obliqua* when compared to the remaining 11 species is probably due to its preference for Anacardiaceae hosts, several of which were present in the study area.

However, climatic conditions and altitude may also explain the difference of relative frequencies among *Anastrepha* species. According to Malvasi et al (2000), in the northeastern region of Brazil, *A. fraterculus* predominates on the coastal regions, which are more humid, and *A. zenildae* and *A. sororcula* occur predominantly in the inland areas and are better adapted to dry climates. Una is a coastal municipality, where *A. fraterculus* was the predominant species (most frequent, dominant and constant), while in studies carried out on commercial guava orchards in Mossoró, Rio Grande do Norte, and in the northern region of the state of Minas Gerais, both located in a semiarid region, the predominant species were *A. zenildae* and *A. sororcula* (Canal et al 1998, Araujo & Zucchi 2003, Corsato 2004). In the northwestern region of the state of Rio de Janeiro, the predominance of *A. fraterculus* was also verified on guava orchards in the municipalities of Italva, Itaperuna (Ferrara et al 2005), Cambuci and Itaocara (Aguar-Menezes et al 2008).

Many different biotic and abiotic stimuli can account for

the presence of the lesser abundant *Anastrepha* species in environments that do not provide optimal host plants, such as commercial orchards (Aluja et al 1996). The authors suggest that the odor of ripening fruit, shelter conditions of perennial trees, and emission of volatiles by certain tree species that are similar to those found in the sexual pheromones of fruit flies could draw adult fruit flies into the orchard.

In this study, we registered the occurrence of 13 *Anastrepha* species and verified the presence of a large number of accidental species. Most species showed a low frequency and were not dominant in any of the years on the orchard under study. However, *A. fraterculus* was the most frequent species and the only one that was dominant and constant over the three-year study, indicating its importance as a pest of guava in the region. The high frequency of *A. obliqua* is probably due to other potential fruit hosts in the vicinity of the guava orchard, since previous studies (Souza-Filho et al 2007) have not registered this species infesting guavas in the region.

Acknowledgments

We would like to thank Carlos Niella and Tania Niella for allowing us to use their farm as a study site; Daniela B Vidal, Nívea M O Silva, and Ricardo A Nink for their help in the field and at the lab. Thanks are due to Carter R Miller and an anonymous reviewer for their helpful comments on the manuscript. The project was supported by Fundação de Amparo à Pesquisa do Estado da Bahia (FAPESB) and UESC. ZASF was supported under a Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) fellowship during his MSc.

References

- Aguar-Menezes E L, Souza S A S, Lima Filho M, Barros H C, Ferrara F A A, Menezes E B (2008) Análise faunística de moscas-das-frutas (Diptera: Tephritidae) nas regiões Norte e Noroeste do estado do Rio de Janeiro. *Neotrop Entomol* 37: 8-14.
- Aluja M (1994) Bionomics and management of *Anastrepha*. *Annu Rev Entomol* 39: 155-178.
- Aluja M (1996) Future trends in fruit fly management, p.309-320. In McPherson B A, Steck G J (eds), *Fruit fly pests: a world assessment of their biology and management*. Delray Beach, St. Lucie Press, 586p.
- Aluja M, Celedonio-Hurtado H, Liedo P, Cabrera M, Castillo F, Guillén J, Rios E (1996) Seasonal population fluctuation and ecological implications for management of *Anastrepha* fruit flies (Diptera: Tephritidae) in commercial mango orchards in southern Mexico. *J Econ Entomol* 89: 654-667.
- Araujo E L, Zucchi R A (2003) Moscas-das-frutas (Diptera: Tephritidae) em goiaba (*Psidium guajava* L.), em Mossoró, RN. *Arq Ins Biol* 70: 73-77.

- Bittencourt M A L, Cova A K W, Silva A C M, Silva V E S, Bomfim Z V, Araujo E L, Souza Filho M F (2006) Espécies de moscas-das-frutas (Tephritidae) obtidas no estado da Bahia, Brasil. *Semina, Ciências Agrárias* 27: 561-564.
- Canal N A, Alvarenga C D, Zucchi R A (1998) Níveis de infestação de goiaba por *Anastrepha zenilldae* Zucchi (Diptera: Tephritidae), em pomares comerciais do norte de Minas Gerais. *An Soc Entomol Brasil* 27: 657-661.
- Corsato C D A (2004) Moscas-das-frutas (Diptera: Tephritidae) em pomares de goiaba no Norte de Minas Gerais: biodiversidade, parasitóides e controle biológico. 2004. Tese de doutorado. Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo, Piracicaba, 95p.
- Faria D, Laps R R, Baumgarten J, Cetra M (2006) Bat and bird assemblages from forests and shade cacao plantations in two contrasting landscapes in the Atlantic Forest of southern Bahia, Brazil. *Biodivers Conserv* 15: 587-612.
- Ferrara F A A, Aguiar-Menezes E L, Uramoto K, Marco Jr P de, Souza S A S, Cassino P C R (2005) Análise faunística de moscas-das-frutas (Diptera: Tephritidae) da Região Noroeste do estado do Rio de Janeiro. *Neotrop Entomol* 34: 183-190.
- Garcia F R M, Campos J V, Corseuil E (2003) Análise faunística de espécies de moscas-das-frutas (Diptera: Tephritidae) na região oeste de Santa Catarina. *Neotrop Entomol* 32: 421-426.
- Jesus C R, Oliveira M N, Souza Filho M F, Silva R A, Zucchi R A (2008) First record of *Anastrepha parishi* Stone (Diptera, Tephritidae) and its host in Brazil. *Rev Bras Ent* 52: 135-136.
- Katiyar K P, Molina J C, Matheus R (2000) Fruit flies (Diptera: Tephritidae) infesting fruits of the genus *Psidium* (Myrtaceae) and their altitudinal distribution in western Venezuela. *Fla Entomol* 83: 480-486.
- Kovaleski A, Sugayama R L, Malavasi A (1999) Movement of *Anastrepha fraterculus* from native breeding sites into apple orchards in Southern Brazil. *Entomol Exp Appl* 91: 457-463.
- Malavasi A, Morgante J S (1980) Biologia de "moscas-das-frutas" (Diptera: Tephritidae) II: Índices de infestação em diferentes hospedeiros e localidades. *Rev Bras Biol* 40: 17-24.
- Malavasi A, Morgante J S, Prokopy R J (1983) Distribution and activities of *Anastrepha fraterculus* (Diptera: Tephritidae) flies on host and nonhost trees. *Ann Entomol Soc Am* 76: 286-292.
- Malavasi A, Morgante J S, Zucchi R A (1980) Biologia de "moscas-das-frutas" (Diptera: Tephritidae) I: Lista de hospedeiros e ocorrência. *Rev Bras Biol* 40: 9-16.
- Malavasi A, Zucchi R A, Sugayama R L (2000) Biogeografia, p.93-98. In Malavasi A, Zucchi R A (eds), Moscas-das-frutas de importância econômica no Brasil. Conhecimento Básico e Aplicado. Ribeirão Preto, Holos Editora, 327p.
- Martini A M Z, Fiaschi P, Amorim A M, Paixão J L (2007) A hot-point within a hot-spot: a high diversity site in Brazil's Atlantic Forest. *Biodivers Conserv* 16: 3111-3128.
- Ministério da Agricultura, Pecuária e Abastecimento (2002) Anuário brasileiro da fruticultura. 176p.
- Nascimento A S, Carvalho R S (2000) Manejo integrado de moscas-das-frutas, p.169-173. In Malavasi A, Zucchi R A (eds), Moscas-das-frutas de importância econômica no Brasil. Conhecimento básico e aplicado. Ribeirão Preto, Holos Editora, 327p.
- Nascimento A S, Zucchi R A (1981) Dinâmica populacional das moscas-das-frutas do gênero *Anastrepha* (Dip., Tephritidae) no Recôncavo Baiano, I – Levantamento das espécies. *Pesq Agropec Bras* 16: 763-767.
- Nascimento A S, Zucchi R A, Silveira Neto S (1983) Dinâmica populacional das moscas-das-frutas do gênero *Anastrepha* (Dip., Tephritidae) no Recôncavo Baiano, III – Análise faunística. *Pesq Agropec Bras* 18: 319-328.
- Norrbom A L, Korytkowski C A (2007) A new species, new synonymy, and taxonomic notes in the *Anastrepha schausi* group (Diptera: Tephritidae). *Zootaxa* 1497: 47-55.
- Norrbom A L, Zucchi R A, Henández-Ortiz V (1999) Phylogeny of the genera *Anastrepha* and *Toxotrypana* (Trypetinae: Toxotrypanini) based on morphology, p.299-342. In M Aluja, A L Norrbom. Fruit flies (Tephritidae): phylogeny and evolution of behavior. New York, CRC Press, 944p.
- Raga A, Souza Filho M F, Prestes D A O, Azevedo Filho J A, Sato M E (2006) Susceptibility of guava genotypes to natural infestation by *Anastrepha* spp. (Diptera: Tephritidae) in the municipality of Monte Alegre do Sul, state of São Paulo, Brazil. *Neotrop Entomol* 35: 121-125.
- Silva F F, Meirelles R N, Redaelli L R, Dal Soglio F K (2006) Diversity of flies (Diptera: Tephritidae and Lonchaeidae) in organic citrus orchards in the Vale do Rio Caí, Rio Grande do Sul, Southern Brazil. *Neotrop Entomol* 35: 666-670.
- Silveira Neto S, Nakano O, Barbin D, Vila Nova N A (1976) Manual de ecologia dos insetos. São Paulo, Agrônômica Ceres, 420p.
- Souza-Filho Z A, Araujo E L, Guimarães J A, Silva J G (2007) Endemic parasitoids associated with *Anastrepha* spp. (Diptera: Tephritidae) infesting guava (*Psidium guajava* L.) in southern Bahia, Brazil. *Fla Entomol* 90: 783-785.
- Thaipong K, Boonprakob U (2005) Genetic and environmental variance components in guava fruit qualities. *Sci Hortic* 104: 37-47.
- Thomas W W, Carvalho A M V, Amorim A M A, Garrison J, Arbela'ez A L (1998) Plant endemism in two forests in southern Bahia, Brazil. *Biodivers Conserv* 7: 311-322.
- Uramoto K, Walder J M M, Zucchi R A (2005) Análise quantitativa e distribuição de populações de espécies de *Anastrepha* (Diptera, Tephritidae) no campus "Luiz de Queiroz", Piracicaba, SP. *Neotrop Entomol* 34: 33-39.
- Vargas R I, Stark J D, Nishida T (1990) Population dynamics, habitat preference, and seasonal distribution patterns of oriental fruit fly and melon fly (Diptera: Tephritidae) in an agricultural area. *Environ Entomol* 19: 1820-1828.
- Zahler P M (1990) Moscas-das-frutas em dois pomares de manga (*Mangifera indica* L.) do Distrito Federal: levantamento de espécies e flutuação populacional. *Rev Ceres* 38: 206-216.

- Zucchi R A (2000) Espécies de *Anastrepha*, sinónimas, plantas hospedeiras e parasitóides, p.41-48. In Malavasi A, Zucchi R A (eds), Moscas-das-frutas de importância econômica no Brasil. Conhecimento básico e aplicado. Ribeirão Preto, Holos Editora, 327p.
- Zucchi R A (2007) Diversidad, distribución y hospederos del género *Anastrepha* en Brasil, p.77-100. In Hernández-Ortiz V (ed), Moscas de la fruta en Latinoamérica (Diptera: Tephritidae): diversidad, biología y manejo. Distrito Federal, México, S y G editores, 167p.
- Zucchi R A (2008) Fruit flies in Brazil - *Anastrepha* species and their hosts plants. (http://www.lef.esalq.usp.br/anastrepha/edita_infos.htm, acessado em 09/janeiro/2009).
- Received 19/XII/07. Accepted 09/I/09.
-