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FRUIT FLY (DIPTERA: TEPHRITIDAE) COMMUNITY IN GUAVA ORCHARDS AND ADJACENT FRAGMENTS OF NATIVE VEGETATION IN BRAZIL

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Abstract

We studied the community of fruit flies in an agricultural habitat (guava orchards) and the adjoining native vegetation, in a caatinga-cerrado transition region in the state of Minas Gerais, Brazil. Sampling was conducted with McPhail traps and by collecting guavas and other fruits in native vegetation. The 3 most common fruit-fly species in the orchards were *Anastrepha zenildae* Zucchi, *A. sororcula* Zucchi, and *A. fraterculus* (Wiedemann), whereas the most common species in the forest fragments were *A. zenildae*, *A. pickeli* Lima, and *A. montei* Lima. The species of fruit flies recorded in the forests were also collected in the guava orchards. Species of economic importance, such as *A. zenildae*, use forest fruits as alternative hosts. Fruit-fly diversity is supported by the presence of native vegetation fragments adjacent to agricultural areas.

Key Words: *Anastrepha*, *Ceratitis capitata*, Dry Forest, Caatinga, Cerrado

Resumo

A comunidade de moscas-das-frutas foi estudada em áreas constituídas por um pomar de goiaba ao lado de um fragmento de vegetação nativa, localizadas em uma região de transição caatinga-cerrado no estado de Minas Gerais, Brasil. As coletas foram realizadas com armadilhas McPhail e pela coleta de goiaba e de frutos nativos. As três espécies de moscas--das-fruta mais comuns nos pomares foram *Anastrepha zenildae* Zucchi, *A. sororcula* Zucchi e *A. fraterculus* (Wiedemann), enquanto as espécies mais comuns nos fragmentos florestais foram *A. zenildae*, *A. pickeli* Lima, e *A. montei* Lima. As espécies de moscas-das-frutas observadas nos fragmentos de vegetação nativa também foram coletadas em pomares de goiaba. As espécies de importância econômica, como *A. zenildae*, usa frutos da mata como hospedeiros alternativos. A diversidade de moscas-das-frutas é sustentada pela presença de fragmentos de vegetação nativa adjacentes às áreas agrícolas.

Palavras-Chave: *Anastrepha*, *Ceratitis capitata*, Dry Forest, Caatinga, Cerrado

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In Brazil, several fruit fly species are economically important. *Anastrepha* spp. and *Ceratitis capitata* (Wiedemann) stand out for their economic importance to the Brazilian fruit industry (Zucchi 2000). These pests not only cause direct damage to fruit, but they are also a major impediment to exporting fresh fruit, given that importing countries apply rigid quarantine measures due to considerable economic losses that these pests can cause to their pomiculture. However, the great majority of studies have been carried out in commercial orchards, whereas preserved areas and native vegetation adjacent to agricultural sites have been neglected.

Research in natural areas is fundamental to understand fruit fly biology and ecology (Aluja 1999). Also, the effect of native vegetation adjacent to agricultural areas has been studied to elucidate the role of these areas in insect dynamics (e.g., Nicholls et al. 2001; Letourneau & Goldstein 2001), but little is known about species of *Anastrepha* in undisturbed areas. Therefore, for a better understanding of the fruit fly community, it is essential to know how the proximity of native vegetation to orchards might affect these insects.

The fragmentation of formerly continuous native vegetation has been altering and isolating forest areas into small, highly degraded remnants. The areas adjacent to these fragments are also being modified by activities including logging, hunting, burning, and the introduction of domestic animals and exotic species. This leads to the reduction and isolation of wild populations and the loss of habitats, reducing gene flow and causing species to become extinct (Britez et al. 2003). A trend that goes hand-in-hand with the expansion of agricultural monocultures is the degradation of their surrounding vegetation, in areas where appropriate preservation and management had previously supported a biologically diversified landscape. This destruction may cause the extinction of many species, including fruit flies (Aluja 1999).

The consequences of biodiversity reduction are most visible in the aspects related to agricultural pests and how they are addressed (Altieri et al. 2003). The importance of biodiversity loss derives not only from the imbalance that it causes in the affected habitats due to loss of species, but also from the fact that it can forestall the discovery of useful information on the biology, ecology, and evolution of fruit flies and other pests.

This paper deals with a fruit fly community consisting mainly of species of *Anastrepha* in an agricultural habitat and its adjacent native vegetation in an ecotone area (caatinga-cerrado) in the state of Minas Gerais, Brazil. The guava (*Psidium guajava* Mill; Myrtales: Myrtaceae) orchards are situated near forest fragments that are legal reserves for the preservation and refuge of fauna in Brazil. The types of agricultural management practices, especially the use of insecticides, differ in each orchard and also affect the adjacent forest fragment. The purpose of this study was to know the fruit fly species composition in native and agricultural environments and if native vegetation adjacent to an agricultural area harbors fruit fly species of economic importance.

Materials and Methods

Study Site

Guava orchards were chosen for the study because it was possible to find orchards under different types of management and with adjacent forest fragments. Moreover, guava is infested by several species of fruit flies in the region. The study was conducted at 3 sites, each containing a guava orchard and an adjacent native vegetation fragment. The agricultural areas were selected on the basis of type of management, presence of adjacent native-forest, availability for sampling, and distance between the orchard and the native forest (Table 1). The areas are located in the municipalities of Jaíba and Matias Cardoso in the state of Minas Gerais, Brazil. The predominant biome in the region is Caatinga (xeric shrubland and thorn forest) with enclaves of Cerrado (savanna) (Drummond et al. 2005).

The mean temperatures in the two municipalities range from 21 to 25 °C (minimum temperatures of 14 to 19 °C and maximum temperatures of 26 to 31 °C). The total annual rainfall is 700 to 1,200 mm, with a rainy season from Oct to Apr and a dry season from May to Sep, and relative humidity ranging from 60 to 70% (Antunes 1994).

Fruit Fly Sampling

Flies were sampled with McPhail traps containing 5% hydrolyzed corn protein stabilized with borax (pH range from 8.5 to 9.0) and guavas and other native fruits were collected. Studies were conducted from Apr 2005 to Mar 2006.

McPhail traps were hung in the tree canopy (3 traps in each orchard and each forest fragment). Traps were placed equidistantly to cover the largest possible area within the forest fragments; 3 traps per orchard were adequate for sampling fruit flies because the orchards were small (Table 1). Every 2 weeks, the bait in the traps was replaced and the specimens were collected. The fruit flies were sexed, counted, and stored in 70% ethanol for later identification.

Fruit collection and processing procedures followed commonly used methods (e.g., Aluja et al. 2003; Silva et al. 2010). Every 2 weeks, ripe or nearly ripe fruits were picked from the trees and/or collected from the ground in the guava orchards and forest fragments. Fruits were stored in plastic containers with a 3.0 cm layer of vermiculite, covered with thin organza fabric, and maintained under controlled temperature (25 °C ± 1 °C), relative humidity (70 ± 10%) and 12:12 h L:D. One week after each collection, the vermiculite was sieved and the fruits were dissected to collect puparia. This procedure was repeated after 5 days. Puparia were stored in plastic containers with a thin layer of vermiculite until the adult flies emerged. The flies were kept in cages and fed with a 10% honey solution for 24 h, after which they were counted, sexed, and fixed in 70% ethanol for species identification. The identification of *Anastrepha* species was based on females. In this study, the designation *Anastepha fraterculus* (Wiedemann) is used sensu lato, as the *fraterculus* complex includes several cryptic species.

Voucher specimens were deposited at the Departamento de Entomologia e Acarologia da Escola Superior de Agricultura Luiz de Queiroz (ESALQ/USP, in Piracicaba, São Paulo, Brazil), and at the Universidade Estadual de Montes Claros (UNIMONTES, in Janaúba, Minas Gerais, Brazil).

Data Analysis

The composition of the tephritid community was determined in all 6 habitats. The faunistic

TABLE 1. LOCATION AND CHARACTERISTICS OF STUDY AREAS COMPRISED OF ORCHARD AND AN ADJACENT NATIVE-FOREST.

Location/Characteristics	Area 1	Area 2	Area 3
Municipality	Jaíba	Jaíba	Matias Cardoso
Geographical coordinates	S 15° 06' 1.9" W 43° 58' 56.5"	S 15° 08' 26.4" W 44° 02' 4.7"	S15° 01' 56.3" W 43° 50' 20.8"
Distance from orchard/forest	130 m	400 m	208 m
Terrain/Soil	Flat, with sandy-clay soils. No fertilizers or soil amendments were used.	Flat, with sandy-clay soils. No fertilizers or soil amendments were used.	Flat, with sandy soils. Fertilizers and soil amendments were used.
Age of orchard	10 yr	10 yr	5 yr
Orchard size	1 ha (10,000 m^2)	0.5 ha (5,000 m^2)	6 ha (60,000 m^2)
Tree spacing	5 × 3 m	5 × 5 m	6 × 6 m
Orchard management	Irrigation by microaspersion. Pruning and hand-weeding throughout the orchard. Fruits fallen on the ground were not collected. Occasionally, other pests were controlled chemically using a backpack sprayer.	Ditch irrigation. The orchard was pruned once per yr and hand-weeded. Fallen fruits were not collected. Occasionally, other pests were controlled chemically using a backpack sprayer.	Irrigation by microaspersion. The orchard was pruned multiple times and weeded with a weed-cutter and herbicides. Fruits fallen on the ground were not collected. Periodically, chemical control was applied using a tractor-mounted sprayer gun, for fruit flies and other pests.
Forest characteristics	Legal reserve, dry-forest vegetation. Degraded. Cattle grazing.	Legal reserve, dry-forest vegetation. Degraded. Cattle grazing.	Legal reserve, dry-forest vegetation. Degraded. No cattle grazing.
Adjoining crops	Banana (*Musa* sp.), lime (*Citrus aurantifolia*), hog plum (*Spondias mombin*), coconut (*Cocos nucifera*), Orange (*Citrus sinensis*), cassava (*Manihot esculenta*) and squash (*Curcubita* sp.)	Banana, corn (*Zea mays*) and beans (*Phaseolus vulgaris*).	Mango (*Mangifera indica*) and atemoya (*Annona atemoya*).
Predominant weeds	Guinea grass (*Panicum maximum*) and Bengal dayflower (*Commelina benghalensis*).	Guinea grass (*Panicum maximum*), southern sandspur (*Cenchrus echinatus*) and asthma weed (*Euphorbia hirta*).	Spanish needle (*Bidens pilosa*), morning glory (*Ipomoea nil*), calotrope (*Calotropis procera*), sourgrass (*Digitaria insularis*), plantain signalgrass (*Brachiaria plantaginea*) and southern sandspur (*Cenchrus echinatus*).

calculations were based on the insects captured in the traps. In order to study the relative abundance of species in each community, the following indexes were calculated: Richness index (S), Shannon-Wiener diversity index (H', also known as the Shannon Index and the Shannon-Weaver Index), Simpson's dominance index (λ), and Pielou's evenness index (E1), using the Statistical Ecology program by Ludwig & Reynolds (1988).

- Richness index (S): derived from the direct counts of species numbers in samples of equal size (Ludwig & Reynolds 1988);
- Shannon-Wiener Index (H'): assumes that a random sample is drawn from an infinitely large population, and that all species in the population are represented in the sample (Poole 1974);
- Simpson Index (D): derived from measures of dominance, it shows the probability that 1 of 2 individuals drawn at random from a large and infinite community will belong to a different species (Magurran 1988).
- Pielou's index of evenness: the ratio of observed diversity [H'] to the maximum possible diversity of a community with the same species richness [H' max] (Pielou 1969).

The similarity in species composition between communities was calculated using Sørensen's coefficient (Cs) (Southwood 1995), as follows:

Cs = 2a/b + c, where: a = number of species shared between both areas; b = total number of species in one area; and c = total number of species in the other area.

A correspondence analysis was performed in order to assess the occurrence of fruit fly species in each habitat using the multivariate procedures provided by SAS (1990).

Results

Composition, Diversity and Richness

A total of 9,300 fruit flies were caught in the McPhail traps. Twelve species of the genus *Anastrepha* (approximately 99% of all specimens, 59% female and 41% male), as well as *Ceratitis capitata* were captured (Table 2).

A total of 9,041 individuals of all 13 species were trapped in the guava orchards, and 259 individuals of 8 species in the native-forest areas. The area with the highest number of individuals collected was orchard 1 (8,436), followed by orchard 2 (572) (Table 2).

Three species were collected in all areas, namely *A. fraterculus*, *A. pickeli* Lima, and *A. zenildae* Zucchi. The fruit fly species composition differed between orchards and forest fragments. Eight species were observed in both orchards and forest fragments, and 5 species were collected exclusively in orchard areas. All species recorded in the forest fragments were also found in the orchards (Table 2). The most common species in the orchards were *A. zenildae*, *A. sororcula* Zucchi, and *A. fraterculus*; whereas the most common species in the forest fragments were *A. zenildae*, *A. pickeli, A. montei* Lima, and *A. fraterculus*. In addition, *A. zenildae* was the species with the highest mean number of individuals collected in all areas (Table 2). *C. capitata* was collected only in orchard areas (Table 2).

The communities of fruit fly species from orchards and adjacent native-forest fragments were characterize by diversity indices. Therefore, it was possible to know the species abundance relationships in the various communities. The highest value for species richness (S) was found in orchard 1 (S = 12) and the lowest was in forest 2 (S = 5) (Table 3).

Orchard 1 showed the highest Simpson's dominance index (λ) and the lowest Shannon-Wiener diversity index (H'), as a result of the high frequency of *A. zenildae*, which proved to be a dominant species, given that dominance (λ) increases as diversity decreases. In orchard 1, Pielou's evenness index (E1) was also low, revealing that species abundance was not distributed evenly. Contrasting results were obtained in Orchard 3 with the lowest index λ, the highest H' and E1 was also high, so they showed no dominant species. Orchard 2 is an intermediate situation.

The forest areas were more similar to the orchards, except for Forest 3, which had a lower index λ reflecting a lower number of dominant species (Table 3). In addition, Forest 3 showed the strongest signs of degradation.

Community Ordination and Similarity

The comparison among areas using Sørensen's similarity index showed that the forest fragments were the most similar in terms of tephritid species composition (F2-F3: Cs = 0.83; F1-F3: Cs = 0.77). The lowest similarities were found between orchards and forest fragments (O1-F2: Cs = 0.47; O2-F2: Cs = 0.50). Orchards 1 and 2 (O1-O2: Cs = 0.74) were the most similar among all orchards analyzed, whereas, the adjacent fragments of native Forest 1 and 2 (F1-F2: Cs = 0.73) were the most similar among forest fragments.

In the correspondence analysis (CA), the first axis was more important, explaining 26.49% of the total variance, while the second axis explained 20.42% (Fig. 1). In an ordination of the 3 areas, 2 large groups were observed, with the forests positioned closer to each other (left side of the axis) and the orchards forming a second group (right side of the axis). The species that are considered to be the most economically important pests were closely associated with orchards (e.g. *A. fraterculus*-

TABLE 2. NUMBER OF INDIVIDUALS (N) AND RELATIVE FREQUENCY (F) OF FRUIT FLIES COLLECTED FROM MCPHAIL TRAPS IN GUAVA ORCHARDS AND ADJACENT NATIVE DRY-FOREST FRAGMENTS IN MINAS GERAIS, BRAZIL.

	AREA 1				AREA 2				AREA 3			
	Orchard 1		Forest 1		Orchard 2		Forest 2		Orchard 3		Forest 3	
Species	n	f	n	f	n	f	n	f	n	f	n	f
Anastrepha alveata	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Anastrepha daciformis	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Anastrepha dissimilis	4	0.05	0	0.00	0	0.00	1	1.79	0	0.00	1	1.67
Anastrepha fraterculus	292	3.46	8	5.59	122	21.33	1	1.79	10	30.30	2	3.33
Anastrepha montei	0	0.00	14	9.79	0	0.00	12	21.43	2	6.06	6	10.00
Anastrepha obliqua	70	0.83	2	1.40	5	0.88	0	0.00	0	0.00	4	6.67
Anastrepha pickeli	8	0.10	17	11.9	5	0.88	8	14.29	3	9.09	19	31.67
Anastrepha serpentina	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Anastrepha sororcula	1000	11.85	3	2.10	15	2.6	0	0.00	0	0.00	0	0.00
Anastrepha turpiniae	4	0.05	0	0.00	4	0.70	0	0.00	1	3.03	0	0.00
Anastrepha undosa	9	0.11	0	0.00	0	0.00	0	0.00	3	9.09	1	1.67
Anastrepha zenildae	7035	83.39	99	69.23	417	72.9	34	60.71	5	15.15	27	45.00
Ceratitis capitata	11	0.13	0	0.00	4	0.70	0	0.00	9	27.27	0	0.00
TOTAL	8436		143		572		56		33			60

TABLE 3. DIVERSITY INDICES OF THE COMMUNITIES OF FRUIT FLY SPECIES FROM ORCHARDS AND ADJACENT NATIVE FOREST FRAGMENTS IN MINAS GERAIS, BRAZIL.

	Area 1		Area 2		Area 3	
Diversity Indices	Orchard 1	Forest 1	Orchard 2	Forest 2	Orchard 3	Forest 3
Richness species (S)	12	6	7	5	7	7
Simpson's Index (λ)	0.71	0.50	0.58	0.43	0.19	0.31
Shannon-Wiener Index (H')	0.59	1.04	0.81	1.06	1.71	1.38
Pielou's Evenness Index (E1)	0.24	0.58	0.42	0.66	0.88	0.71

lus, *A. sororcula, A. obliqua* (Macquart) and *A. turpiniae* Stone), except for to *A. zenildae* and *A. pickeli* that were abundant in both the orchard and the forest. *A. montei*, however, was most strongly associated with the forest.

Species Composition Associated with Host Fruits

A total of 1,084 fruit flies were obtained from fruits (22% from the forest fragments and 78% from the guava orchards) (Table 4). In the forest fragments, *A. zenildae* and *A. sororcula* were only collected from juá fruits (*Ziziphus joazeiro* Mart.; Rosales: Rhamnaceae). This is the first report of these species in juá in the Minas Gerais semi-arid region.

The fruit fly species associated with guava in the 3 orchards were *A. fraterculus*, *A. obliqua*, *A. sororcula*, *A. turpiniae*, *A. zenildae* and *C. capitata*. *Anastrepha zenildae* and *A. sororcula* were the most abundant species in guava.

The fruit flies observed in the forest fragments were also detected in guavas. This means that species of economic importance, such as *A. zenildae*, use fruits in the forest as alternative hosts. The number of species collected from each

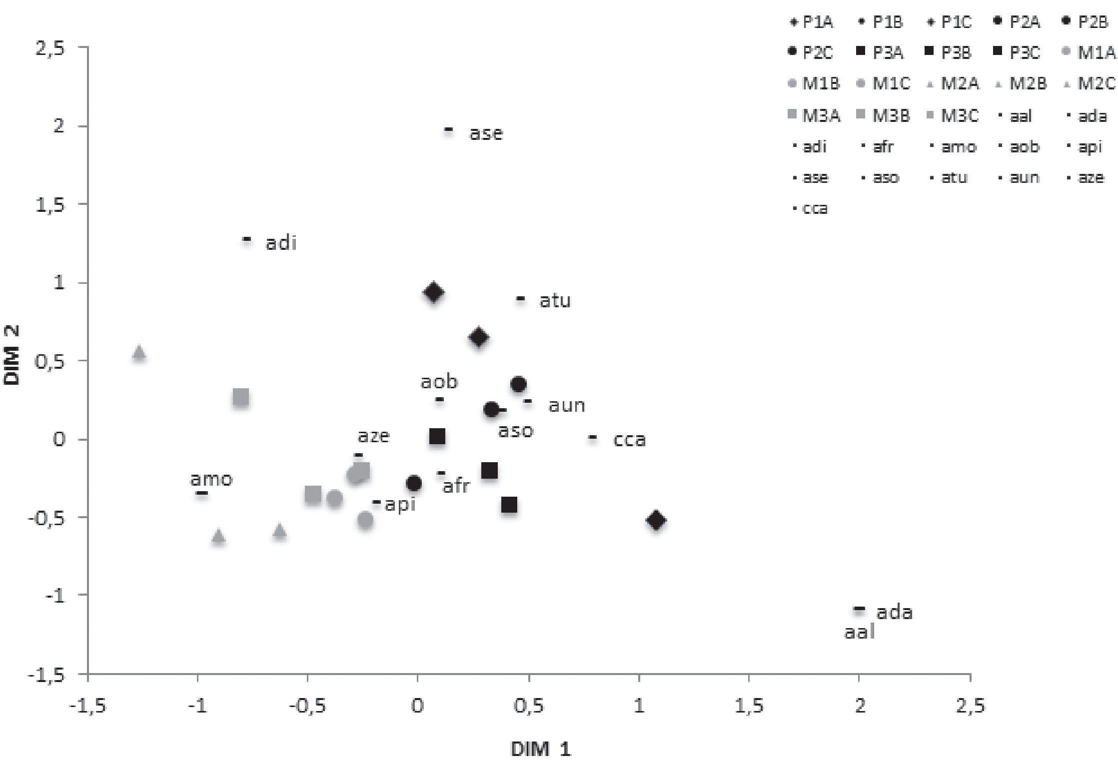

Fig. 1. Correspondence analysis of fruit fly species, guava orchards and adjacent native-forest fragments (DIM: dimension; O: orchard; F: forest; aal: *Anastrepha alveata*; ada: *Anastrepha daciformis*; adi: *Anastrepha dissimilis*; afr: *Anastrepha fraterculus*; amo: *Anastrepha montei*; aob: *Anastrepha obliqua*; api: *Anastrepha pickeli*; ase: *Anastrepha serpentina*; aso: *Anastrepha sororcula*; atu: *Anastrepha turpiniae*; aun: *Anastrepha undosa*; aze: *Anastrepha zenildae*; cca: *Ceratitis capitata*).

TABLE 4. FRUIT FLY SPECIES COLLECTED FROM GUAVA (ORCHARDS) AND JUÁ FRUITS (FORESTS) IN MINAS GERAIS, BRAZIL.

Locations	Host fruits	Species	n
Forest 1	Juá	*A. zenildae*	23
Orchard 1	Guava	*A. fraterculus*	83
		A. obliqua	2
		A. sororcula	129
		A. turpiniae	1
		A. zenildae	558
		Ceratitis capitata	1
Forest 2	Juá	*A. sororcula*	1
		A. zenildae	215
Orchard 2	Guava	*A. fraterculus*	10
		A. sororcula	6
		A. turpiniae	3
		A. zenildae	43
Orchard 3	Guava	*A. sororcula*	1
		Ceratitis capitata	5

orchard was different, with orchard 1 showing the highest species richness. The native vegetation adjoining this orchard had the highest diversity of hosts. Forest 3 was the only area where none of the collected fruits were infested by fruit flies. The lowest number of fruit fly species was detected in area 3 (only *A. sororcula* and *C. capitata*), possibly due to the type of management with the intensive use of insecticides.

DISCUSSION

Among the 26 species of *Anastrepha* reported in the state of Minas Gerais (e.g., Alvarenga et al. 2000, 2009), approximately 50% were detected in this study, such as *Anastrepha zenildae*, *A. sororcula* and *A. fraterculus*, all of them are species of economic importance for the semi-arid region of Minas Gerais. *Anastrepha fraterculus*, *A. sororcula* and *A. zenildae* were collected both in the guava orchards and forest fragments in all three areas.

In a previous study conducted in the same region, *A. zenildae* and *A. fraterculus* accounted for more than 90% of all flies captured in traps (Alvarenga-Corsato 2004), indicating that these species are well adapted to feed on guava in semi-arid regions and are therefore considered to be pests of guava (Alvarenga et al. 2009). In a another semi-arid region of Brazil, in Mossoró/Assu in the state of Rio Grande do Norte, *A. zenildae*, *A. sororcula* and *A. obliqua* are the most common species, but guava is first infested by *A. zenildae* and later on by *A. sororcula* (Araújo & Zucchi 2003). A similar situation has also been observed in northern Minas Gerais (Canal et al. 1998). On the other hand, in the South Pantanal and adjacent areas in Brazil, *A. sorocula* and *A. zenildae* were the fruit flies that infested the greatest number of host fruits (Uchôa & Nicácio 2010).

As observed for other Brazilian semi-arid areas (Canal et al. 1998), *A. zenildae* was the most abundant species both in orchards and forest in our study. However, *A. sororcula*, which is also adapted to dry conditions (Nascimento 1990; Haji et al. 1991), was found only in orchards. In addition, *A. fraterculus*, a very common species widely distributed in Brazil (Zucchi 2012), can be overcome by *A. zenildae and A. sororcula*, even when guava, its preferred host, is present in the semi-arid area (Table 2).

Ceratitis capitata, an invasive species, was collected only in the orchards, but the number of specimen was small (Table 2). However, in the Yungas forest in Argentina, although *A. fraterculus* has been the dominant species in the wild guava, occurrence of *C. capitata* was significant (Ovruski et al. 2005). On the other hand, *C. capitata* is more common than *Anastrepha* spp. in Brazilian urban areas, and the opposite occurs in rural areas (Alvarenga et al. 2009, 2010). That would be the reason for small number of *C. capitata* captured in the guava orchards sampled, which are located in rural areas. However, the presence of *C. capitata* in the Minas Gerais semi-arid region confirms the high invasive capability of this species.

The host-use pattern in tropical areas is that polyphagous tephritid species do not exploit hosts of monophagous tephritid species, and that the predominant *Anastrepha* species are polyphagous (Aluja et al. 2003). This pattern has been observed in disturbed agricultural settings in tropical areas in Mexico (Aluja et al. 2003), as well as in commercial and family orchards surrounded by Atlantic rainforest in Southeastern Bahia, Brazil (Silva et al. 2010). In the latter, the predominant *Anastrepha* species were polyphagous (i.e., *A. fraterculus*, *A. obliqua*, and *A. sororcula*). Consistent with this, *Anastrepha fraterculus*, *A. sororcula*, *A. zenildae* and *A. obliqua* were most abundant in the guava orchards in our study.

Eight species were collected in the forest fragment (Table 2), including pest species of the *fraterculus* group namely *A. fraterculus*, *A. obliqua*, *A. sororcula* and *A. zenildae*. These species also occur in other Brazilian natural reserves, indicating that the native vegetation acts as a reservoir for economically important *Anastrepha* species (Uramoto et al. 2008; Uchôa & Nicácio 2010).

The composition of *Anastrepha* spp. was different in the guava orchards and forest fragments, and more specimens were captured in the traps hung in the orchards (Table 2). *Anastrepha turpiniae* was collected exclusively in the guava orchards. On the other hand, *A. montei* was collected almost exclusively in the traps in the forest fragments, with the exception of two individuals collected in orchard 3. In Brazil, the hosts of *A. montei* are fruits/seeds of some species of Euphorbiaceae, such as *Manihot esculenta* (cassava) and *Jatropha* sp., and *A. turpiniae* infests a wide range of fruits of economic importance in several plant families (Zucchi 2008). The capture of *A. montei* in the traps hung in orchards was similarly to that found by Taira et al. (2013). Other species, such as *A. alveata*, *A. daciformis* and *A. serpentina* were collected exclusively in orchard 1 and have no reported hosts in the semi-arid region of Minas Gerais.

The number of species in orchard 1 (S = 12) was higher than in the other areas. This can be attributed to the diversity of host plants in its adjoining areas (squash, banana, hog plum, coconut, orange, papaya, cassava, and citrus) and the absence of insecticide control of pests, in addition to the presence of juá trees in the adjoining forest fragment. Orchards located in areas with a higher diversity of fruit-bearing trees contain a higher richness of *Anastrepha* species (Aluja et al. 1996), as confirmed in orchard 1. This commercial orchard showed two strongly dominant species, as well as the highest value of Simpson's dominance index. These data confirm that in commercial orchards, only one or two species of *Anastrepha* are dominant (Aluja 1994). Species dominance is influenced mainly by ecological factors such as abundance and richness of host plants, orchard complexity, adjoining agro-ecosystem, and altitude (Soto-Manitiu & Jirón 1989; Aluja 1994).

Orchard 3 was intensively managed, with frequent use of pesticides, and thus this directly influenced the adjacent forest reserve. Therefore, this habitat had the lowest relative frequency and lowest mean number of flies collected.

Fruit fly diversity varied among orchards mainly because of the type of management applied in each orchard, which affected the surrounding areas and also the fruit fly population. Although the forest fragments are located in legal reserves, they are significantly degraded by logging and cattle grazing, which reduced the diversity of available fruits in these areas. Therefore, low fruit fly diversity in the forest could be explained by the degradation of the surrounding areas, especially in the legal reserve.

Perhaps as a result of degradation of the forest fragments we found a similar proportion of monophagous and oligophagous fly species versus polyphagous species (50 versus 50%) in guava orchards and forests fragments. The overall pattern in the Neotropical genus *Anastrepha* is a greater proportion of monophagous and oligophagous species than polyphagous species in tropical unperturbed environments, and the reverse numerical pattern is observed in perturbed agricultural. On the other hand, the continued devastation of tropical environments will irreparably lead to the loss of numerous specialist fruit fly species, while a few generalist species, released from competition, will be able to survive and probably thrive in perturbed environments (Aluja et al. 2003).

According to our data, the fragments of native vegetation and orchards harbor fruit fly species in common, and there is a dynamic interaction among flies of both areas, as well as forest fragments play an important role in maintaining the communities of fruit flies.

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