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Faunal analysis of the species *Anastrepha* in the fruit growing complex Gavião River, Bahia, Brazil

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Abstract

Besides being considered the greatest pests of fruit growing, fruit flies constitute a large obstacle to the growth of the exportation of fresh fruit. Knowledge of the structure of fruit fly communities is of great importance to the bioecological studies of these insects, but there is a lack of information about the faunistic composition of fruit flies in Brazil. The objective of this work was to analysis the composition of the species of *Anastrepha*, in eleven mango orchards of the fruit growing complex Gavião River, Bahia, Brazil. These studies were done in 2004 and 2005, in Anagé, Caraíbas and Belo Campo town, 23 McPhail traps, which collected 798 female fruit flies from the genus *Anastrepha*. The structure of these communities was evaluated in each orchard by means of faunistic indexes frequency, constancy, dominance, diversity and similarity. The number of species varied from four to eight in each orchard; and the following species was recorded: *Anastrepha fraterculus* (Wiedemann), *Anastrepha obliqua* (Macquart), *Anastrepha dissimilis* Stone, *Anastrepha amita* Zucchi, *Anastrepha distincta* Greene, *Anastrepha pickeli* Lima, *Anastrepha sororcula* Zucchi and *Anastrepha zenildae* Zucchi. The most frequent and dominant species were *A. fraterculus* and *A. obliqua*. The indexes of diversity varied from 1.01 to 1.62. In general, the similarity between orchards was high (above 55.0%). We observed the formation of groups, one constituted by Frutvale, Carlan, Santa Clara and Panorama orchards; another composed of Cofet, Campo Gavião and Ouro Verde and a third group formed by Boa Vista orchard. Barra da Onça and Arruda are distinguished from other orchards.

Key words: faunistic analysis, fruit fly, *Mangifera indica*, monitoring, similarity.

Introduction

The region of the Gavião River, located in the southwest of the Bahia State, Brazil, is a new area of fruit production, especially mangoes, demonstrating great potential to generate revenue for the state and regional economies.

Fruit flies constitute a big obstacle to the growth of Brazilian fresh fruit, as well as causing damages in various fruit production chains. The monitoring of the fruit fly population is the principal pre-requisite for efficient control, so that the population can be characterized from a qualitative and quantitative point of view (Nascimento *et al*., 2000). The monitoring permits the identification of the most frequent species of fruit flies, the population densities and fluctuations and the levels of control, aspects which serve as subsidies to the fruit producers in respect to the correct moment to adopt control measures.

Information on the structure of the communities is of great importance to bioecological studies of insect pests and to adoption of integrated management strategies. Notwithstanding the importance of these studies, there is a lack of information about faunistic analysis of the fruit flies in Brazil (Canal *et al*., 1998). There are various indices that express the diversity of species. The concept of diversity of species of a community has two components: abundance or density of species, estimated in relation to the total number of species present in the system, and uniformity or equitability, based on the repartition of the individuals between the species (Bueno and Pérez-Maluf, 2000).

The frequency of fruit fly species varies according to the region being studied. Kovaleski (1997), studying adaptative processes in the colonization of apples for *Anastrepha fraterculus* (Wiedemann) in Vacaria, Rio Grande do Sul State (RS), verified that the frequency this species was always superior to 80%. However, in Porteirinha - MG, *Ceratitis capitata* (Wiedemann) was the most frequent with 66.77% of the samples collected. *Anastrepha obliqua* (Macquart) was the second most frequently collected species. However, Garcia *et al*. (2003) verified that *A. fraterculus* was constant, more frequent, very abundant and dominant in the four towns of the west of SC. In contrast, Thomazini *et al*. (2003), in Acre State (AC), verified that *A. obliqua* was the most abundant. Uramoto *et al*. (2005) analyzed the distribution of populations of the species of *Anastrepha* in Piracicaba, São Paulo State (SP), and verified that *A. fraterculus* and *A. obliqua* were dominant, with greater frequency and constancy than *A. fraterculus*, 82% and coinciding with the results obtained by Garcia *et al*. (2003). In BA, similar results were observed for the species *Anastrepha* in coffee plantations by Torres *et al* (2010) in terms of frequency (85.71% to 92.15%) and constancy (90.48%) of *A. fraterculus.*

In Bahia state, Cova and Bittencourt (2003) studied the occurrence of fruit flies in fruits of the semi arid region of Irecê and confirmed that the most frequent species was

A. obliqua (71%) followed by *C. capitata* (24%). In this same state, Nascimento *et al*. (1982) studied the population dynamic of fruit flies of the genus *Anastrepha* in the years 1977 to 1979 and verified that *A. obliqua* was the predominant species in the citric orchards, while *A. fraterculus* predominated the areas with tropical hosts, guava being the host that most attracts this species.

In studies done in fruit orchards located in the submedium region of the São Francisco River Valley, BA, Nascimento *et al*. (1994) verified the predominance of the species *A. fraterculus* and *Anastrepha sororcula* Zucchi. The species *A. obliqua* presented a relatively low frequency (4.55%).

Within the complex of the species of the genus *Anastrepha*, four utilize the mango as a host: *A. obliqua*, *A. fraterculus*, *A. sororcula* and *Anastrepha pseudoparalela* (Loew). The first species is responsible for practically 100% of damages to mangoes, given its preference for this fruit, as well as for fruits of the Anacardiaceae family, like jocote (*Spondias purpurea* L.) or "cajá" (*Spondias mombin* L.) (Zucchi, 1988).

The population monitoring of fruit flies (Tephritidae) has been done in the fruit growing complex Gavião River - BA since 2002. It has provided considerable knowledge about population indices of Tephritidae, expressed in fly/trap/day (FTD). However, there is not information about their communities.

The objective of this work was to analysis the composition of the species of *Anastrepha*, in eleven mango orchards of the fruit growing complex Gavião River, Bahia, Brazil.

Materials and methods

The studies were developed in complex Gavião River in commercial mango orchards, Tommy Atkins variety, located in three towns of southwest of Bahia: Anagé (14º36'S - 41º08'W), Belo Campo (15º02'S - 41º15'W) and Caraíbas (14º40'S - 41º14'W) and in the dependencies of the Entomology Laboratory of the Southwest Bahia State University - UESB, campus of Vitória da Conquista, BA, in the period of February of 2004 to December of 2005.

The predominant climate of the region is semi arid and sub humid to dry, with a pluviometric regime in the spring and summer (SEI, 2005).

The distribution of traps and collection of adult fruit flies were done adopting the density of one trap per 10 ha in commercial orchards with wild hosts in the vicinities. Twenty three McPhail traps were installed in ten orchards that participate in the State of Bahia program for monitoring fruit flies, totalling 205.4 ha of mango cultivation: a) Anagé: Ouro Verde - one trap and Cofet - one trap; b) Belo Campo: Carlan - one trap; Panorama - one trap; Campo do Gavião - four traps; c) Caraíbas: Boa Vista - one trap; Barra da Onça - one trap, Arruda - one trap, Frutvale - five traps, Santa Clara - seven traps.

The traps were supplied with an attractant of hydrolyzed corn protein at 5%, placing 250 mL of the attractant in each trap. There was a weekly transference of captured fruit flies to plastic containers containing 70% alcohol, and labelled with the trap unique identifying code. Only females were used to quantify the species because identification is performed by observing of the aculeus. The fruit flies were then counted, sexed and transferred to glass containers containing 70% alcohol, later being identified at species level by examining the apex of the aculeus, prepared according to the methodology described by Zucchi (2000a). That is, the female was placed in 70% alcohol, and then placed in a ventral position on a slide under a stereoscopic microscope (40×) and, with the assistance of two stilettos, the aculeus was extruded. The aculeus thus placed in a ventral position was examined using a biological microscope (100×). The identification of the species was done utilizing the keys described in Zucchi (2000a) and Uramoto (2002). The females were relocated, pinned and labeled with the place and date of collection, host plant, species and collector, then deposited in the entomologic collection at UESB.

The structure of *Anastrepha* communities was evaluated in each orchard by calculating faunistic frequency indices, constancy, dominance, diversity and similarity, according to Silveira Neto *et al*. (1976):

a) Frequency (F): $F = n_i/N$, where n_i = number of individuals of the species and N= total individuals of the sample. This index gives the proportion of individuals of a species in relation to the total of individuals of the sample;
b) Constancy (C): Percent of the samples in which a determined species was present. C = p.100/N, where p: number of samples with the species and N= total number of samples taken. Classification of the species in reference to constancy:
c) Constant species (w): present in more than 50% of the samples;
d) Accessory species (y): present in 25 to 50% of the samples;
e) And accidental species (z): present in less than 25% of the samples;
f) Dominance (D): one species is considered dominant when it presents a frequency superior to 1/S, where S is the total number of species in the community;
g) Diversity: utilizing the Shannon Index that measures the degree of uncertainty by foreseeing to which species a chosen individual will pertain in the case of a sample with S species and N individuals. The smaller the value of the Shannon Index, the lower the degree of uncertainty and therefore the diversity of the sample is low. The diversity tends to be higher when the value of the index is higher. It is calculated by means of the formula $H' = -\Sigma\ (p_i.\ln\ p_i)$ where p_i = frequency of each species, for i varying from 1 to S (Richness).

A dendogram was constructed by Index of Similarity of Kulczynski, utilizing the Systat 8.0 program.

Results

Seven hundred and ninety eight *Anastrepha* females were collected in the orchards, with 98% of them in the orchards Carlan (39.70%), Frutvale (18.60%), Santa

Clara (19.50%), Panorama (15.30%), Cofet (2.50%) and Ouro Verde (4.00%). In the orchards Campo do Gavião, Boa Vista, Arruda and Barra da Onça, the capture was low, with 0.76%, 0.38%, 0.25% and 0.13%, respectively. The Carlan orchard, which presented the highest number of female *Anastrepha* specimens, is near small farms with large numbers of fruit trees like jocote (*S. purpurea*) and native "umbu" (*Spondias tuberosa* Arruda), which may have favored the results. The Campo do Gavião, Ouro Verde and Barra da Onça orchards began production in 2005, which can justify the lower number of specimen collected. The Panorama orchard neighbours the Carlan orchard and, due to the large number of native and exotic fruit trees in their proximities, obtained the fourth highest abundance of *Anastrepha* specimen.

The Cofet orchard covers a relatively small area (eight hectares) when compared to the other more distant orchards with greater production of fruit trees, which may have contributed to the small number of specimens collected.

The faunistic analyses were done for each orchard, considering each as a distinct community, excluding the Barra da Onça, Arruda, Campo do Gavião and Boa Vista orchards due to the small number of specimen collected, total number 16, not justifying the analyses except for similarity. In these orchards *A. obliqua* was the most frequent, with a total of 7 specimens in three orchards (Boa Vista, Barra da Onça, and Campo do Gavião), followed by *A. fraterculus* with five specimens in three orchards (Boa Vista, Arruda, Campo do Gavião). *Anastrepha dissimilis* Stone, *Anastrepha zenildae* Zucchi and *A. sororcula* occurred in the Boa Vista, Arruda, and Campo do Gavião orchards, respectively, with an individual collected in each orchard.

The faunistic analyses of the Carlan, Frutvale, Santa Clara, Cofet, Panorama and Ouro Verde orchards were made with a total of 782 flies caught (table 1). The composition of the species of the communities demonstrates that *A. fraterculus* and *A. obliqua* occurred in nine of the ten orchards studied, indicating the ample distribution of these species in the region. Also deserving of attention are *A. sororcula*, *A. zenildae* and *Anastrepha distincta* Greene, with occurrence seven, six and five orchards, respectively. The species *A. amita* had a restricted occurrence in the Panorama orchard probably due to vicinity of hosts such as coffee and the plants of the family Verbenaceae.

The most frequent species were *A. fraterculus* and *A. obliqua*. The species *A. fraterculus* was the most frequent in the Carlan (0.46) and Frutvale (0.39) orchards while *A. obliqua* was the most frequent in Panorama (0.40), Cofet (0.50) and Ouro Verde (0.58).

In reference to dominance, *A. fraterculus* was dominant in the Carlan, Frutvale, Santa Clara, Panorama and Cofet orchards; *A. obliqua* was dominant in Carlan, Frutvale, Santa Clara, Cofet and Ouro Verde; and *Anastrepha* sp. was dominant in the Santa Clara and Panorama orchards. The other five species were not dominan. The constancy indexes indicated that all the species are accidental, with varying rates of 1 to 20%. The diversity, calculated by the Shannon index, varied from 1.01 (Cofet orchard) to 1.62 (Santa Clara orchard).

The similarity dendrogram shown in figure 1 indicates an expressive global similarity between most of the orchards studied. The orchards Barra da Onça and Arruda are grouped into a distinct branch (less than 60% similarity), probably because of the few individuals collected, one and two, respectively, and exhibit high values of similarity between them (approximately 75%). The remaining orchards form the other branch, where we observe clearly the distinction of the orchard Boa Vista which presented the lowest similarity between the others (between 60 and 65%).

Discussion

The variation in the number of collected specimen has been reported by other authors (Canal *et al*., 1998; Garcia *et al*., 2003; Uramoto *et al*., 2005).

The abundance of *Anastrepha* varied in relation to the orchards, the highest values occurring in the Carlan, Frutvale, Santa Clara and Panorama orchards (table 1). The Santa Clara and Frutvale orchards are the largest with 68.0 and 46.4 ha, respectively. The Panorama and Carlan orchards, though smaller, are near each other and there is other fruit production in their area, which may have contributed to the capture of a larger number of species.

The occurrence of all the species found in the present work had already been registered for Bahia state by Nascimento and Zucchi (1981) and by Canal *et al*. (1998) for the north of MG, as well as by various other authors for other Brazilian regions.

The maximum abundance of richness of species verified in the present work (eight) can be considered relatively low in relation to the results obtained by other authors in other edafo-climactic and ecological conditions. In Bahia´s "Recôncavo" Region, 21 *Anastrepha* species were collected (Nascimento and Zucchi, 1981) and in the north of MG, region of with a climate similar to that of the research, 18 species were registered (Corsato, 2004). The variation in the number of species is common when collections are done in different places (Canal, 1997; Garcia *et al*., 2003; Uramoto *et al*. 2005; Ferrara *et al*. 2005).

According to Zucchi (2000b), the species *A. fraterculus* and *A. obliqua* are the more polyphagous. *A. fraterculus* develops in 67 species of hosts and *A. obliqua*, in 28. *A. fraterculus* was also the most frequent in guava orchards in the Bahian "Recôncavo" Region (Nascimento *et al*., 1983) and in other regions of Brazil (Kovaleski 1997; Garcia *et al*., 2003; Uchôa-Fernandes *et al*., 2003; Corsato, 2004; Uramoto *et al*., 2005).

From the species collected in this study, *A. obliqua*, *A. fraterculus*, *A. sororcula*, *A. distincta* and *Anastrepha pickeli* Lima was been related to mango fruits in the Bahia´s "Recôncavo" Region (Nascimento and Carvalho, 2000), while *A. obliqua* also been recorded in a Southweast region of the same state (Sá, 2006). The species *A. obliqua* and *A. fraterculus*, along with *C. capitata*, are considered the most frequent and important from the quarentenary standpoint in the mango orchards (Nasci-

Table 1. Faunistic analysis of *Anastrepha* species in the fruit growing complex Gavião River, Bahia, Brazil, in the period between February 2004 to December of 2005.

Orchard	Species	N	F	D
Carlan	*A. fraterculus*	144	0.46	d
	A. obliqua	99	0.32	d
	A. dissimilis	01	0.00	nd
	A. sororcula	23	0.07	nd
	A. distincta	40	0.13	nd
	A. pickeli	01	0.00	nd
	A. zenildae	02	0.01	nd
	Anastrepha sp.	04	0.01	nd
	Total	314	1	
	S	08		
	H'	1.30		
Frutvale	*A. fraterculus*	57	0.39	d
	A. obliqua	47	0.32	d
	A. dissimilis	01	0.01	nd
	A. sororcula	12	0.08	nd
	A. distincta	11	0.07	nd
	A. pickeli	05	0.03	nd
	A. zenildae	04	0.03	nd
	Anastrepha sp.	10	0.07	nd
	Total	147	1	
	S	08		
	H'	1.56		
Cofet	*A. fraterculus*	08	0.40	d
	A. obliqua	10	0.50	d
	A. sororcula	01	0.05	nd
	A. zenildae	01	0.05	nd
	Total	20	1	
	S	4		
	H'	1.01		
Santa Clara	*A. fraterculus*	41	0.27	d
	A. obliqua	42	0.27	d
	A. dissimilis	01	0.01	nd
	A. sororcula	16	0.10	nd
	A. distincta	07	0.06	nd
	A. pickeli	03	0.02	nd
	A. zenildae	03	0.02	nd
	Anastrepha sp.	41	0.27	d
	Total	154	1.02	
	S	08		
	H'	1.62		
Panorama	*A. fraterculus*	40	0.33	d
	A. obliqua	49	0.40	d
	A. amita	03	0.02	nd
	A. sororcula	12	0.10	nd
	A. distincta	12	0.10	nd
	A. pickeli	01	0.01	nd
	A. zenildae	03	0.02	nd
	Anastrepha sp.	01	0.02	nd
	Total	121	1	
	S	08		
	H'	1.45		
Ouro Verde	*A. fraterculus*	05	0.19	nd
	A. obliqua	15	0.57	d
	A. sororcula	03	0.12	nd
	A. distincta	03	0.12	nd
	Total	26	1	
	S	04		
	H'	1.13		

N = number of individuals; F = relative frequency; D = dominance, being dominant (d) and non dominant (nd); S = number of species; H': indice of diversity.

mento and Carvalho, 2000, Ferreira *et al*., 2003). Similar results were obtained in reference to the dominance of *A. fraterculus* and *A. obliqua* in various regions of Brazil (Nascimento *et al*., 1983; Canal *et al*., 1998; Uramoto *et al*., 2005; Ferreira *et al*., 2003; Ferrara *et al*., 2005).

The other species collected in traps have limited number of hosts, such as fruits of *Ziziphus joazeiro* Mart. and *Passiflora* sp. to *A. dissimilis* (Zucchi, 2000b), and *Citharexylum myrianthum* Cham. (Zucchi, 2000b) and *Coffea arabica* L. (Torres *et al*., 2010) for *Anastrepha amita* Zucchi. On the other hand, *A. zenildae* presents a wider range of hosts, among which several species that occur in the region under study as *S tuberosa*, *S. purpurea*, *Z. joazeiro* and *Psidium guajava* L.

The indices of constancy observed coincided with the results obtained by Kovaleski (1997) and Canal *et al*. (1988) who obtained, from 20 species collected, 18 accidental.

Lower values of diversity by the Shannon index were obtained by Uramoto *et al*. (2005). Other studies involving diversity of fruit flies indicate similar values (Canal *et al*., 1998; Garcia *et al*., 2003; Ferrara *et al*., 2005). According to Garcia *et al*. (2003), the indices of diversity of fruit flies obtained for the eastern region of SC, were near other regions of Brazil, approximately 0.9 to 2.0. According to this affirmation, the indices obtained in the present work are coherent with those normally registered in the literature. Uramoto (2002) considered cultural treatments such as picking and burying of fallen fruit in the ground thus eliminating locations of egg laying for the fruit flies, which decreases their population and can possibly contribute to the low levels of capture and diversity observed.

In general, the similarity between orchards was high (above 55.0%), agreeing with Canal (1997), which also had high indices of similarity in nearby orchards. Canal *et al*. (1998), in studies of faunistic analysis of fruit fly species in six locations of four towns in the northern region of Minas Gerais State, verified that the communities present indices of low diversity and quotients of similarity between 73 and 100%. However, we observe the formation of groups, one constituted by Frutvale, Carlan, Santa Clara and Panorama orchards; another composed of Cofet, Campo Gavião and Ouro Verde and a third group formed by Boa Vista orchard (figure 1). Barra da Onça and Arruda, due to the low frequency of flies collected, are distinguished from the others.

The geographical position of the orchards probably did not influence in the differences of communities of

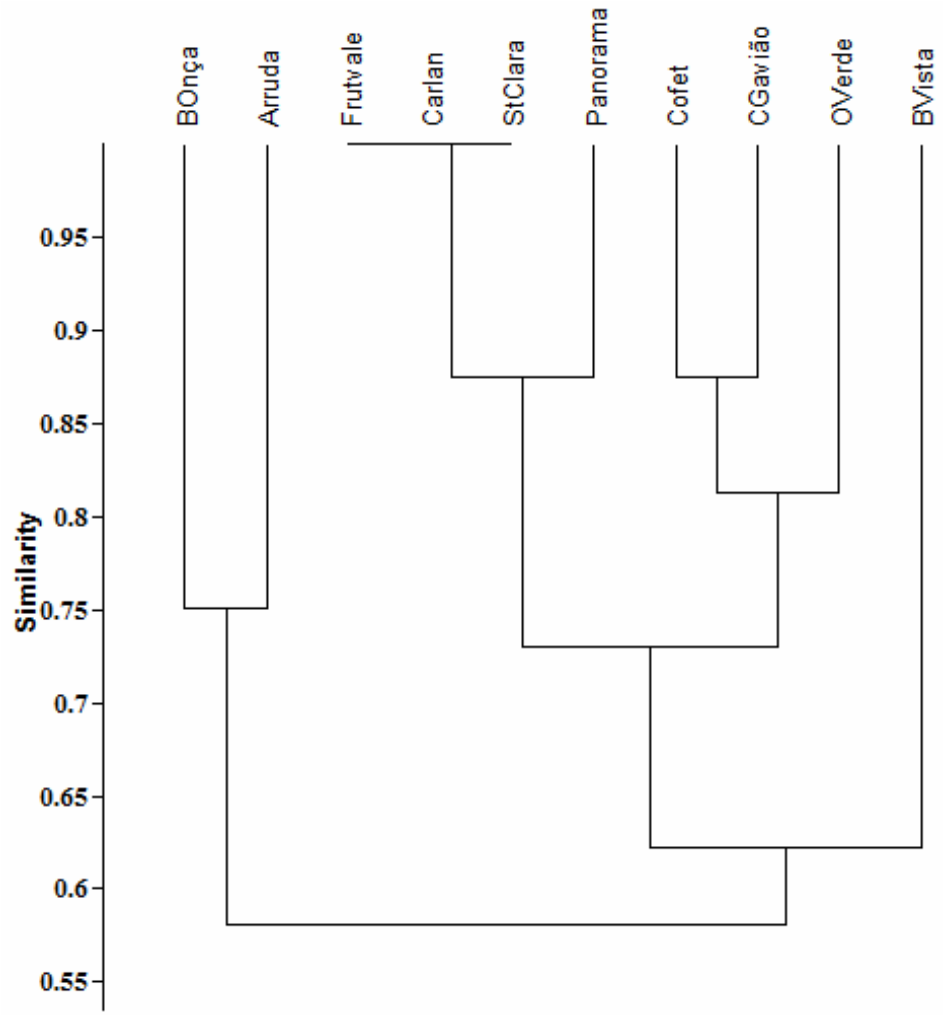

Figure 1. Dendogram of hierarchical grouping by Index of Similarity of Kulczynski calculated for *Anastrepha* species in ten different mango orchards (fruit growing complex Gavião River, Bahia, Brazil) from February 2004 to December 2005.

Anastrepha, because the orchards Santa Clara and Frutvale, for example, presented 100% similarity and are located in the extreme points of the area covered by orchards, while the orchards Boa Vista and Barra da Onça are relatively close and had the lowest ratio of similarity. The varietal composition of mango orchards could interfere in the communities of fruit flies, but the predominant variety in the region is the 'Tommy Atkins', that is the only variety within commercial orchards studied, and so, do not constitute the cause of the observed variation. Another hypothesis to explain the formation of groups could be the size of the production area of each orchard. From the orchards with maximum similarity, Santa Clara and Frutvale have the largest areas of production, 68.0 ha and 46.4 ha, respectively, and the fourth largest area Carlan (15 ha), while Arruda and Bar of the Jaguar, which form another group, are smaller with 8 ha each. Finally, the most likely hypotheses to explain the formation of distinct groups of communities of *Anastrepha* spp. are related to different plant species which are host of flies found in the vicinity of orchards sampled. Ferrara *et al*. (2005) observed the creation or two distinct population groups of fruit flies. According to the authors, the plants existing near the areas of sampling could explain the groupings.

The creation of groups of orchards with distinct compositions of species can subsidize the differentiated development actions of managing fruit flies in the fruit production complex studied.

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References

BUENO V. H., PÉREZ-MALUF R., 2000.- *Bases ecológicas no manejo de insetos*.- UFLA/FAEPE, Lavras, MG, Brazil.

CANAL N. A., 1997.- Levantamento, flutuação populacional e análise faunística das espécies de moscas-das-frutas (Dip., Tephritidae) em quatro municípios do Norte do Estado de Minas Gerais. *Ph.D. Thesis*, Escola Superior de Agricultura Luiz de Queiroz, Universidade de São Paulo, Piracicaba, SP, Brazil.

CANAL N. A., ALVARENGA C. D., ZUCCHI R. A., 1998.- Análise faunística de espécies de moscas-das-frutas (Dip., Tephritidae) em Minas Gerais.- *Scientia Agricola*, 55 (1): 15-24.

CORSATO C. D. A., 2004.- Moscas-das-frutas (Diptera: Tephritidae) em pomares de goiaba no norte de Minas Gerais: biodiversidade, parasitóides e controle biológico. *Ph.D. Thesis*, Escola Superior de Agricultura Luiz de Queiroz, Universidade de São Paulo, Piracicaba, SP, Brazil.

COVA A. K. W., BITTENCOURT M. A. L., 2003.- Ocorrência de moscas-das-frutas (Tephritidae) e parasitóides em frutos da região do semi-árido da Bahia.- *Magistra* (Cruz das Almas), 15 (1): 67-70.

FERRARA F. A. A., AGUIAR-MENEZES E. L., URAMOTO K., DE MARCO J. R. P., 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.- *Neotropical Entomology*, 34 (2): 183-190.

FERREIRA H. de J., VELOSO V. R. S., NAVES R. V. , BRAGA FILHO J. R., 2003.- Infestação de moscas-das-frutas em variedades de manga (*Mangifera indica* L.) no Estado de Goiás.- *Pesquisa Agropecuária Tropical*, 33 (1): 43-48.

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.- *Neotropical Entomology*, 32 (3): 421-426.

KOVALESKI A., 1997.- Processos adaptativos na colonização da maçã (*Malus domestica* l.) por *Anastrepha fraterculus* (Weid.) (Diptera: Tephritidae) na região de Vacaria - RS. *Ph.D. Thesis*, Departamento de Biologia do Instituto de Biociências, Universidade de São Paulo, São Paulo, SP, Brazil.

NASCIMENTO A. S., CARVALHO R. da S., 2000.- Manejo Integrado de Moscas-das-frutas, pp. 169-173. In: *Moscas-das-frutas de importância econômica no Brasil: conhecimento básico e aplicado*. (MALAVASI A., ZUCCHI R. A., Eds).- Holos, Ribeirão Preto, SP, Brazil.

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.- *Pesquisa Agropecuária Brasileira*, 16 (6): 763-767.

NASCIMENTO A. S., ZUCCHI R. A., MORGANTE J. S., MALAVASI A., 1982.- Dinâmica populacional das moscas-das-frutas do gênero *Anastrepha* (Dip., Tephritidae) no Recôncavo Baiano II - flutuação populacional.- *Pesquisa Agropecuária Brasileira*, 17 (7): 969-980.

NASCIMENTO A. S., ZUCCHI, R. A., SILVEIRA NETO S., 1983.- Dinâmica populacional das moscas-das-frutas no recôncavo baiano III - Análise faunística.- *Pesquisa Agropecuária Brasileira*, 18 (4): 319-321.

NASCIMENTO A. S., HAJI F. N. P., CARVALHO R. S., COUTINHO C. C., 1994.- Monitoramento e caracterização das espécies de moscas-das-frutas presentes na região do submédio São Francisco. In: *Resumos do 13º. Congresso Brasileiro de Fruticultura*, 1994, Salvador, BA, Brazil. Volume 3. SBF.

NASCIMENTO A. S., CARVALHO R. S., MALAVASI A., 2000.- Monitoramento populacional, pp. 109-117. In: *Moscas-das-frutas de importância econômica no Brasil - conhecimento básico e aplicado* (MALAVASI A., ZUCCHI R. A., Eds).- Holos, Ribeirão Preto, SP, Brazil.

SÁ R. F., 2006.- Bioecologia de moscas-das-frutas (Diptera: Tephritidae) e dispersão de machos estéreis de *Ceratitis capitata* (Wied.) em pomares comerciais de manga (*Mangifera indica* L.) na Região Sudoeste da Bahia. *Thesis (Masters)*, Universidade Estadual do Sudoeste da Bahia, Vitória da Conquista, Bahia, Brazil.

SEI, 2005.- Superintendência de Estudos Econômicos e Sociais da Bahia. [online] URL: http://www.sei.ba.gov.br/.- Accessed: January 10, 2005.

SILVEIRA NETO S., NAKANO O., VILLA NOVA N. A., 1976.- *Manual de ecologia dos insetos*. 15th edition.- Agronômica Ceres, Piracicaba, SP, Brazil.

THOMAZINI M. J., ALBUQUERQUE E. S., SOUZA FILHO M. F., 2003.- Primeiro registro de espécies de *Anastrepha* (Diptera: Tephritidae) no Estado do Acre.- *Neotropical Entomology*, 32 (4): 723-724.

TORRES C. A. S., CASTELLANI M. A., MALUF R. P., SILVA J. C. G., NASCIMENTO A. S., SÃO JOSÉ A. R., MOREIRA A. A., SÁ R. F., 2010.- Infestation of coffee plantation by fruit flies (Diptera: Tephritidae): associated species and natural parasitism on the Midwest region of Bahia, Brazil.- *Pesquisa Aplicada & Agrotecnologia*, 3 (1): 143-152.

UCHÔA-FERNANDES M. A., MOLINA R. M. S., OLIVEIRA I., ZUCCHI R. A., CANAL N. A., DIAZ N. B., 2003.- Larval endoparasitoids (Hymenoptera) of frugivorous flies (Diptera, Tephritoidea) reared from fruits of the cerrado of the State of Mato Grosso do Sul, Brazil.- *Revista Brasileira de Entomologia*, 47 (2): 181-185.

URAMOTO K., 2002.- Biodiversidade de moscas-das-frutas do gênero Anastrepha (Diptera: Tephritidae) no campus Luiz de Queiroz. *M.Sc. Dissertation*, Escola Superior de Agricultura Luiz de Queiroz, Universidade de São Paulo, Piracicaba, SP, Brazil.

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.- *Neotropical Entomology*, 34 (1): 33-39.

ZUCCHI R. A. 2000a.- Taxonomia, pp. 13-24. In: *Moscas-das-frutas de importância econômica no Brasil - conhecimento básico e aplicado* (MALAVASI A., ZUCCHI R. A., Eds).- Holos, Ribeirão Preto, SP, Brazil.

ZUCCHI R. A., 2000b.- Espécies de *Anastrepha*, sinonímias, plantas hospedeiras e parasitóides, pp. 41-48. In: *Moscas-das-frutas de importância econômica no Brasil - conhecimento básico e aplicado* (MALAVASI A., ZUCCHI R. A., Eds).- Holos, Ribeirão Preto, SP, Brazil.

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