

# FRUIT FLIES AND THEIR PARASITOIDS IN THE FRUIT GROWING REGION OF LIVRAMENTO DE NOSSA SENHORA, BAHIA, WITH RECORDS OF UNPRECEDENTED INTERACTIONS<sup>1</sup>

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**ABSTRACT-** Several fruit fly species (Diptera: Tephritidae and Lonchaeidae) assume the status of primary pests in fruit trees grown in Brazil, causing direct production losses. The aims of the study were to know aspects of diversity of fruit flies and their parasitoids in the fruit growing region of Livramento de Nossa Senhora, Bahia. Fruit samples were collected from 19 plant species during November/2011 and June/2014. Infestation rates were calculated in pupae.kg<sup>-1</sup> of fruit and pupae.fruit<sup>-1</sup>. The results indicate the occurrence of *Anastrepha obliqua* (Macquart), *Ceratitidis capitata* (Wiedemann) and *Neosilba pendula* (Bezzi). Plant species *Anacardium occidentale*, *Averrhoa carambola*, *Carica papaya*, *Eugenia uniflora*, *Malpighia emarginata*, *Mangifera indica* var. "Haden", "Rosa" and "Tommy Atkins", *Opuntia ficus indica*, *Pereskia bahiensis*, *Psidium guajava*, *Spondias lutea*, *Spondias purpurea* and *Spondias tuberosa* are hosts of fruit flies in the region. Unprecedented bitrophic relationships between *P. bahiensis* and *C. capitata* and *Anastrepha* sp. and between *Opuntia ficus indica* and *C. capitata* and *A. obliqua* were recorded. Unprecedented tritrophic relationship for the state of Bahia *Averrhoa carambola* and *C. capitata* and parasitoid of the Pteromalidae Family were also recorded. Tritrophic associations between *M. indica* var. "Tommy Atkins" and *S. purpurea* and *A. obliqua* and *Doryctobracon areolatus*; and between *S. purpurea* and *A. obliqua* and *Utetes anastrephae* were observed.

**Index terms:** *Anastrepha obliqua*. Cactaceae. *Ceratitidis capitata*. *Doryctobracon aureolatus*. *Neosilba pendula*.

## MOSCAS FRUGÍVORAS E SEUS PARASITOIDES NO POLO DE FRUTICULTURA DE LIVRAMENTO DE NOSSA SENHORA, BAHIA, COM REGISTRO DE INTERAÇÕES INÉDITAS

**RESUMO-** Várias espécies de moscas frugívoras (Diptera: Tephritidae e Lonchaeidae) assumem o status de pragas primárias em fruteiras cultivadas no Brasil, determinando prejuízos diretos à produção. O objetivo do trabalho foi conhecer aspectos da diversidade de moscas frugívoras e seus parasitoides no polo de fruticultura de Livramento de Nossa Senhora-BA. Foram realizadas amostragens de frutos em 19 espécies vegetais durante novembro/2011 e junho/2014. Foram calculados os índices de infestação em pupário.kg<sup>-1</sup> de fruto e pupário.fruto<sup>-1</sup>. Os resultados indicaram a ocorrência de *Anastrepha obliqua* (Macquart), *Ceratitidis capitata* (Wiedemann) e *Neosilba pendula* (Bezzi). As espécies vegetais *Anacardium occidentale*, *Averrhoa carambola*, *Carica papaya*, *Eugenia uniflora*, *Malpighia emarginata*, *Mangifera indica* var. "Haden", "Rosa" e "Tommy Atkins", *Opuntia ficus indica*, *Pereskia bahiensis*, *Psidium guajava*, *Spondias lutea*, *Spondias purpurea* e *Spondias tuberosa* são hospedeiros de moscas frugívoras na região. Registram-se, as relações bitróficas inéditas entre *P. bahiensis* e *C. capitata* e *Anastrepha* sp.; e entre *Opuntia ficus indica* e *C. capitata* e *Anastrepha obliqua*. Registra-se a relação tritrófica inédita para o Estado da Bahia *A. carambola* e *C. capitata* e parasitoide da Família Pteromalidae. Foram contatadas, também, as associações tritróficas entre *M. indica* var. "Tommy Atkins" e *S. purpurea* e *A. obliqua* e *Doryctobracon areolatus*; e entre *S. purpurea* e *A. obliqua* e *Utetes anastrephae*.

**Termos para indexação:** *Anastrepha obliqua*. Cactáceas. *Ceratitidis capitata*. *Doryctobracon aureolatus*. *Neosilba pendula*.

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## INTRODUCTION

Brazil is the third largest world's fruit producer. Fruit flies (Diptera: Tephritidae) are the main pests of the world's fruit production, considering the direct damage they cause and the capacity to adapt to other regions when introduced (DIAS et al., 2013). In Brazil, fruit flies are recognized as one of the greatest pests of the fruit growing activity, especially when fruits produced are aimed at external market (SÁ et al., 2008). The fruit fly species of economic importance are distributed in the genera *Anastrepha* Schiner (1868) and *Ceratitis* MacLeay (1829). The several *Anastrepha* species is native to the American continent, while *Ceratitis capitata* (Wiedemann, 1824), known as the Mediterranean fly, is the only representative of the genus *Ceratitis* in the country, originated from the African continent (FEITOSA et al., 2008).

*Anastrepha fraterculus* (Wiedemann, 1830) and *A. obliqua* species are the most economically important occurring species in the whole country, mainly infesting plants of the Anarcadiaceae and Myrtaceae families.

Although a large part of the economic damage caused by insects in Brazilian fruit crops is due to the attack of tephritid species *Anastrepha* spp. and *C. capitata* (SOUZA FILHO et al., 2000), lonchaeidae (Diptera: Lochaedidae), also stand out as primary pest in fruit trees such as acerola (ARAÚJO; ZUCCHI, 2002).

The main quarantine barriers to be overcome by the Brazilian fruit growing sector are phytosanitary. Population monitoring allows knowing the most frequent fly species, population densities and fluctuations and levels of control, aspects that serve as a subsidy to fruit growers for the adoption of control measures (NASCIMENTO et al., 2000).

The structure of the communities of frugivorous flies, their natural enemies and their relationships with host fruits vary among agroecosystems (BITTENCOURT et al., 2012), and this knowledge is of fundamental importance for the management of fruit fly species fruit growing regions of northeastern Brazil, where *C. capitata* is the predominant species in several fruit crops (SÁ et al., 2008). The adaptive capacity of *C. capitata* is related to several hosts in Brazil, either exotic or native. According to Zucchi (2012), *C. capitata* attacks 89 plant species, demonstrating that it is well suited to different environments. For Aguiar (2012), *C. capitata* exerts a strong competition with *Anastrepha* species, favoring its expansion with competitiveness by food niche.

The aim of this study was to know aspects of the diversity of frugivorous flies (Tephritidae and Lonchaeidae) and their parasitoids in several plant species in the fruit growing region of Livramento de Nossa Senhora, Bahia, as subsidies to improve the methods of control of these pests.

## MATERIAL AND METHODS

Studies were carried out in commercial mango orchards and in their vicinities, located in the municipality of Livramento de Nossa Senhora, BA and in the facilities of the Laboratory of Fruit Flies of the State University of Southwestern Bahia, campus of Vitória da Conquista, BA, from November 2011 to June 2014. The municipality of Livramento de Nossa Senhora is located in a region called "Polígono das Secas" (Drought Polygon), in the semi-arid region of Bahia. It is located at coordinates 13°15' S and 41°50' W, with average annual rainfall of 760 mm and mean annual temperature of 22.6° C (SEI, 2015).

The collection of mature fruits from plant and soil, according to their availability, was performed in 27 hosts, comprising 19 plant species and six mango varieties (Table 1).

The methodology of packaging and processing of fruits was performed according to Nascimento et al. (2000) and Silva et al. (2011a). After collection, fruits were sent to the laboratory for counting, weighing and packing in plastic trays containing vermiculite as substrate for larvae pupation. Samples were maintained under ambient and humidity temperature conditions. Processing was performed after 12-13 days with fruits at the rotting stage. Fruits were examined with the aid of a sharp knife, aiming at the location of late larvae and later discarded. The vermiculite was sieved to obtain puparia, which were individualized and transferred to transparent plastic tubes, containing a thin layer of vermiculite for the emergence of adults, both of fruit flies and parasitoids. The emerged specimens were counted and stored in tubes with 70% alcohol for further identification.

The emerged flies of the *C. capitata* species were separated and counted and *Anastrepha* species were identified by the aculeus tip, prepared according to methodology described by Zucchi (2000). Lonchaeidae were identified by the taxonomist MSc Pedro Carlos Stricks. For the identification of parasitoids, the key of Marinho et al. (2011) was used.

The genus *Pereskia* was identified by taxonomist PhD Avaldo de Oliveira Soares Filho, from the Department of Natural Sciences - State

University of Southwestern Bahia - UESB, Campus of Vitória da Conquista. The material was herborized and deposited in the Herbarium collection of the State University of Southwestern Bahia, Campus of Vitória da Conquista, under identification code HUESBVC8198.

The infestation rates were calculated in pupae.kg<sup>-1</sup> of fruit and pupae.fruit<sup>-1</sup>.

## RESULTS AND DISCUSSION

A total of 23,371 fruits in plants and soil of 27 hosts were collected, totaling 1,747.04 kg (Table 2). A total of 2,160 puparia (Table 3) were obtained, of them, 1,916 (88.7%) were tephritids and 223 (10.3%) were lonchaeidae, in addition to 21 parasitized puparia (1.0%).

Infestation by frugivorous flies occurred in 14 of the 26 sampled hosts: acerola, cajá, cashew, star fruit, guava, papaya, “Haden”, “Tommy Atkins” and “Rosa” mango, palm, pitanga, quiabento, seriguela and umbu. Considering infestation in pupae.kg<sup>-1</sup> of fruit in both fruits collected from plant and soil, seriguela was the most infested host with 35.47 and 347.50, respectively. Other hosts that stood out with infestation rates above 10 fruit pupae.kg<sup>-1</sup> were acerola for fruits collected from the plant; star fruit and pitanga for fruits collected from the soil (Table 3).

Infestation (pupae.kg<sup>-1</sup> of fruit) was higher in star fruit (plant) and seriguela (soil). The results obtained corroborate Sá et al. (2008) for the conditions of the fruit growing region of Anagé, BA. These authors observed infestation by fruit flies in umbu, mango, seriguela and acerola. The authors determined that, among 21 host species studied, the highest infestation rates were observed in seriguela (61.3 pupae.kg<sup>-1</sup> of fruit), juá (38.3 pupae.kg<sup>-1</sup> of fruit) and umbu (33.1 pupae.kg<sup>-1</sup> of fruit), agreeing in part with data obtained in the present study. On the other hand, data from Sá et al. (2008) showed that acerola presented one of the lowest infestation rates (0.9 pupae.kg<sup>-1</sup> of fruit), whereas in the present study, this result was 12.11 pupae.kg<sup>-1</sup> of fruits for fruits collected from the plant. For the conditions of Mossoró, RN, the infestation in acerola was 199.4 pupae.kg<sup>-1</sup> (ARAÚJO et al., 2011). The infestation rate in pitanga was 25.0 pupae.kg<sup>-1</sup> of fruits (soil); however, Melo et al. (2012) obtained infestation rate of 263.1 pupae.kg<sup>-1</sup> of fruits.

The infestation rate in guava and umbu was 0.17 pupae.fruit<sup>-1</sup> (plant) and 0.19 pupae.fruit<sup>-1</sup> (soil), respectively, lower than the rates obtained by

Alvarenga et al. (2009) in guava and umbu, which reached 1.70 and 1.74 pupae.fruit<sup>-1</sup>, respectively.

A total of 1,282 adult flies were obtained, of which 1,199 (93.5%) tephritids and 83 (6.5%) lonchaeidae specimens were obtained. Among tephritids, 640 (53.4%) were *C. capitata* and 559 (46.6%) *Anastrepha obliqua* (Macquart, 1835), and lonchaeidae of the *Neosilba pendula* species (Bezzi, 1919) (Table 4).

Acerola, cajá, cashew, star fruit, papaya, “Haden”, “Tommy Atkins” and “Rosa” mango, palm, pitanga, quiabento and seriguela were associated with *C. capitata*; “Haden”, “Tommy Atkins” mango, palm, pitanga, seriguela and umbu to *A. obliqua*; and acerola, cashew, guava, pitanga and seriguela to *N. pendula*, in which seriguela stands out as the only host of the three fruit fly species, also associated to parasitoids *Uteetes anastrephae* (Viereck, 1913) and *Doryctobracon areolatus* (Szépigeti, 1911) (Table 4).

Low diversity of tephritids was observed in the present study in relation to other works already conducted fruit growing regions of Bahia. Considering commercial orchards of the same fruit growing region (Livramento de Nossa Senhora), Aguiar (2012), through collections with McPhail traps from 2006 to 2009, found *C. capitata*, *A. obliqua*, *A. fraterculus*, *Anastrepha serpentina* (Wiedemann, 1830), *Anastrepha sororcula* Zucchi, 1979, *Anastrepha zenildae* Zucchi, 1979, *Anastrepha grandis* (Macquart, 1846), *Anastrepha montei* Lima, 1934, *Anastrepha amita* Zucchi, 1979, *Anastrepha pseudoparalela* (Loew, 1873), *Anastrepha manihot* Lima, 1934, *Anastrepha pickeli* Lima, 1934, *Anastrepha dissimilis* Stone, 1942 and *Anastrepha distincta* Greene, 1934, being the first three dominant species. In the same way, Sá et al. (2012a), working in the fruit growing region of Vale do Rio Gavião, BA, which is approximately 153 km from the Livramento de Nossa Senhora, found at least four and a maximum of seven *Anastrepha* species as a function of the sampled orchard.

One of the hypotheses to explain the low diversity of c obtained in the present study is probably due to the prolonged drought that occurred in the region, covering a good part of the fruit collection period (end of 2012 to 2014). In several collections, scarcity or absence of fruits was observed, limiting the samplings process, consequently, the collection of flies.

On the other hand, low diversity of tephritids was also observed in the works of Lopes et al. (2008), who obtained only *C. capitata* in mandarin orchards located in Paraíba, and by Nunes et al. (2012) and

Dias et al. (2013), who verified the occurrence of *C. capitata* and *A. fraterculus* in non-commercial orchards of several fruit trees in Rio Grande do Sul.

*Neosilba pendula* occurred in acerola, cashew, guava, pitanga and seriguela in a total of 83 individuals. Seriguela and guava were reported as hosts of *N. pendula* in the southern region of the Pantanal (NICÁCIO; UCHÔA, 2011). The infestation rates by lonchaeidae in acerola collected from the plant were 12.11 pupae.kg of fruit<sup>-1</sup> and 0.04 pupae.fruit<sup>-1</sup>, similar to data presented by Araújo and Zucchi (2002), who obtained infestation rates of 14.90 pupae.kg of fruit<sup>-1</sup> and 0.08 pupae.kg of fruit<sup>-1</sup> in acerola fruits. Species belonging to the genus *Neosilba* were also found infesting guava in the city of Pelotas and Campo Leão, RS (NUNES et al., 2012), showing that lonchaeidae are widely distributed in Brazil, deserving greater attention in bioecological studies of frugivorous flies. Ferreira et al. (2003) identified the presence of *Neosilba* species infesting “Imperial” and “Tommy Atkins” mangoes, representing 29.7% of identified fruit flies, being the first record of this genus in mango fruits in the state of Goiás, which was not observed in the present study.

Parasitism occurred in *Anastrepha* puparia from “Tommy Atkins” mango and seriguela and in *C. capitata* puparia from star fruit, and parasitoids of the Braconidae family emerged from *Anastrepha* puparia and those of the Pteromalidae family emerged from *C. capitata* puparia. Of the 21 specimens found, *D. areolatus* occurred in a higher frequency (90.50%) parasitizing larvae / pupae of fruit flies in mango and seriguela fruits and *U. anastrephae* (4.75%) in larvae / pupae in seriguela and one specimen of the Pteromalidae family (4.75%) in larvae / pupae of *C. capitata*, and this tritrophic relationship is unprecedented for the state of Bahia. Ferreira et al. (2003) found the *D. areolatus* species associated with “Imperial” and “Tommy Atkins” mango fruits, with the highest frequency (94.1%) occurring in fruits of the “Imperial” variety. Of the 71 specimens of parasitoids found in the fruit growing region of Anagé, Bahia, 63 (88.7%) were of the *D. areolatus* species, being the most abundant (SÁ et al., 2012b), a fact also reported in other studies (ALVARENGA et al., 2009; MARSARO JÚNIOR et al., 2011a; ARAÚJO et al., 2015).

The association acerola and *N. pendula* indicated the importance of this host for the maintenance of populations of this fly that infests several other vegetables of economic importance, such as cajarana, seriguela, acerola, guava, star fruit, juá and mandarin (ARAÚJO; ZUCCHI, 2002). Infestations by lonchaeidae of the genus *Neosilba*

have also been observed in peach (MONTES et al., 2011) and by *Neosilba* and *Lonchea* in star fruit and papaya (DIAS et al., 2013).

Both cactaceae species were infested with tephritides, palm (*O. ficus indica*) by *C. capitata* and *A. obliqua* and quiabento (*P. bahiensis*) by *C. capitata* and *Anastrepha* sp., in this case, it was not possible to infer on the species because it was a male specimen. These bitrophic relationships are unprecedented, with record of infestation in *Pereskia aculeata* Mill. (1768) by *Anastrepha barbiellinii* Lima (1918) in Santa Catarina (GARCIA; NORRBOM, 2011) and by *A. barbiellinii* and *C. capitata* in Ponte Nova, MG (MARSARO JÚNIOR et al., 2011b). These bitrophic relationships are of importance to fruit growing regions of northeastern Brazil, since such hosts are common in commercial orchards aimed at external markets. Quiabento fruits may be an option for the survival of tephritids in prolonged periods of drought when the number of primary hosts is reduced (LEITE, 2016). Forage palm is a multipurpose plant cultivated in arid and semi-arid regions of northeastern Brazil (OLIVEIRA et al., 2010).

*C. capitata* species is polyphagous and new records of bitrophic interactions involving this fly were also reported by Araújo et al. (2016) in *Garcinia acuminata* Planch. & Triana and *Garcinia brasiliensis* C. Martius fruits. The high abundance of *C. capitata* was also observed in other studies carried out in the northeastern region of Brazil, like Aguiar (2012) in the fruit growing regions of Bahia; De Araújo et al. (2011) in Rio Grande do Norte; and Lopes et al. (2008) in Paraíba. Aguiar (2012) associated this aspect to the expansion of areas cultivated with different fruit trees and that probably *C. capitata* is exerting a strong competition on the *Anastrepha* species. For Silva (2012), *C. capitata* began to occupy areas previously filled by species of the genus *Anastrepha*, influencing the displacement of the native species (*A. obliqua*) by the invasive species (*C. capitata*). The adaptive capacity of *C. capitata* was reported by Feitosa et al. (2007), who recorded for the first time infestation in star fruit. In the fruit growing region of Anagé, BA, Sá et al. (2008) found *C. capitata* infesting only mango.

Fruit flies of the genus *Anastrepha* are predominant under certain conditions, such as those occurring in guava crops in the southeastern region of the state of São Paulo (SÃO JOÃO et al., 2014) and in mango orchards at the fruit growing region of Itaberaba, BA (AGUIAR, 2012). In the present work, *A. obliqua* was the only species obtained during the study period. This species has been reported as one of the most frequent in mango orchards as observed in



the Vale do Rio Gavião Region, BA (SÁ et al., 2012b) and in Piauí (FEITOSA et al., 2008) and in several hosts for the conditions of Roraima (MARSARO JÚNIOR et al., 2011a) and Piauí (ARAÚJO et al., 2014). On the other hand, Silva et al. (2011b) obtained three *Anastrepha* species in myrtle fruits in the state of Bahia, *A. fraterculus*, *A. zenildae* and *A. sororcula*, with no record of *A. obliqua*.

With data obtained in this study, the adaptability of *A. obliqua* to other hosts, such as cactaceae, is emphasized, and in some cases *A. obliqua* has been predominant in relation to *A. fraterculus* (SÁ et al., 2012b; AGUIAR, 2012)

**TABLE 1** - Family, scientific name, common name and origin of hosts studied in the larval monitoring of frugivorous flies. Livramento de Nossa Senhora, BA, November / 2011 to June / 2014.

Family	Host		
	Scientific name	Common name	Origin
	<i>Spondias lutea</i> L.	Cajá	Exotic
	<i>Anacardium occidentale</i> L.	Cashew	Native
Anacardiaceae	<i>Mangifera indica</i> L.	Mango varieties: "Ataulfo, Carlota, Coquinho, Espada, Haden, Keit, Palmer, Rosa, Tommy Atkins".	Exotic
	<i>Spondias purpurea</i> L.	Seriguela	Exotic
	<i>Spondias tuberosa</i> Arruda	Umbu	Native
Cactaceae	<i>Opuntia ficus indica</i> (L.) Mill	Palm	Exotic
	<i>Pereskia bahiensis</i> Gürke	Quiabento	Native
Caricaceae	<i>Carica papaya</i> L.	Papaya	Exotic
Malpighiaceae	<i>Malpighia emarginata</i> DC	Acerola	Exotic
Moraceae	<i>Morus nigra</i> L.	Blackberry	Exotic
Musaceae	<i>Musa</i> sp.	Banana	Exotic
Myrtaceae	<i>Psidium guajava</i> L.	Guava	Exotic
	<i>Eugenia uniflora</i> L.	Pitanga	Native
Oxalidaceae	<i>Averrhoa bilimbi</i> L.	Biri-biri	Exotic
	<i>Averrhoa carambola</i> L.	Star fruit	Exotic
Passifloraceae	<i>Passiflora edulis</i> f. <i>flavicarpa</i> Dgener	Passion fruit	Exotic
Rhamnaceae	<i>Ziziphus joazeiro</i> Mart.	Juá	Native
Rutaceae	<i>Citrus limonium</i> Risso	Lemon	Exotic
	<i>Citrus reticulata</i> Blanco	Mandarin	Exotic

**TABLE 2** - Number of samples, number of fruits and fruit mass (kg) collected from the plant, from the soil and from both (total), according to the sampled hosts. Period from November / 2011 to June / 2014, Livramento de Nossa Senhora, BA.

Host	Nº. of samples	Nº. of fruits			Fruit mass (kg)		
		Soil	Plant	Total	Soil	Plant	Total
Acerola	17	2,264	4,440	6,704	6.20	13.38	19.58
Blackberry	1	-	120	120	-	0.11	0.11
Banana	1	-	18	18	-	1.55	1.55
Biri biri	1	48	19	67	0.64	0.16	0.80
Cajá	3	25	10	35	2.44	0.76	3.20
Cashew	11	95	125	220	5.39	7.22	12.61
Star fruit	44	602	1,801	2,403	31.98	107.63	139.61
Guava	3	17	6	23	1.11	0.77	1.88
Juá	9	1,808	1.282	3,090	3.81	3.40	7.21
Lemon	3	49	111	160	3.99	11.40	15.49
Papaya	30	90	171	261	30.39	63.21	93.60
Ataulfo Mango	1	18	-	18	3.52	-	3.52
Carlota Mango	1	66	-	66	9.87	-	9.87
Coquinho Mango	1	14	14	28	2.06	2.20	4.26
Keit Mango	1	-	16	16	-	4.60	4.60
Espada Mango	12	124	23	147	29.92	4.88	34.80
Haden Mango	5	12	14	26	5.84	5.39	11.23
Palmer Mango	6	19	28	47	6.88	13.85	20.73
Rosa Mango	48	803	348	1,151	192.30	89.35	281.65
Tommy Mango	64	1,229	926	2,155	518.98	354.94	873.92
Passion fruit	19	385	112	497	43.82	10.33	54.15
Palm	13	-	485	485	-	40.97	40.97
Quiabento	19	864	1,121	1985	19.70	25.47	45.17
Pitanga	5	88	188	276	0.24	0.56	0.80
Seriguela	15	60	1,640	1,700	0.40	15.79	16.19
Mandarin	4	4	172	176	0.50	12.10	12.60
Umbu	12	959	538	1,497	22.53	14.51	37.04
<b>Total</b>	<b>345</b>	<b>9,643</b>	<b>13,728</b>	<b>23,371</b>	<b>942.51</b>	<b>804.53</b>	<b>1,747.04</b>

**TABLE 3** - Number of puparia (No.) and infestation rates (pupae.kg<sup>-1</sup> of fruit and pupae.fruit<sup>-1</sup>) in fruits collected from the plant and soil as a function of the hosts. Period from November / 2011 to June / 2014, Livramento de Nossa Senhora, BA.

Host	Infestation rate (Plant)			Infestation rate (Soil)		
	Puparia (N <sup>o</sup> .)	Pupae.kg <sup>-1</sup> of fruit	Pupae. fruit <sup>-1</sup>	Puparia (N <sup>o</sup> .)	Pupae.kg <sup>-1</sup> of fruit	Pupae. fruit <sup>-1</sup>
Acerola	162	12.11	0.04	15	2.42	0.001
Cajá	1	1.32	0.10	-	-	-
Cashew	19	2.63	0.15	11	2.04	0.12
Star fruit	482	4.48	2.28	433	13.54	0.72
Guava	1	1.30	0.17	-	-	-
Papaya	15	0.24	0.09	-	-	-
Haden Mango	25	4.63	1.79	-	-	-
Rosa Mango	-	-	-	14	0.07	0.002
Tommy Mango	111	0.31	0.12	66	0.13	0.05
Palm	3	0.08	0.001	-	-	-
Pitanga	5	8.93	0.03	6	25.00	0.07
Quiabento	2	0.08	0.001	-	-	-
Seriguela	560	35.47	0.34	139	347.50	2.32
Umbu	12	1.57	0.04	78	7.10	0.19
<b>Total</b>	<b>1398</b>			<b>762</b>		

**TABLE 4** - Species of frugivorous flies (Tephritidae and Lonchaeidae) obtained in fruits collected from the plant and soil, according on the host. Period from November / 2011 to June / 2014, Livramento de Nossa Senhora, BA.

Host	Tephritidae				Lonchaeidae		Parasitoids
	<i>Ceratitis capitata</i>		<i>Anastrepha obliqua</i>		<i>Neosilba pendula</i>		
	Plant	Soil	Plant	Soil	Plant	Soil	
Acerola	4	2	0	0	44	12	
Cajá	1	0	0	0	0	0	
Cashew	0	2	0	0	9	0	
Star fruit	264	162	19	51	1	0	Pteromalidae
Guava	0	0	0	0	1	0	
Papaya	15	0	0	0	0	0	
Haden Mango	22	0	2	0	0	0	
Rosa Mango	1	1	3	0	0	0	
Tommy Mango	86	43	1	0	0	0	<i>Doryctobracon areolatus</i>
Palm	1	0	2	0	0	0	
Pitanga	0	3	3	0	0	3	
Quiabento	1	0	1	0	0	0	
Seriguela	24	8	353	110	12	1	<i>Doryctobracon areolatus</i> and <i>Utetes anastrephae</i>
Umbu	0	0	2	12	0	0	
<b>Total</b>	<b>419</b>	<b>221</b>	<b>386</b>	<b>173</b>	<b>67</b>	<b>16</b>	

## CONCLUSIONS

In the fruit growing region of Livramento de Nossa Senhora, BA, the occurrence of frugivorous flies *Anastrepha obliqua*, *Ceratitis capitata* and *Neosilba pendula* has been reported.

*Anacardium occidentale*, *Averrhoa carambola*, *Carica papaya*, *Eugenia uniflora*, *Malpighia emarginata*, *Mangifera indica* var. “Haden”, “Rosa” and “Tommy Atkins”, *Opuntia ficus indica*, *Pereskia bahiensis*, *Psidium guajava*, *Spondias lutea*, *Spondias purpurea* and *Spondias tuberosa* are hosts of frugivorous flies in the region.

Unprecedented bitrophic relationships between *P. bahiensis* and *C. capitata* and *Anastrepha* sp. and between *Opuntia ficus indica* and *C. capitata* and *A. obliqua* were recorded.

Unprecedented tritrophic relationships for the state of Bahia *Averrhoa carambola* and *Ceratitis capitata* and parasitoid of the Pteromalidae family was also recorded.

Tritrophic associations between *Mangifera indica* var. “Tommy Atkins” and *Spondias purpurea* and *Anastrepha obliqua* and *Doryctobracon areolatus*; and between *Spondias purpurea* and *Anastrepha obliqua* and *Utetes anastrephae* were also verified.

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