

CROP PROTECTION

Diversity of Flies (Diptera: Tephritidae and Lonchaeidae) in Organic Citrus Orchards in the Vale do Rio Caí, Rio Grande do Sul, Southern Brazil

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Diversidade de Moscas (Diptera: Tephritidae e Lonchaeidae) em Pomares Orgânicos de Citros no Vale do Rio Caí, RS

RESUMO - Este estudo foi conduzido nos municípios de Montenegro e Pareci Novo, localizados na região do Vale do Rio Caí, principal área de produção de citros do estado do Rio Grande do Sul, com o objetivo de determinar as espécies de Tephritidae e Lonchaeidae que ocorrem em pomares orgânicos de laranja doce [*Citrus sinensis* (L.) Osb.] cultivar Céu e de tangoreiro Murcott (*Citrus reticulata* Blanco x *C. sinensis*), durante as respectivas fases de maturação dos frutos em 2003 e 2004. Foram instaladas armadilhas McPhail contendo suco de uva integral diluído a 25% em quatro pomares, duas em cada espécie de citros. As armadilhas foram vistoriadas semanalmente, nesta ocasião efetuou-se a troca do atrativo alimentar e as moscas capturadas foram separadas e preservadas em álcool etílico 70%. Também foram coletados frutos, os quais foram acondicionados em potes telados contendo areia umedecida. Os tefritídeos representaram 86,2% de todas as moscas capturadas nos quatro pomares nos dois anos de coleta. Foram capturadas cinco espécies de Tephritidae nas armadilhas: *Anastrepha fraterculus* (Wiedemann), *Anastrepha grandis* (Macquart), *Anastrepha pseudoparallela* (Loew), *Anastrepha dissimilis* Stone e *Ceratitis capitata* (Wiedemann). As espécies de Lonchaeidae capturadas foram: *Neosilba zadolicha* McAlpine & Steyskal, *Neosilba* n. sp. 3, *Neosilba* sp. e *Lonchaea* sp. Tanto em laranja 'Céu', como em tangoreiro 'Murcott', obteve-se *A. fraterculus* em 99% dos frutos coletados. *Neosilba* n. sp. 3 somente foi obtida de frutos do tangoreiro 'Murcott'.

PALAVRAS-CHAVE: *Anastrepha*, *Neosilba*, *Lonchaea*, *Ceratitis capitata*, armadilha McPhail, fruto hospedeiro

ABSTRACT - This study was carried out in the Counties of Montenegro and Pareci Novo located in the region of the Vale do Rio Caí, Rio Grande do Sul, Southern Brazil, aiming to determine the fruit fly species of Tephritidae and Lonchaeidae that occur in organic orchards of sweet orange [*Citrus sinensis* (L.) Osb.] cultivar Céu, and Murcott tangor (*Citrus reticulata* Blanco x *C. sinensis*), during the fruit ripening stages in 2003 and 2004. Eight McPhail traps baited with integral grape juice diluted to 25% were installed in four orchards, two in each citrus species. The traps were checked weekly, when the baits were changed, the flies separated and preserved in 70% ethyl alcohol. Fruits were also sampled from the orchards, placed in containers with damp soil and closed with a mesh. The tephritid flies represented 86.2% of all captured flies in the four orchards during both years. Five Tephritidae species were captured from traps: *Anastrepha fraterculus* (Wiedemann), *Anastrepha grandis* (Macquart), *Anastrepha pseudoparallela* (Loew), *Anastrepha dissimilis* Stone and *Ceratitis capitata* (Wiedemann). The captured species of Lonchaeidae were: *Neosilba zadolicha* McAlpine & Steyskal, *Neosilba* n.sp.3, *Neosilba* sp. and *Lonchaea* sp. *Anastrepha fraterculus* was found in 99% of the fruit samples, both in 'Céu' orange and 'Murcott' tangor, and *Neosilba* n.sp.3 were only obtained from 'Murcott' tangor fruits.

KEY WORDS: *Anastrepha*, *Neosilba*, *Lonchaea*, *Ceratitis capitata*, McPhail trap, host fruit

The Vale do Rio Cai is the main citrus production area in the State of Rio Grande do Sul. The region presents distinct edaphic-climatic and socio-economic characteristics, resulting in fruit production with potential for fresh consumption, produced in small farms, in areas between five and ten hectares, with a great diversification of plant species (Bonine & João 2002).

Citrus hosts a large number of pests worldwide, and of these, Tephritidae fruit flies may represent major pests (Smith & Peña 2002). The Mediterranean fruit fly, *Ceratitidis capitata* (Wiedemann), and species of the genus *Anastrepha* Schiner are reported as the most common fruit fly pests attacking citrus in Brazil (Uchôa-Fernandes *et al.* 2003, Chiaradia *et al.* 2004, Raga *et al.* 2004).

Lonchaeidae only recently is receiving attention although it is known for at least 70 years (Araújo & Zucchi 2002). Members of this family are considered by some authors as opportunists, that is, they infest citrus fruits attacked by the mentioned tephritids, making use of the oviposition hole (Souza *et al.* 1983, Malavasi *et al.* 1994, Araújo & Zucchi 2002). Other authors point out that some species can be considered primary citrus pests (Uchôa-Fernandes *et al.* 2003, Raga *et al.* 2004, Strikis & Prado 2005).

The present work aimed to evaluate the diversity of fruit flies in orchards of sweet orange var. Cêu and 'Murcott' tangor, and the natural infestation level of their fruits in two counties of the Vale do Rio Cai region, Rio Grande do Sul State.

Material and Methods

The study was carried out in four citrus orchards: two of sweet orange [*Citrus sinensis* (L.) Osbeck] var. Cêu, one located in Montenegro County (29°38'S and 51°28'W) and the other in Pareci Novo County (29°37'S and 51°24'W), and two of 'Murcott' tangor [*Citrus reticulata* Blanco x *C. sinensis* (L.) Osbeck], both at Montenegro (29°41'S and 51°31'W; 29°40'S and 51°32'W), in the Vale do Rio Cai region, Rio Grande do Sul State. Orchards were around eight and 12 years old and were managed under organic production system without fruit fly control.

The fruit flies surveys were performed in 2003 and 2004, from January to May on sweet orange, and from May to September on 'Murcott' tangor, during the respective fruit ripening phases of these citrus species. Two collection methods were employed.

McPhail trapping. The traps were hung on citrus trees at about 1.5 m high, approximately 15 m apart, positioned along an east-west transect. The number of traps was based on the number of plants, with a trap for every 15 trees. Four and six traps were used on the orange orchards and six and five ones on 'Murcott' tangor, as the areas of orchards had different sizes. Approximately 200 ml of integral grape juice diluted to 25% was used as bait per trap. They were checked weekly, the bait was renewed after sieving the trap contents, and all captured insects were transferred to labeled plastic flasks filled with 70% ethyl alcohol for later identification.

Sampling sufficiency was verified through a cumulative tephritid species curve (Camargo 2001), since this family is the one presenting higher abundance and economic importance at the Southern region of Brazil (Salles 1995, Chiaradia *et al.* 2004). To determine the influence of meteorological factors over the fruit-fly population, a multiple regression analysis was run, evaluating the significance of the coefficient of determination.

Collection of fruits. Five damaged fruits fallen under the canopy of three randomly selected plants were collected in each orchard at each sampling occasion. Fruits damaged were recognized by juice flowing through the *Anastrepha* oviposition orifice when manually pressed, or by the presence of a softened and/or rotten circular area. These fruits were placed on labeled plastic bags, tried in the lab, and those on advanced decomposition state were eliminated. Selected fruits were kept isolated in plastic containers, made with the inferior half of a two liters soft drink bottle, closed with a voile mesh fixed with rubber bands, and containing damp sand as pupation substrate. These vessels were kept under environmental conditions at the Training Center of Emater-RS in Montenegro County.

Fruits were maintained in these containers for a period of 20 days, when the sand was sieved to remove Tephritidae and Lonchaeidae pupae. Individuals were registered and transferred to gerbox boxes partially filled with a layer of damp sand, and kept in a climatic chamber (25 ± 1°C; photophase 12h). The containers were observed every two days until complete fruit decomposition, when fruits were discarded. After complete emergence, adults were preserved in 70% ethyl alcohol for later identification.

The indices of infestation by flies (Tephritidae and Lonchaeidae) were calculated as the number of flies per fruit and number of pupae per fruit.

Results and Discussion

Traps. In 2003, 4,812 and 393 specimens of Tephritidae and Lonchaeidae were collected in the traps, respectively, on the orchards of sweet orange var. Cêu (Table 1). The number of flies captured by trap was smaller on the 'Murcott' tangor orchards. In the following year, the number of fruit flies captured on both citrus species decreased. The tephritid flies represented 86.2% of all captured flies on the four orchards during 2003 and 2004.

The numerical difference in abundance between sampling years was probably due to a drought that occurred in the first trimester of 2004, with rainfalls below normal. This may have negatively influenced the populations of the flies captured in that year ($R^2 = 0.4883$; $P = 0.0062$).

The number of samplings by McPhail traps was adequate to assess Tephritidae richness for both years and citrus species (Fig. 1). In 2004, fewer samples were necessary for the curve to reach a plateau. This could, in part, be a consequence of the drought period mentioned before.

Five species of Tephritidae were collected from traps in the citrus species (Table 1). *C. capitata* was only captured in the traps installed on the sweet orange trees in 2003.

Table 1. Number of individuals (N) and frequency (%) of Tephritidae and Lonchaeidae (Diptera) species captured by McPhail traps on organic orchards of *C. sinensis* (sweet orange var. Céu) and *C. reticulata* x *C. sinensis* ('Murcott' tangor) in the municipalities of Montenegro and Pareci Novo, Vale do Rio Caí region, RS, Brazil, during their respective maturation periods in 2003 and 2004.

Frugivorous fly species	2003				2004			
	'Céu' orange		'Murcott'		'Céu' orange		'Murcott'	
	N	%	N	%	N	%	N	%
Tephritidae								
<i>Anastrepha</i> spp. ¹	4,812		1,314		1,175		553	
<i>A. fraterculus</i> ²	2,768	99.6	726	98.7	679	97.4	305	91.1
<i>A. grandis</i> ²	6	0.2	9	1.2	7	1.0	15	4.5
<i>A. pseudoparallela</i> ²	2	0.1	0	0	11	1.6	14	4.1
<i>A. dissimilis</i> ²	0	0	1	0.1	0	0	1	0.3
<i>Ceratitis capitata</i> ¹	3	0.1	0	0	0	0	0	0
Lonchaeidae								
<i>Neosilba</i> spp. ¹	393		346		289		234	
<i>Neosilba</i> sp. ³	257	47.4	157	31.5	131	26.5	104	35.7
<i>Neosilba zadolicha</i> ³	124	22.9	133	26.7	107	21.4	98	33.7
<i>Neosilba</i> n. sp. ³	12	2.2	56	11.2	51	10.2	32	10.9
<i>Lonchaea</i> spp. ¹	149	27.5	153	30.7	66	13.2	57	19.6

¹Males and females; ²only females; ³only males.

Anastrepha dissimilis Stone was not captured on 'Murcott' tangor orchards in both years. *A. fraterculus* was the most abundant species, comprising more than 91% of all females captured on the orchards of each citrus species. Garcia et al. (2003) and Chiaradia et al. (2004) found similar results on citrus orchards in Santa Catarina State, registering *A. fraterculus* as the main species. Chiaradia et al. (2004) also captured one specimen of *A. dissimilis*.

The results of the present study also agree with those of Salles (1995), who reported that *A. fraterculus* is the most abundant fruit fly in Southern Brazil.

In 2003 and 2004, flies of two genera of Lonchaeidae were trapped on the orchards of both citrus species (Table 1). *Neosilba* sp. was the most frequent species, representing 26.5% to 47.4% of all lonchaeid specimens (males) captured. One species of *Neosilba* was also captured in McPhail traps in citrus orchards of Mato Grosso do Sul State and was considered as the most frequent and abundant species (Uchôa-Fernandes et al. 2003). *Lonchaea* species are poorly known, however, species of this genus may have predatory and saprophytic habits (Uchôa-Fernandes et al. 2003).

The sweet orange and 'Murcott' tangor fruits were infested by Tephritidae (all females were identified as *A. fraterculus*) on both years (Table 2). Raga et al. (2004) showed that *A. fraterculus* represented about 77% of tephritids recovered from citrus fruit samples collected in 25 municipalities of São Paulo State, in 14 different cultivars, mainly from *C. sinensis* ('Pera', 'Hamlin', 'Natal' and 'Bahia').

Thus, the trapping of other species besides *A. fraterculus*

may be due to peculiar characteristics of the Vale do Rio Caí region. There a variety of fruit bearing plant species are cultivated around citrus orchards (i.e. passion fruit) and between lines, as cucurbitaceous, whose fructification periods coincided, in part, with the samplings. This could explain the occurrence of *Anastrepha grandis* (Macquart) and *Anastrepha pseudoparallela* (Loew) in the traps considering they are reported to infest Cucurbitaceae and Passifloraceae, respectively (Gomes Silva & Malavasi 1993, Zucchi 2000, Weems Jr. 2001).

Flies collected from fruits. A total of 688 fruits were sampled in both citrus species, from which 99 individuals of *A. fraterculus* and one of *Neosilba* n. sp. 3 emerged. The relationship between adult obtained per collected fruit varied from 0.18 to 0.44 in sweet orange var. Céu and from 0.06 to 0.12 in the Murcott tangor, in 2003 and 2004, respectively. A lesser relationship in 2004 was probably related to a smaller infestation, as a consequence of the drought period occurring in the first semester. The ratio of pupae per fruit in sweet orange var. 'Céu' was 0.86 in 2003 and 0.40 in 2004, which were higher than those found in 'Murcott' tangor, which was 0.34 and 0.30, respectively in 2003 and 2004. These results were similar to those found by Raga et al. (2004) in São Paulo State.

There was no emergence of parasitoids from the fruit flies pupae obtained in the collected fruits despite the organic management of the orchards.

A. fraterculus is recognized as an important citrus pest

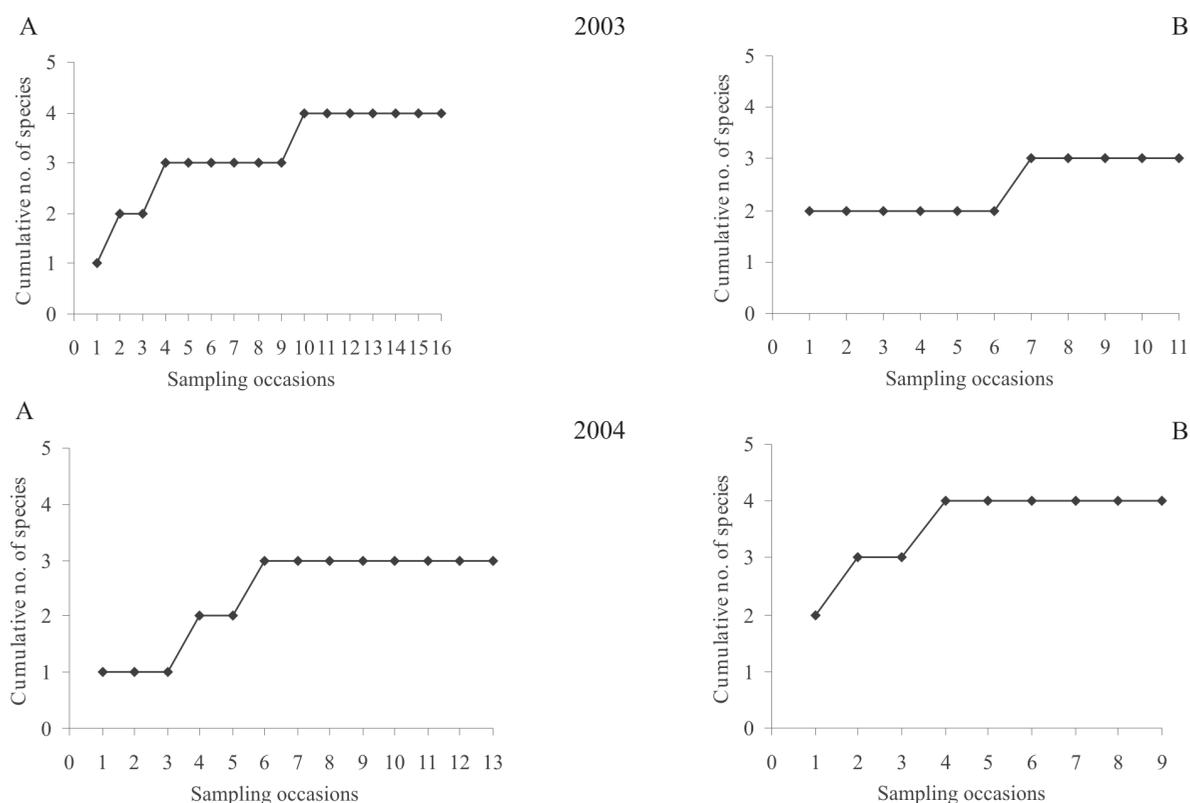


Fig. 1 Tephritidae species accumulation curves in sampling occasions in 2003 and 2004 (A: 'Céu' sweet orange and B: 'Murcott' tanger).

in South America. Nevertheless in some regions of the world, its importance on citrus crop is discussed. Aluja *et al.* (2003), for example, showed that *A. fraterculus* had problems developing in fruits of *C. sinensis* cultivar 'Valencia' and *C. paradisi* cultivar 'Rubi' in laboratory studies carried out in Veracruz, Mexico. In Brazil, Malavasi *et al.* (1994) and Salles (1995) stated that *A. fraterculus* does not have the citrus crop as its main host, this crop being considered as a secondary host.

The *Neosilba* n.sp.3, found in 2004 infesting 'Murcott'

tanger (Table 2), represents the first record of this genus in the South region of Brazil. Malavasi & Morgante (1980), working in several Brazilians localities, verified that 43.2% of all emerged dipterans of the citrus fruits belonged to the *Neosilba* genus. According to Raga *et al.* (2004), *Neosilba* spp. is a primary invader of citrus fruits, representing about 22% of the dipteran adults recovered.

No citrus samples were infested by Mediterranean fruit fly (Table 2). Similar results were found by Raga *et al.* (2004) in São Paulo State. These authors point out that the pest

Table 2. Species of Tephritidae and Lonchaeidae obtained from fallen and damaged fruits of *C. sinensis* (sweet orange var. Céu) and *C. reticulata* x *C. sinensis* ('Murcott' tanger) collected on organic orchards in the municipalities of Montenegro and Pareci Novo, Vale do Rio Caí region, RS, Brazil, in 2003 and 2004.

Year	Citrus host	No. of fruits sampled	No. of puparia/fruit	No. of flies obtained ♂(♀)	Species (no. of individuals)
2003	'Céu' orange	232	0.86	102 (63)	<i>A. fraterculus</i> (63)
	'Murcott' tanger	148	0.34	18 (11)	<i>A. fraterculus</i> (11)
2004	'Céu' orange	173	0.40	31 (19)	<i>A. fraterculus</i> (19)
	'Murcott' tanger	135	0.30	7 (6) 1	<i>A. fraterculus</i> (6) <i>Neosilba</i> n. sp.3 (1)
Total		688	359	159 (99)	

status of this species in citrus would change due to an intensive urbanization process occurring in the sampled sites. In the region of our study, the existence of small areas of citrus inside the agricultural towns and the proximity with the metropolitan region of Rio Grande do Sul State would influence this trend.

Our results showed that *A. fraterculus* is the most important species in the studied region, occurring in large population numbers either in orchards as infesting fruits.

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