

Frugivorous flies and their parasitoids associated with native fruits in an urban area

Moscas frugívoras e seus parasitoides associados a frutos nativos em área urbana

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Highlights:

First record of *C. capitata* and *N. pendula* on *Spondias purpurea* in Piauí;

First record of *T. giffardianus* parasitizing *C. capitata* on *Spondias purpurea* in Piauí;

First record of *P. vindemmia* in *A. obliqua* on umbu-cajá (*S. bahiensis*) in Brazil.

Abstract

This study aimed to know the species of frugivorous flies (Tephritidae and Lonchaeidae) and their parasitoids associated with fruits in home orchards. It was conducted in the Gurgueia Valley, municipality of Bom Jesus, Piauí, Brazil. Fruit collection was carried out from April to December 2016. A total of 959 fruits (12 kg) belonging to seven fruit species were sampled, such as acerola (*Malpighia glabra*), carambola (*Averrhoa carambola*), lime (*Citrus aurantifolia*), balsam pear (*Momordica charantia*), cherry of the Rio Grande (*Eugenia involucrata*), umbu-cajá (*Spondias bahiensis*), and purple mombin (*Spondias purpurea*). Only three among these species (acerola, umbu-cajá, and purple mombin) were host, with 2,770 frugivorous flies. Umbu-cajá hosted 316 specimens of *Anastrepha obliqua*, from which puparia have emerged 84 specimens of *Opius bellus* and four of *Pachycrepoideus vindemmia*. Purple mombin hosted *Ceratitis capitata* (2,384 specimens), *Neosilba pendula* (69 specimens), and *Anastrepha* sp. (one male). Eleven specimens of *Tetrastichus giffardianus* emerged from the puparia of *C. capitata*. Acerola hosted only one female of *C. capitata* and six specimens of *N. pendula*. *Ceratitis capitata* and *N. pendula* were recorded for the first-time infesting fruits of purple mombin in Piauí. *Tetrastichus giffardianus* parasitizing *C. capitata* in purple mombin was first recorded in the state of Piauí. *Pachycrepoideus vindemmia* is a new record in *A. obliqua* in umbu-cajá in Brazil.

Key words: *Ceratitis capitata*. *Anastrepha obliqua*. Host fruits. Parasitoids.

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Resumo

O objetivo desta pesquisa foi conhecer as espécies de moscas frugívoras (Tephritidae e Lonchaeidae) e seus parasitoides associados a frutos em pomares domésticos. O estudo foi conduzido no vale do Gurgueia, município de Bom Jesus, Piauí, Brasil. As coletas de frutos foram realizadas de abril a dezembro de 2016. Foram amostrados 959 frutos (12 kg), pertencentes a sete espécies de frutíferas, tais como, acerola [*Malpighia glabra*], carambola [*Averrhoa carambola*], citros [*Citrus aurantifolia*], melão-de-são-caetano [*Momordica charantia*], cereja-da-terra [*Eugenia involucrata*], umbu-cajã [*Spondias bahiensis*] e ciriguela [*Spondias purpurea*]. Dessas, apenas três espécies foram hospedeiras - acerola, umbu-cajã e ciriguela, das quais obtiveram-se 2.770 moscas frugívoras. Em umbu-cajã, obtiveram-se 316 espécimes de *Anastrepha obliqua*, de cujos pupários emergiram 84 exemplares de *Opius bellus* e quatro de *Pachycrepoideus vindemniae*. Em ciriguela, obtiveram-se *Ceratitis capitata* (2.384), *Neosilba pendula* (69) e um macho de *Anastrepha* sp. Onze espécimes de *Tetrastichus giffardianus* emergiram dos pupários de *C. capitata*. Em acerola, obteve-se apenas uma fêmea de *C. capitata*, além de seis espécimes de *N. pendula*. *Ceratitis capitata* e *N. pendula* são registradas pela primeira vez infestando frutos de ciriguela no Piauí. *Tetrastichus giffardianus* parasitando *C. capitata* em ciriguela é registrado pela primeira vez no estado do Piauí. *Pachycrepoideus vindemniae* é novo registro em *A. obliqua* em umbu-cajã no Brasil.

Palavras-chave: *Ceratitis capitata*. *Anastrepha obliqua*. Frutos hospedeiros. Parasitoides.

Several fly species have larvae that infest fruits throughout Brazil, such as those of the genera *Anastrepha* Schiner, *Ceratitis capitata* (Wiedemann) (Tephritidae), *Neosilba* McAlpine and *Lonchaea* Fallén (Lonchaeidae) (Strikis & Prado, 2005; Zucchi & Moraes, 2008). Larvae feed on fruit pulp, making them unviable for consumption and commercialization. In addition, the scar formed on the fruit when the female lays the eggs may favor the appearance of pathogens (Dias & Silva, 2014). In urban orchards, fruits ripen in different seasons, providing excellent food conditions for frugivorous larvae, favoring the dispersal and exploration of different niches. These sites become a reservoir for these insects, favoring population growth and attack on commercial orchards (Alvarenga, Alves, Silva, Lopes, & Lopes, 2010).

Studies involving fruit flies in the state of Piauí were first recorded in the 1990s (Menezes, Nunes, Branco, & Zucchi, 2000). Currently, 17 species of *Anastrepha* and *C. capitata* have been registered in the state of Piauí infesting fruits of carambola (*Averrhoa carambola* L.) and yellow mombin (*Spondias mombin* L.) (Zucchi & Moraes,

2008, 2012). Parasitoids of subfamilies Eucilinae (Figitidae) and Opiinae (Braconidae) are high potential biological control agents to control frugivorous dipterous larvae (Nunes, Nava, Müller, Gonçalves, & Garcia, 2011), but only *Tetrastichus giffardianus* Silvestri (Hymenoptera: Eulophidae), *Doryctobracon areolatus* (Szépligeti), and *Opius bellus* Gahan (Hymenoptera: Braconidae) have been recorded in fruit flies in the state of Piauí (Araújo, Silva, Querino, Souza, & Soares, 2014; Araújo, Silva, Querino, & Sousa, 2016).

Further studies on fruit flies and parasitoid records are promising components for biological control and have had increasing importance in the management strategies of these insects. Improvement in the techniques of mass multiplication of exotic and native parasitoids, for example, allows the development of new levels of fruit fly control (Núñez-Campero, Aluja, Rull, & Ovruski, 2014). Parasitoid hymenopterans are important natural enemies of frugivorous larvae and good biological control agents of pest populations.

Fruit farming in the state of Piauí is highly diverse and is under expanding. However, little is known

on the species of flies associated with native and cultivated fruits in the state. In addition, few efforts have been directed to the knowledge of fly species associated with urban orchards, which constitute natural reservoirs of these insects. Therefore, this study aimed to know the species of flies and their parasitoids associated with fruits of home orchards located in Bom Jesus, the southern region of the state of Piauí.

The study was conducted in the Gurgueia Valley, municipality of Bom Jesus, PI, Brazil (09°04'28" S and 44°21'31" W, with an altitude of 296 m). Fruits (acerola, carambola, cherry of the Rio Grande, purple mombin, lime, balsam pear, and umbu-cajá) were collected from April to December 2016 in urban orchards.

Fruits in a good state of preservation, i.e., with no holes that indicated the larvae exit, were randomly collected from the soil. These samples were taken to the Laboratory of Zoology of the Campus Prof. Cinobeline Elvas of the Federal University of Piauí (UFPI/CPCE), Bom Jesus, Piauí, Brazil. Fruits were quantified, individually weighed, labeled, packed in plastic containers containing autoclaved sand, closed with voile fabric, and maintained under ambient conditions (25±5 °C, 50±10% RH, and 12:12 LD).

Fruit sorting was performed from 10 to 15 days and puparia were transferred to containers with autoclaved sand for adult emergence. Emerged insects were placed in labeled glass bottles containing 70% ethanol for later identification.

Taxonomic identification of *Anastrepha* species was performed by observing mainly the characteristics of female aculeus (Zucchi, 2000), being deposited in the collection of the Laboratory of Zoology of the Federal University of Piauí (CPCE/UFPI). Lonchaeids were identified mainly based on male genitalia (McAlpine & Steyskal, 1982; Strikis, 2011) and were deposited at the University of São Paulo (USP). Parasitoids were identified by Dr. Ranyse Barbosa Querino and deposited at the Laboratory of Entomology of the Embrapa Mid-North, Teresina, PI, Brazil.

The frequency of frugivorous flies was calculated as follows: $F (\%) = (\text{number of adults per species} / \text{total number of adults}) \times 100$.

A total of 959 fruits (12,331 g) of umbu-cajá (*Spondias bahiensis* P. Carvalho, Van den Berg & M. Machado), purple mombin (*Spondias purpurea* L.) (Anacardiaceae), balsam pear (*Momordica charantia* L.) (Cucurbitaceae), acerola (*Malpighia glabra* L.) (Malpighiaceae), cherry of the Rio Grande (*Eugenia involucreta* DC.) (Myrtaceae), carambola (*Averrhoa carambola* L.) (Oxalidaceae), and lime (*Citrus aurantifolia* (Christm.) Swingle) (Rutaceae) (Table 1) were sampled.

Table 1
Frugivorous flies and their parasitoids associated with fruits from April to December 2016 in an urban area of Bom Jesus, PI

Family	Host	Fruit (n)	Weight (g)	Fly (n)	Freq. (%)	Frugivorous flies	Parasitoid
Anacardiaceae	<i>Spondias bahiensis</i>	97	2,050	316	11.38	<i>Anastrepha obliqua</i> (145)	<i>Opius bellus</i> (84) <i>Pachycrepoideus vindemmiae</i> (4)
Anacardiaceae	<i>Spondias purpurea</i>	814	9,737	2,384	85.85	<i>Ceratitis capitata</i> [1.222]	<i>Tetrastichus giffardianus</i> (11)
				69	2.49	<i>Neosilba pendula</i> [34]	
				1	0.04	<i>Anastrepha</i> sp.	
Cucurbitaceae	<i>Momordica charantia</i>	4	26	–	–	–	
Malpighiaceae	<i>Malpighia glabra</i>	30	117	1	0.04	<i>Ceratitis capitata</i> [1]	
				6	0.22	<i>Neosilba pendula</i> [3]	
Myrtaceae	<i>Eugenia involucrata</i>	5	31	–	–	–	
Oxalidaceae	<i>Averrhoa carambola</i>	4	193	–	–	–	
Rutaceae	<i>Citrus aurantifolia</i>	5	177	–	–	–	
Total		959	12,331	2,770	100	1,405*	99**

*Values corresponding to females (*Anastrepha* and *Ceratitis*) and males (*Neosilba*); **Abundance of parasitoids.

A total of 316 specimens of *Anastrepha obliqua* (Macquart) (171 males and 145 females), 84 specimens of *O. bellus*, and four specimens of *Pachycrepoideus vindemmiae* Rondani (Pteromalidae) were obtained from 97 umbu-cajá fruits (2,050 g) (Table 1). A total 2,789 puparia were obtained among 814 purple mombin fruits (9,737 g) sampled, from which 2,384 specimens of *C. capitata* (1,162 males and 1,222 females), 69 specimens of *Neosilba pendula* (Bezzi) (34 males and 35 females), and one male of *Anastrepha* emerged (Table 1). Eleven specimens of *T. giffardianus* emerged from the puparia of *C. capitata*, and four specimens of this parasitoid emerged from a single puparium

obtained from a purple mombin fruit. Moreover, only one female of *C. capitata* and six specimens of *N. pendula* (3 males and 3 females) were obtained from acerola fruits (117 g). Carambola, cherry of the Rio Grande, lime, and balsam pear showed no emergence of adults (Table 1).

Anastrepha obliqua has already been recorded in the state of Piauí (Menezes et al., 2000; Santos & Pádua, 2004; Feitosa et al., 2007). Although *A. obliqua* prefers Anacardiaceae species (Zucchi, 2000; Alvarenga et al., 2010; Araújo et al., 2014), only umbu-cajá was infested in this study. However, purple mombin is also a primary host of *A. obliqua* (Araújo et al., 2014).

The high frequency of *C. capitata* (85.85%) on purple mombin (first record in the state) shows the importance of this fruit as a natural repository of the Mediterranean fly in the region. Purple mombin can be considered as the primary host of *C. capitata* in the municipality of Bom Jesus because the infestation exceeded the minimum index (30 puparia/kg of fruit), similar to that observed in Rio Grande do Norte semiarid, where 34 puparia/kg of fruit were obtained (Araujo, Medeiros, Silva, & Zucchi, 2005). New studies investigating the relationship between lonchaeids and purple mombin are needed.

Although *C. capitata* infests acerola in several Brazilian states (Zucchi & Moraes, 2012), only one specimen was collected from home orchards in Bom Jesus. The presence of *C. capitata* has already been found in other regions of Piauí, such as in the municipalities of Altos, Teresina, and Parnaíba (Feitosa et al., 2007).

In this study, specimens of *N. pendula* were obtained from acerola and purple mombin. Lonchaeids infest flower buds and fruits of various species of wild and cultivated plants and can reach important infestation levels as those of tephritids (Minzão & Uchoa, 2008; Araujo & Zucchi, 2002a). Lonchaeids are economically important as citrus pests in the states of Mato Grosso do Sul (Uchoa et al., 2003) and Pará (Castilho, Lemos, Strikis, Sousa, & Adaime, 2017). *Neosilba pendula* has a wide distribution and wide range of hosts (Strikis & Prado, 2009). Lonchaeids and fruit fly species may have the status of pest in the Northeast of Brazil, especially *N. pendula*, which attacks acerola (Araujo & Zucchi, 2002a).

The percentage of parasitism of frugivorous flies was low in purple mombin and umbu-cajá, despite the high infestation rate of *C. capitata*. Natural parasitism in fruit flies in the semiarid regions is probably low due to adverse weather conditions (Araujo & Zucchi, 2002b).

Tetrastichus giffardianus parasitizes *C. capitata* on purple mombin in the state of Piauí (first record). Previously, this parasitoid was obtained from puparia of *A. obliqua* on umbu-cajá in the state (Araújo et al., 2016). Records of *T. giffardianus* has become frequent in the Northeast of Brazil in recent years, although it has been 60 years without records since its introduction and release in 1937 in the state of São Paulo (Costa, Araújo, Guimarães, Nascimento, & Lasalle, 2005). *Tetrastichus giffardianus*, *D. areolatus*, and *O. bellus* are the only fruit fly parasitoids recorded in the state of Piauí (Araújo et al., 2014, 2016). Specimens of *O. bellus* were obtained associated with *A. obliqua* in umbu-cajá. Fruit pulp thickness acts as a barrier to fruit fly parasitism because there is a relationship between ovipositor length and pulp depth exploited by parasitoids to locate the larvae, and parasitoids with short ovipositor can only parasitize larvae in fruits with shallow pulp (Hickel, 2002).

The species *P. vindemmiae* was recorded in *A. obliqua* larvae on umbu-cajá. It is a solitary and generalist primary and secondary ectoparasitoid of many groups of dipterans, including species of Tephritidae (Rossi Stacconi et al., 2013; Farrugia, 2016). *Pachycrepoideus vindemmiae* was also recorded in the state of Minas Gerais parasitizing *Anastrepha* spp. on carambola (Silva, Marchiori, Fonseca & Torres, 2003), being also obtained from *A. fraterculus* in Itumbiara, state of Goiás (Marchiori, Silva Oliveira, Martins, Bossi, & Oliveira, 2000) and raised in *C. capitata* on peach in the state of São Paulo (Montes, Raga, Boliani, & Santos, 2011).

There was no record of parasitoids in *N. pendula*. This lonchaeid is considered a primary pest in acerola, as the female lays directly on the fruit, i.e., it does not require the oviposition puncture of fruit flies to lay their eggs on fruits. Two parasitoid species (*O. bellus* and *P. vindemmiae*) were associated with *A. obliqua* and one (*T. giffardianus*) with *C. capitata*. The results obtained

in this study show the need for new studies on fruit flies in southern Piauí. In addition, it is necessary to explore native vegetation environments and know the tritrophic relationships involved in these ecosystems, whose information may be the basis for the use of native parasitoids in future integrated fruit fly management programs.

Based on the sampling, the following species were recorded for the first time: (1) *C. capitata* and *N. pendula* on *Spondias purpurea* in the municipality of Bom Jesus, state of Piauí; (2) *T. giffardianus* parasitizing *C. capitata* on *Spondias purpurea* in the state of Piauí; and (3) *P. vindemmiae* in *A. obliqua* on umbu-cajá (*S. bahiensis*) in Brazil.

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References

- Alvarenga, C. D., Alves, D. A., Silva, M. A., Lopes, E. M., & Lopes, G. N. (2010). Moscas-das-frutas (Diptera: Tephritidae) em pomares da área urbana no Norte de Minas Gerais. *Revista Caatinga*, 23(2), 25-31. doi: 237116915005
- Araújo, A. A. R., Silva, P. R. R., Querino, R. B., & Sousa, E. P. S. (2016). *Tetrastichus giffardianus* on pupae of *Anastrepha* in Brazil. *Ciência Rural*, 46(7), 1134-1135. doi: 10.1590/0103-8478cr20150890
- Araújo, A. A. R., Silva, P. R. R., Querino, R. B., Souza, E. P. S., & Soares, L. L. (2014). Moscas-das-frutas (Diptera: Tephritidae) associadas às frutíferas nativas de *Spondias* spp. (Anacardiaceae) e *Ximenia americana* L. (Olacaceae) e seus parasitoides no estado do Piauí, Brasil. *Semina: Ciências Agrárias*, 35(4), 1739-1750. doi: 10.5433/1679-0359.2014v35n4p1739
- Araujo, E. L., Medeiros, M. K. M., Silva, V. E., & Zucchi, R. A. (2005). Moscas-das-frutas (Diptera: Tephritidae) no semi-árido do Rio Grande do Norte: plantas hospedeiras e índices de infestação. *Neotropical Entomology*, 34(6), 889-894. doi: 10.1590/S1519-566X2005000600003
- Araujo, E. L., & Zucchi, R. A. (2002a). Hospedeiros e níveis de infestação de *Neosilba pendula* (Bezzi) (Diptera: Lonchaeidae) na região de Mossoró/Assu, RN. *Arquivos do Instituto Biológico*, 69(2), 91-94. doi: 277714240
- Araujo, E. L., & Zucchi, R. A. (2002b). Parasitoides (Hymenoptera: Braconidae) de moscas-das-frutas (Diptera: Tephritidae) na região de Mossoró/Assu, estado do Rio Grande do Norte. *Arquivos do Instituto Biológico*, 69(2), 65-68. doi: 277714150
- Castilho, A. P., Lemos, W. P., Strikis, P. C., Sousa, M. S. M., & Adaime, R. (2017). Species of *Neosilba* (Diptera: Lonchaeidae) recorded in citrus-producing region in the state of Pará, Brazil. *Biotemas*, 30(3), 85-87. doi: 10.5007/2175-7925.2017v30n3p85
- Costa, V. A., Araújo, E. L., Guimarães, J. A., Nascimento, A. S., & Lasalle, J. (2005). Redescoberta de *Tetrastichus giffardianus* (Hymenoptera: Eulophidae) após 60 anos da sua introdução no Brasil. *Arquivos do Instituto Biológico*, 72(4), 539-541. doi: 242025354
- Dias, N. P., & Silva, F. F. (2014). Moscas-das-frutas (Diptera: Tephritidae e Lonchaeidae) na região da Fronteira Oeste do Rio Grande do Sul. *Revista de Ciências Agrárias/Amazonian Journal of Agricultural and Environmental Sciences*, 57(1), 29-34. doi: 10.4322/rca.2013.062
- Farrugia, L. A. (2016). First record of *Pachycrepoideus vindemmiae* (Rondani, 1875) (Hymenoptera, Pteromalidae) from Malta. *Bulletin of the Entomological Society of Malta*, 8, 77-78. doi: 10.17387/BULLENTSOCMALTA.2016.07
- Feitosa, S. S., Silva, P. R. R., Pádua, L. E. M., Sousa, M. P. S., Passos, E. P., & Soares, A. A. R. A. (2007). Primeiro registro de moscas-das-frutas (Diptera: Tephritidae) em carambola nos municípios de Teresina, Altos e Parnaíba no estado do Piauí. *Semina: Ciências Agrárias*, 28(4), 629-634. doi: 10.5433/1679-0359.2007v28n4p629
- Hickel, E. R. (2002). Espessura da polpa como condicionante do parasitismo de mosca-das-frutas (Diptera: Tephritidae) por Hymenoptera: Braconidae. Santa Maria, *Ciência Rural*, 32(6), 1005-1009. doi: 10.1590/S0103-84782002000600014

- Marchiori, C. H., Silva Oliveira, A. M., Martins, F. F., Bossi, F. S., & Oliveira, A. T. de. (2000). Espécies de mosca-das-frutas (Diptera: Tephritidae) e seus parasitóides em Itumbiara-GO. *Pesquisa Agropecuária Tropical*, 30(2), 73-76. doi: 235911177
- McAlpine, J. F., & Steyskal, G. C. A. (1982). Revision of *Neosilba* McAlpine with a key to the world genera of Lonchaeidae (Diptera). *Canadian Entomologist*, 114(2), 105-137. doi: 10.4039/Ent114105-2
- Menezes, R. V. S., Nunes, E. M., Branco, R. S. C., & Zucchi, R. A. (2000). Piauí. In A. Malavasi, & R. A. Zucchi, (Eds.). *Moscas-das-frutas de importância econômica no Brasil: conhecimento básico e aplicado*. (Cap. 29, pp. 213-215). Ribeirão Preto: Holos Editora.
- Minzão, E. R., & Uchoa, M. A. (2008). Diversidade de moscas frugívoras (Diptera, Tephritoidea) em áreas de matas decídua e ciliar no Pantanal Sul-Mato-Grossense, Brasil. *Revista Brasileira de Entomologia*, 52(3), 44-445. doi: 10.1590/S0085-56262008000300018
- Montes, S. M. N. M., Raga, A., Boliani, A. C., & Santos, P. C. D. (2011). Dinâmica populacional e incidência de moscas-das-frutas e parasitoides em cultivares de pessegueiros (*Prunus persica* L. Batsch) no município de Presidente Prudente-SP. *Revista Brasileira de Fruticultura*, 33(2), 402-411. doi: 10.1590/S0100-29452011005000052
- Nunes, A. M., Nava, D. E., Müller, F. A., Gonçalves, R. D. S., & Garcia, M. S. (2011). Biology and parasitic potential of *Doryctobracon areolatus* on *Anastrepha fraterculus* larvae. *Pesquisa Agropecuária Brasileira*, 46(6), 669-671. doi: 10.1590/S0100-204X2011000600014
- Núñez-Campero, S. R., Aluja, M., Rull, J., & Ovruski, S. M. (2014). Comparative demography of three neotropical larval-prepupal parasitoid species associated with *Anastrepha fraterculus* (Diptera: Tephritidae). *Biological Control*, 69, 8-17. doi: 10.1016/j.biocontrol.2013.10.013
- Rossi Stacconi, M. V., Rassi, A., Dalton, D. T., Miller, B., Ouantar, M., Loni, A.,... & Anfora, G. (2013). First field records of *Pachycrepoideus vindemiae* (Rondani) (Hymenoptera Pteromalidae) as a parasitoid of *Drosophila suzukii* in European and Oregon small fruit production areas. *Entomologia*, 1(1), 11-16, doi: 10.4081/entomologia.2013.e3
- Santos, G. S., & Pádua, L. E. M. (2004). Flutuação populacional e espécies de moscas-das-frutas em *Citrus* na cidade de Teresina, PI. *Revista Caatinga*, 17(2), 87-82.
- Silva, C. G., Marchiori, C. H., Fonseca, A. R., & Torres, L. C. (2003). Himenópteros parasitoides de larvas de *Anastrepha* spp. em frutos de carambola (*Averrhoa carambola* L.) na região de Divinópolis, Minas Gerais, Brasil. *Ciência Agrotecnologia*, 27(6), 1264-1267. doi: 10.1590/S1413-70542003000600009
- Strikis, P. C. (2011). Description of 11 new species of genus *Neosilba* (Diptera: Lonchaeidae) from Brazil, its hosts and geographical distribution. *Trends of Entomology*, 7(8), 67-79. doi: 20123175910
- Strikis, P. C., & Prado, A. P. (2005). A new species of the genus *Neosilba* (Diptera: Lonchaeidae). *Zootaxa*, 828(1), 1-4. doi: 10.11646/zootaxa.828.1.1
- Strikis, P. C., & Prado, A. P. (2009). Lonchaeidae associados a frutos de nêspera, *Eryobotria japonica* (thunb.) Lindley (Rosaceae), com a descrição de uma espécie nova de *Neosilba* (Diptera: Tephritoidea). *Arquivos do Instituto Biológico*, 76(1), 49-54. doi: 20093102539
- Uchoa, M. A., Molina, R. M. S., Oliveira, I., Zucchi, R. A., Canal, N. A., & Díaz, 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), 181-186. doi: 10.1590/S0085-56262003000200005
- Zucchi, R. A. (2000). Espécies de *Anastrepha*, sinônimas, plantas hospedeiras e parasitoides. In A. Malavasi, R. A. Zucchi (Eds.). *Moscas-das-frutas de importância econômica no Brasil: conhecimento básico e aplicado* (Cap. 4, pp. 41-48). Ribeirão Preto: Holos Editora.

