Parasitoids associated with South American fruit fly in native fruits in the state of Santa Catarina, Brazil

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Abstract - In Southern of Brazil, the South American fruit fly (*Anastrepha fraterculus*) is the main insect pest of native and exotic fruit trees. This study was conducted in agricultural areas of seven municipalities belonging to the Alto Vale do Rio do Peixe region, in the state of Santa Catarina, Brazil, from 2015 to 2022. It aimed to evaluate the entomofauna of micro-hymenopteran parasitoids associated with *A. fraterculus* in native fruit trees. A sample of 200 fruits of *Eugenia involucrata* (cherry of the Rio Grande), *Eugenia pyriformis* ('uvaia'), *Acca sellowiana* ('feijoa'), *Psidium cattleyanum* (yellow and red cattley guava), *Campomanesia xanthocarpa* ('guabiroba') and *Campomanesia guazumifolia* ('sete capotes') per municipality and in each crop season was collected to determine the parasitism index and perform the faunistic analysis of parasitoid species. Seven parasitoid species were recorded, three from the family Figitidae and four from the family Braconidae. *Aganaspis pelleranoi* was the most often recorded species, with a constant presence, very abundant, and dominant incidence in the investigated region. Parasitism rates ranged from 0.2% to 39%, emphasizing the need for conservation-oriented and applied biological control studies.

Index terms: *Anastrepha fraterculus;* Natural biological control; Micro-hymenopteran.

Parasitoides associados à mosca-das-frutas sul-americana em frutíferas nativas em Santa Catarina, Brasil

Resumo - No Sul do Brasil, a mosca-das-frutas sul-americana (*Anastrepha fraterculus*) é o principal inseto-praga das frutíferas nativas e exóticas. O estudo foi realizado em áreas agrícolas de sete municípios pertencentes à região do Alto Vale do Rio do Peixe, em Santa Catarina, Brasil, no período de 2015 a 2022. Este estudo teve como objetivo avaliar a entomofauna de micro-himenópteros parasitoides associados à *A. fraterculus* em frutíferas nativas. Uma amostra de 200 frutos de *Eugenia involucrata* (cerejeira-do-mato), *Eugenia pyriformis* (uvaieira), *Acca sellowiana* ('feijoa'), *Psidium cattleianum* (araçazeiros amarelo e vermelho), *Campomanesia xanthocarpa* (guabirobeira) e *Campomanesia guazumifolia* (sete-capotes) foram coletadas por município e em cada safra agrícola para determinar os índices de parasitismo e a análise faunística das espécies de parasitoides. Foram registradas sete espécies de parasitoides, três da família Figitidae e quatro de Braconidae. A espécie mais frequente foi *Aganaspis pelleranoi*, apresentando ocorrência constante, muito abundante e dominante na região. Os índices de parasitismo variaram entre 0,2 a 39%, reforçando a necessidade de estudos sobre controle biológico, por conservação e/ou aplicado.

Termos para indexação: *Anastrepha fraterculus*; **C**ontrole biológico natural; Micro-hymenoptera.

Introduction

The South American fruit fly, *Anastrepha fraterculus* (Wiedemann, 1830) (Diptera: Tephritidae), is one of the main pests affecting native and exotic temperate climate fruit trees in Southern Brazil (GARCIA & NORRBOM, 2011; ROSA et al., 2017; SANTOS & GUIMARÃES, 2018). The application of toxic baits and insecticides in the cover area are the main practices used by fruit growers to suppress fruit fly populations. However, the use of insecticides is increasingly limited due to the demand of importing countries for fresh fruits without chemical residues (BORGES et al., 2015). In addition, Brazilian

Received on 16 Feb. 2024. Accepted for publication on 09 Apr. 2024. Doi: https://doi.org/10.52945/rac.v37i1.1816
Section editor: Joatan M. da Rosa
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consumers and producers are more environmentally conscious; therefore, management practices applied to *A. fraterculus* need to improved and other control strategies must be adopted (DIAS et al., 2018). In this sense, biological control can play a crucial role in the fruit sector (NAVA, 2007).

Biological control is a promising alternative for managing Tephritidae fruit flies in Brazil, mainly by implementing of native parasitoids (DIAS et al., 2022). One of the management strategies used is the maintenance of refuges adjacent to orchards, based on cultural control and the use of selective insecticides (NAVA, 2007). These practices alow for the establishment and the reproduction of parasitoid species found in agroecosystems (SANTOS, 2022).

Several native fruit tree species cultivated in Southern Brazil are host to flies of the genus *Anastrepha*, mainly those of the family Myrtaceae (GARCIA & NORRBOM, 2011; SANTOS et al., 2018; BOLDO et al., 2019; SANTOS et al., 2022). It is essential to detect and measure fruit fly populations in these hosts to better understand their infestation and parasitism levels (SANTOS et al., 2018; BOLDO et al., 2019). These steps play an essential role in the implementation of biological control techniques (SANTOS et al., 2018). The last surveys on parasitoids associated with *A. fraterculus* in the state of Santa Catarina were carried out in the 1990s (LEONEL JUNIOR et al., 1995; GUIMARÃES et al., 2000; NORA et al., 2000; GARCIA & CORSEUIL, 2004), highlighting the need to conduct new studies on this topic. Thus, this study aimed to evaluate the entomofauna of micro-hymenopteran parasitoids associated with the South American fruit fly, *A. fraterculus*, in native fruit trees in the Alto Vale do Rio do Peixe region (AVRP), state of Santa Catarina, Brazil.

Materials and Methods

This study was carried out from 2015 to 2022, and the harvesting season was from October to April of each year, which corresponds to the period of fruit ripening of native species cultivated in the AVRP region, state of Santa Catarina. The following native fruit trees were assessed: *Eugenia involucrata* DC. (cherry of the Rio Grande), *Eugenia pyriformis* Cambess. ('uvaia'), *Acca sellowiana* (O. Berg.) Burret ('feijoa'); *Psidium cattleianum* Sabine (red and yellow cattley guava), *Campomanesia xanthocarpa* O. Berg. ('guabiroba'); and *Campomanesia guazumifolia* (Cambess.) O. Berg. ('sete capotes') (Table 1). Fruit sampling was carried out in the following municipalities: Caçador; Calmon; Macieira; Matos Costa; Rio das Antas; Videira and Lebon Régis. In Caçador, sampling was carried out from 2015 to 2019; in Calmon, Macieira, Matos Costa, Rio das Antas and Videira, sampling was carried out from 2019 to 2022, and in Lebon Régis, sampling was conducted from 2020 to 2022 (Table 1).

Samples of 200 ripe fruits of each species per municipality were collected in each crop season. The fruits were collected randomly both from the ground and treetops. These plants were not sprayed with pesticides and were located near commercial orchards where *Malus domestica* Borkh. (apple), *Pyrus* spp. (pear), *Prunus persica* L. Batsch (peach), *Prunus domestica* L. (plum) and *Vitis* spp. (grape) are grown. Fruits sampled from the ground and treetops were categorized as single samples and assessed together because they were at the same stage of the ripening.

The native fruit species studied had an intense and short ripening period of about 15 to 20 days. Thus, the samples collected here only included fruits that were fully ripe, i.e., that were most susceptible to fruit fly infestation. The analysis of fruit ripening stage included the following parameters: pulp firmness, measured with a digital motorized penetrometer equipped with a 3mm diameter plunger, and harvest time of each native fruit tree species, established based on data reported in previous surveys conducted in the AVRP region. Changes in fruit epidermis color were also monitored.

The fruits were placed in plastic containers covered with a layer of sterilized sand of approximately 1cm and kept in a room with controlled climatic conditions (25 ± 1ºC; 60 ± 10% relative humidity; 12h photophase) at the Entomology Laboratory of the Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina (Epagri), at the Experimental Station of Caçador "José Oscar Kurtz". After seven, 14 and 21 days of incubation, the sand was examined for puparia counting. Puparia were kept in Petri dishes covered with sterilized sand (substrate) and placed in cages (40.0 x 29.0 x 51.5cm) or in 48 well cell culture plates to favor the emergence of adults.

The emerged fruit fly specimens were stored in plastic vials (50mL) filled with 70% alcohol. They were then identified to the species level according to Zucchi (2000). Parasitoid specimens were identified using specific dichotomous keys described by Canal & Zucchi (2000) and Guimarães et al. (2000).

The parasitism index was determined using the following formula: PI% = (P TA^{-1}) x 100, in which: P = total number of emerged parasitoids and TA = total number of emerged adults (fruit flies + parasitoids). The relative frequency of species, expressed in percentage (%), was calculated by considering the proportion of individuals belonging to the same species and the total number of individuals in the sample.

Faunistic analysis was carried out in

Table 1. Period of fruit collection of native fruit tree species in different municipalities of the Alto Vale do Rio do Peixe region, state of Santa Catarina, Brazil (crop seasons from 2015/2016 to 2021/2022)
Tabela 1. Período de coleta de frutos de frutíferas nativas em diferentes municípios da região do Alto Vale do Rio do Peixe, Santa Catarina, Brasil (safras 2015/2016 a 2021/2022)

Native fruit trees species Municipalities	Crops/fruit collection months						
	2015/2016	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022
Eugenia involucrata (cherry of the Rio Grande)							
Caçador	Oct/2015	Nov/2016	Nov/2017	Nov/2018	-	-	-
Macieira	-	-	-	-	Nov/2019	Oct/2020	Nov/2021
Videira	-	-	-	-	-	Nov/2020	Nov/2021
Campomanesia xanthocarpa ('guabiroba')							
Caçador	Dec/2015	Dec/2016	Dec/2017	Dec/2018	-	-	-
Rio das Antas	-	-	-	-	Dec/2019	Dec/2020	Dec/2021
Macieira	-	-	-	-	Dec/2019	Dec/2020	Dec/2021
Matos Costa	-	-	-	-	Dec/2019	Dec/2020	Dec/2021
Calmon	-	-	-	-	Jan/2020	Dec/2020	Dec/2021
Videira	-	-	-	-	-	Dec/2020	Dec/2021
Lebon Régis	-	-	-	-	-	Dec/2020	Dec/2021
Campomanesia guazumifolia ('sete capotes')							
Videira	-	-	-	-	Feb/2020	Feb/2021	Feb/2022
Eugenia pyriformis ('uvaia')	-	-	-	-			
Caçador	-	-	-	-	Jan/2020	-	-
Macieira	-	-	-	-	Feb/2020	-	-
Calmon	-	-	-	-	Feb/2020	-	-
Videira	-	-	-	-	-	-	Jan/2022
Acca sellowiana ('feijoa')							
Caçador	-	Mar/2017	-	Mar/2019	-	-	-
Videira	-	-	-	-	Feb/2020	Feb/2021	Feb/2022
Lebon Régis	-	-	-	-	-	Feb/2021	Mar/2022
Psidium cattleianum (yellow cattley guava)							
Caçador	Abr/2016	Mar/2017	Feb/2018	Mar/2019	-	-	-
Rio das Antas	-	-	-	-	Feb/2020	Feb/2021	Feb/2022
Macieira					Mar/2020	Feb/2021	Feb/2022
Matos Costa					Mar/2020	-	-
Videira					Mar/2020	-	Feb/2022
Psidium cattleianum (red cattley guava)							
Caçador	Mar/2016	Mar/2017	Feb/2018	Mar/2019	-	-	-
Rio das Antas	-	-	-	-	Mar/2020	Mar/2021	Mar/2022
Matos Costa	-	-	-	-	Mar/2020	Mar/2021	Mar/2022
Videira	-	-	-	-	Mar/2020	Feb/2021	Feb/2022
Lebon Régis	-	-	-	-	-	Mar/2021	-

Dashes (-) represent the crop seasons when no fruits were collected.

The species were divided into the following frequency classes: little frequent (LF) - frequency below the lower limit of the confidence interval (CI) of the mean; frequent (F) - frequency ranging between the lower and upper limits of the CI of the mean; very frequent (VF) - frequency above the upper limit of the CI of the mean.

Constancy rates were classified as follows: constant (W) - higher than the CI limit; accessory (Y) – within the CI; and accidental (Z) - below the lower CI limit.

For dominance, species were classified as follows: super dominant (SD) and dominant (D) - frequency above the dominance limit; and

non-dominant (ND) - frequency below than the dominance limit.

Abundance was divided into the following classes: rare (r) - number of individuals below the lower limit of the CI of the mean; dispersed (d) - number of individuals between the lower and upper limits of the CI of the mean; common (c) - number of individuals between the lower and upper limits of the CI of the mean; abundant (a) - number of individuals meeting the upper limits of the CI of the mean; and very abundant (va) - number of individuals above the upper limit of the CI of the mean.

The researchers responsible for the current study were duly authorized by the Chico Mendes Institute for Biodiversity Conservation (ICMBio) and Authorization and Information System in Biodiversity (SISBIO).

Results and Discussion

In total, 23,709 puparia of *Anastrepha* spp. were observed in this study, of which 7,414 flies of the species *A. fraterculus* emerged. In 355 of these puparia parasitoids emerged. The remaining pupae were unviable. The highest abundance rate of *A. fraterculus* observed among tephritids in the state of Santa Catarina had already been recorded in citrus (GARCIA & LARA, 2006), peach (ALBERTI et al., 2009; GARCIA & NORRBOM, 2011), passion fruit (ALBERTI et al., 2009), pear (ROSA et al., 2017), plum and 'feijoa' (GARCIA & NORRBOM, 2011; ROSA et al., 2017), and apple (SANTOS & GUIMARÃES, 2018).

Seven parasitoid species were recorded, four of which belonged to the family Braconidae (Opiinae): *Doryctobracon brasiliensis* (Szépligeti, 1911); *Doryctobracon areolatus* (Szépligeti, 1911); *Opius* sp. and *Utetes anastrephae* (Viereck, 1913); while three belonged to the family Figitidae (Eucoilinae): *Aganaspis pelleranoi* (Brèthes, 1924); *Aganaspis nordlanderi* Wharton, 1998 and *Odontosema anastrephae* Borgmeier, 1935 (Table 2). The subfamilies Eucoilinae (Figitidae) and Opiinae (Braconidae) included the most representative species used for biological control of tephritids (CANAL & ZUCCHI, 2000; GUIMARÃES et al., 2003; DIAS et al., 2022). The main genus of *Anastrepha* parasitoids observed in the state of Santa Catarina belonged to the families Braconidae, Diapriidae and Figitidae (GARCIA & COURSEUIL, 2004; SANTOS & GUIMARÃES, 2018). Some of the Braconidae species we identified in this work had previously been recorded in association with *Anastrepha* in the state of Santa Catarina, such as: *U. anastrephae* (LEONEL JUNIOR et al., 1995; NORA et al., 1995; NORA et al., 2000; GARCIA & COURSEUIL, 2004); *D. areolatus*, *D. brasiliensis* (LEONEL JUNIOR et al., 1995; NORA et al., 1995; NORA et al., 2000; GARCIA & COURSEUIL, 2004; SANTOS & GUIMARÃES, 2018), and *Opius bellus* Gahan, 1930 (LEONEL JUNIOR et al., 1995; NORA et al., 1995; NORA et al., 2000; GARCIA & COURSEUIL, 2004). According to Canal & Zucchi (2000), *U. anastrephae* was misidentified as *Opius tomopagliae* (Costa Lima, 1937). As a resulted, this species currently lacks records in the state of Santa Catarina.

The following Figitidae species (Eucoilinae) recorded in this study had already been reported in the state of Santa Catarina: *O. anastrephae* (GUIMARÃES et al., 2000; GARCIA & COURSEUIL, 2004); *A. pelleranoi* (GUIMARÃES et al., 2000; NORA et al., 2000; GARCIA & COURSEUIL, 2004; SANTOS & GUIMARÃES, 2018); and *A. nordlanderi* (SANTOS & GUIMARÃES, 2018). Although Garcia and Courseuil (2004) reported *Trichopria anastrephae* Lima, 1940 (Diapriidae) in fruits of *Psidium guajava* L. (guava), this species was not recorded in the present study, probably because it was a not evaluated host.

Of the all parasitoid species recorded in this study, only *A. nordlanderi* had not been recorded in surveys carried out in the state of Santa Catarina in the 1990s. In fact, *A. nordlanderi* was first documented in Southern Brazil in 2015, specifically in Caçador, in the state of Santa Catarina (SANTOS & GUIMARÃES, 2018). In our study, this species was recorded in the municipalities of Caçador and Macieira (Table 2).

Red cattley guava and cherry of the Rio Grande were the hosts harboring the highest number of parasitoid species, comprising six of the seven species recorded here (Table 2). These findings corroborate those reported by Garcia and Corseuil (2004), who found that cattley guava, cherry of the Rio Grande and guava were the hosts harboring the highest number of parasitoid species in *A. fraterculus* in Western Santa Catarina. Nora et al. (1995) recorded parasitoids associated with *A. fraterculus* in fruits of 'feijoa' (*D. areolatus*, *D. brasiliensis*, *O. bellus* and *U. anastrephae*), 'guabiroba' (*D. brasiliensis*, *O. bellus* and *U. anastrephae*), 'sete capotes' (*D. areolatus* and *D. brasiliensis*) and yellow cattley guava (*D. brasiliensis*) in the AVRP region. In the study mentioned above, Eucoilinae (not identified at the species level) was also recorded in fruits of all hosts assessed.

Parasitism rates ranged from 0.2% to 39%, with variations between fruit trees and collection municipalities (Table 2). According to Nora et al. (2000), the level of parasitism in the state of Santa Catarina is variable and influenced by the host plant species in which fruit flies develop. According to Canal and Zucchi (2000), the natural parasitism of fruit flies varies depending on aspects such as host fruit, location and time of collection. However, these rates rarely exceed 50%, which is considered low

Table 2. Parasitoids associated with Anastrepha fraterculus (Diptera: Tephritidae) and parasitism index recorded for native fruit tree species, in the Alto Vale do Rio do Peixe region, state of Santa Catarina, Brazil (crop seasons from 2015/2016 to 2021/2022)
Tabela 2. Parasitoides associados à Anastrepha fraterculus (Diptera: Tephritidae) e índice de parasitismo em frutos de frutíferas nativas, na região do Alto Vale do Rio do Peixe, Santa Catarina, Brasil (safras 2015/2016 a 2021/2022)

Native fruit trees species	Parasitoid Family/Species	Collection Municipality (Parasitism index %)
Psidium cattleianum (red cattley guava)	Figitidae	
	Aganaspis pelleranoi	Caçador (0.2); Rio das Antas (7.2); Videira (4.7); Lebon Régis (1.5)
	Aganaspis nordlanderi	Caçador (0.2)
	Braconidae	
	Doryctobracon brasiliensis	Caçador (7); Videira (1.4); Matos Costa (0.3); Rio das Antas (3); Lebon Régis (2)
	Doryctobracon areolatus	Caçador (4.4); Videira (16.3); Matos Costa (0.3); Lebon Régis (3)
	Utetes anastrephae	Videira (1.5)
	Opius sp.	Rio das Antas (0.4); Videira (4.5)
Psidium cattleianum (yellow cattley guava)	Figitidae	
	Aganaspis pelleranoi	Caçador (2.5); Macieira (23); Rio das Antas (0.8); Videira (2.4)
	Aganaspis nordlanderi	Macieira (9)
	Odontosema anastrephae	Rio das Antas (0.9)
	Braconidae	
	Doryctobracon brasiliensis	Caçador (12); Matos Costa (11.5); Macieira (5)
	Doryctobracon areolatus	Macieira (15); Rio das Antas (2)
Acca sellowiana ('feijoa')	Figitidae	
	Aganaspis pelleranoi	Caçador (4.2)
	Braconidae	
	Doryctobracon brasiliensis	Caçador (4); Videira (1.3)
	Doryctobracon areolatus	Caçador (4.5); Videira (3)
Eugenia involucrata (cherry of the Rio Grande)	Figitidae	
	Aganaspis pelleranoi	Caçador (4); Videira (3.3)
	Aganaspis nordlanderi	Caçador (0.9)
	Odontosema anastrephae	Videira (0.6)
	Braconidae	
	Doryctobracon brasiliensis	Macieira (3.3); Videira (0.8)
	Doryctobracon areolatus	Caçador (5); Macieira (1.2)
	Utetes anastrephae	Caçador (7); Macieira (8); Videira (10)
Campomanesia xanthocarpa ('guabiroba')	Figitidae	
	Aganaspis pelleranoi	Videira (31); Matos Costa (9); Lebon Régis (1)
	Aganaspis nordlanderi	Caçador (6)
	Braconidae	
	Doryctobracon brasiliensis	Calmon (4); Videira (7)
	Utetes anastrephae	Videira (2); Macieira (6); Rio das Antas (39); Lebon Régis (1)
Eugenia pyriformis ('uvaia')	Braconidae	
	Doryctobracon areolatus	Caçador (6)
Campomanesia guazumifolia ('sete capotes')	Figitidae	
	Aganaspis pelleranoi	Videira (0.9)

for integrated pest management programs. According to the authors, natural parasitism can be enhanced by conservation-oriented or applied biological control based on massive releases. According to Nava (2007), several potential species have already been listed for the applied biological control of *A. fraterculus* in the state of Rio Grande do Sul, Brazil. Among them, *Opius* sp., *D. brasiliensis*, *D. areolatus* and *A. pelleranoi* were found to parasitize up to 40% of fruit fly larvae in different orchards.

Of the seven species studied here, *A. pelleranoi* was not associated with 'uvaia'. Therefore, this parasitoid species was recorded in most assessed hosts (Table 2). It was also the most frequent species, accounting for 31.8% of the emerged parasitoids, and was constant, very abundant and dominant in the AVRP region (Table 3). *Aganaspis pelleranoi* was not recorded in Calmon. Moreover, it was a little frequent and had an accidental, dispersed and non-dominant incidence in Macieira. On the other hand, in the other municipalities, it had a frequent or very frequent incidence, was mostly dominant (Table 3). According to Garcia & Corseuil (2004), *A. pelleranoi* was the most frequent species recorded in Western Santa Catarina (25.6%), followed by *D. brasiliensis* (21.1%) and *D. areolatus* (18.6%). These authors observed that cattley guava was a common host for these three parasitoid species, which is in line with the present results.

Utetes anastrephae was the second most frequent species. It was associated with three hosts (Table 2) and accounted for 24% of emerged parasitoids. It was very frequent and had an accessory, abundant and dominant incidence in the AVRP region (Table 3). The species *D. areolatus* and *D. brasiliensis* were associated with five hosts (Table 2) accounting for 18.0% and 21.7% of emerged parasitoids, respectively, and showing frequent, common and dominant incidence in the AVRP region. *Odontosema anastrephae* (1.1%), *A. nordlanderi* (1.4%), and *Opius* sp. (2.0%) were the least frequent species, with an accidental incidence in the AVRP region. *Opius* sp. and *O. anastrephae* were observed only in the cities of Videira and Rio das Antas, while *A. nordlanderi* was recorded in Macieira and Caçador (Table 2). *A. nordlanderi* and *O. anastrephae* had a rare and non-dominant incidence, while *Opius* sp. had a dispersed and dominant incidence (Table 3). Calmon only recorded one parasitoid of the species *D. brasiliensis*; therefore, it was not possible to perform its faunistic analysis.

Since the use of insecticides is increasingly limited, especially in fruits grown for export, it is necessary to find other strategies focused on controlling fruit flies in orchards based on integrated pest management. Thus, studies focused on investigating the diversity of parasitoid species can help the biological control of fruit flies by providing essential information on fruit species that act as hosts for these natural enemies, besides encouraging future studies aimed at applied biological control.

Conclusion

- The parasitoids of the species *A. pelleranoi*, *A. nordlanderi*, *O. anastrephae* (Figitidae), *D. brasiliensis*, *D. areolatus*, *Opius* sp. and *U. anastrephae* (Braconidae) were associated with *A. fraterculus* in fruits from native host trees grown in the Alto Vale do Rio Peixe region, state of Santa Catarina;

- *Aganaspis pelleranoi* was the most frequent species, with a constant, very abundant and dominant incidence;

- The region showed a diversity of parasitoid species, although at low parasitism rates, and it is necessary to conduct new studies focused on investigating conservation-oriented and applied biological control processes.

Acknowledgment

The authors would like to thank the FAPESC (Fundação de Amparo à Pesquisa e Inovação do Estado de Santa Catarina) and CNPq/INCT – HYMPAR (Instituto Nacional de Ciência e Tecnologia dos Hymenoptera Parasitoides) for providing the financial support necessary for the development of the current research.

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Table 3. Faunistic analysis applied to parasitoid species associated with Anastrepha fraterculus (Diptera: Tephritidae) in the Alto Vale do Rio do Peixe region, Santa state of Catarina, Brazil (crop seasons from 2015/2016 to 2021/2022)

Tabela 3. Análise faunística das espécies de parasitoides associadas à Anastrepha fraterculus (Diptera: Tephritidae) na região do Alto Vale do Rio do Peixe, Santa Catarina, Brasil (safras 2015/2016 a 2021/2022)

Collection Municipality	Parasitoid Family/Species	Relative frequency (%)	Classes			
			Frequency[1]	Constancy[2]	Abundance[3]	Dominance[4]
Caçador	Figitidae					
	Aganaspis pelleranoi	32.3	F	Y	c	D
	Aganaspis nordlanderi	4.2	LF	Z	d	ND
	Braconidae					
	Doryctobracon areolatus	15.6	F	Z	c	D
	Doryctobracon brasiliensis	40.6	VF	Z	va	D
	Utetes anastrephae	7.3	F	Z	c	D
Rio das Antas	Figitidae					
	Aganaspis pelleranoi	38.9	VF	Y	va	D
	Odontossema anastrephae	2.8	LF	Z	r	ND
	Braconidae					
	Doryctobracon areolatus	8.3	F	Z	c	ND
	Doryctobracon brasiliensis	13.9	F	Z	c	ND
	Utetes anastrephae	19.4	F	Z	c	D
	Opius sp.	16.7	F	Y	c	D
Videira	Figitidae					
	Aganaspis pelleranoi	36.7	VF	Y	va	D
	Odontossema anastrephae	1.8	LF	Z	d	ND
	Braconidae					
	Doryctobracon areolatus	18.3	F	Z	c	D
	Doryctobracon brasiliensis	7.7	F	Y	c	D
	Utetes anastrephae	34.9	VF	Z	va	D
	Opius sp.	0.6	LF	Z	d	ND
Macieira	Figitidae					
	Aganaspis pelleranoi	8.0	LF	Z	d	ND
	Aganaspis nordlanderi	2.6	LF	Z	r	ND
	Braconidae					
	Doryctobracon areolatus	31.6	F	Y	c	D
	Doryctobracon brasiliensis	28.9	F	Y	c	D
	Utetes anastrephae	28.9	F	Z	c	D
Matos Costa	Figitidae					
	Aganaspis pelleranoi	11.1	F	Y	va	ND
	Braconidae					
	Doryctobracon areolatus	11.1	F	Y	va	ND
	Doryctobracon brasiliensis	77.8	VF	W	va	D
Lebon Régis	Figitidae					
	Aganaspis pelleranoi	33.3	F	Y	c	ND
	Braconidae					
	Doryctobracon areolatus	33.3	F	Z	c	ND
	Doryctobracon brasiliensis	16.7	F	Z	c	ND
	Utetes anastrephae	16.7	F	Z	c	ND
Alto Vale do Rio do Peixe region	Figitidae					
	Aganaspis pelleranoi	31.8	VF	W	va	D
	Aganaspis nordlanderi	1.4	LF	Z	r	ND
	Odontossema anastrephae	1.1	LF	Z	r	ND
	Braconidae					
	Doryctobracon areolatus	18.0	F	Y	c	D
	Doryctobracon brasiliensis	21.7	F	W	c	D
	Utetes anastrephae	24.0	VF	Y	a	D
	Opius sp.	2.0	LF	Z	d	D

1 - Frequency: LF = little frequent; F = frequent; VF= very frequent.

2 - Constancy: Z = accidental; Y = accessory; W = constant.

3 - Abundance: r = rare; d = dispersed; c = common; va = very abundant.

4 - Dominance: ND = non-dominant; D = dominant.

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