Parasitoid diversity (Hymenoptera: Braconidae and Figitidae) on frugivorous larvae (Diptera: Tephritidae and Lonchaeidae) at Adolpho Ducke Forest Reserve, Central Amazon Region, Manaus, Brazil

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(With 2 figures)

Abstract

This study aimed to identify parasitoid species of frugivorous larvae and to describe the tritrophic interactions involving wild fruits, frugivorous insects and their natural enemies at Adolpho Ducke Forest Reserve (RFAD) (Manaus, AM, Brazil). Collections were performed in four 1 km^2 quadrants in the corners of the RFAD. The wild fruits were collected inside the forest in access trails leading to each collection area and in trails that surrounded the quadrants, up to five metres from the trail on each side. The fruits were placed in plastic containers covered with thin fabric, with a vermiculite layer on the base to allow the emergence of flies or parasitoids. Seven Braconidae species were collected, distributed among Opiinae: *Doryctobracon areolatus* (Szépligeti, 1911), *Utetes anastrephae* (Viereck, 1913), and *Opius* sp., and Alysiinae: *Asobara anastrephae* (Muesebeck, 1958), *Phaenocarpa pericarpa* Wharton and Carrejo, 1999, *Idiasta delicata* Papp, 1969, and *Asobara* sp. Parasitism rates by braconids and figitids are presented. *Doryctobracon areolatus* was the most frequent, parasitizing the highest number of fly species, and showing the highest parasitism percentage in larvae feeding on *Micropholis williamii* fruits. The collected figitids belong to *Aganaspis nordlanderi* Wharton, 1998 and *A. pelleranoi* (Brethes, 1924). All 15 tritrophic associations are new records for the Brazilian Amazon region. The RFAD is an important natural reservoir of frugivorous larvae parasitoids.

Keywords: fruit fly, parasitoids, forest reserve, native fruit, Amazon.

Diversidade de Parasitóides (Hymenoptera: Braconidae e Figitidae) de larvas frugívoras (Diptera: Tephritidae e Lonchaeidae) na Reserva Florestal Adolpho Ducke, Amazônia Ocidental, Manaus, Brasil

Resumo

Este trabalho teve por objetivo identificar as espécies de parasitóides de larvas frugívoras e descrever as interações tritróficas desses inimigos naturais com seus insetos hospedeiros e frutos silvestres da Reserva Florestal Adolpho Ducke (RFAD). As coletas foram realizadas em quatro quadrantes de 1 km^2, ocupando áreas próximas aos cantos da RFAD. Os frutos silvestres foram coletados no interior da floresta nas trilhas de acesso a cada área de coleta e nas trilhas que delimitavam os quadrantes, até cinco metros em cada lado. Os frutos foram acondicionados em recipientes plásticos, cobertos com tecido fino, contendo camada de vermiculita, para obtenção das moscas ou dos parasitóides, que eram individualizados, contados, sexados e fixados em álcool 70%. As taxas de parasitismo por braconídeos e figitídeos são apresentadas. Foram coletadas sete espécies de Braconidae, distribuídas em Opiinae: *Doryctobracon areolatus* (Szépligeti, 1911), *Utetes anastrephae* (Viereck, 1913), *Opius* sp. e Alysiinae: *Asobara anastrephae* (Muesebeck, 1958), *Phaenocarpa pericarpa* Wharton e Carrejo, 1999, *Idiasta delicata* Papp, 1969 e *Asobara* sp. *Doryctobracon*

areolatus foi a espécie mais frequente, parasitando o maior número de espécies de moscas e apresentando a maior percentagem de parasitismo em larvas em frutos de *Micropholis williamii.* OS figitídeos pertenciam a *Aganaspis nordlanderi* Wharton, 1998 e *A. pelleranoi* (Brethes, 1924). Todas as 15 associações tritróficas obtidas representam novos registros para a região Amazônica brasileira.

Palavras-chave: moscas-das-frutas, parasitóides, reserva florestal, frutos nativos, Amazônia.

1. Introduction

The deforestation rate in the Amazon Region has been on the rise in recent years, due to the actions of sawmills and the inappropriate use of forest resources by the local population (Fearnside, 2003). Among other implications, deforestation affects the environment and causes biodiversity losses by habitat fragmentations (Myers, 1992), which have a greater impact on parasitoids than on insect hosts (Krues and Tscharntke, 2000). It is estimated that 75% of the insect species in the Brazilian Amazon Rainforest are still unknown, and many species disappear before even being described (J. A. Rafael, pers. info.).

The rapid deforestation of the tropics may cause the extinction of many fruit fly species and consequently of their parasitoids (Aluja et al., 2003). The diversity of fruit hosts of tephritids is relatively high in the Neotropical region; however, there is a lack of biological information on most fruit fly species, as well as on their parasitoids, especially those associated with fruit fly species without significant economic importance (Ovruski et al., 2000).

The necessary information for understanding fruit fly biology, ecology, and evolution must be researched in nearly-unchanged native vegetation areas (Aluja et al., 2003). Studies in these areas are essential for obtaining knowledge of the tritrophic interactions among parasitoids, insect hosts, and associated plants.

In the Brazilian Amazon region, fruit flies have been studied in domestic orchards and agroforestry plantations; however, information on wild fruits is scarce. The availability of host fruits, in addition to the great biodiversity of the Amazon ecosystem, make fruit plants potential infestation sites, since they produce fruits throughout the year (Silva and Ronchi-Teles, 2000).

Twelve plant families have been identified whose fruits are hosts of fruit flies in the State of Amazonas (Silva et al., 1996). Many are still found in their wild state, such as mapati (Moraceae: *Pourouma cecropiaefolia*), camucamu (Myrtaceae: *Myrciaria dubia*), mari (Icacinaceae: *Poraqueiba paraensis*), bacuri (Clusiaceae: *Rheedia brasiliensis*), ice-cream bean (Mimosaceae: *Inga edulis*), bell-apple (Passifloraceae: *Passiflora nitida*), and guava-de-anta (Melastomataceae: *Bellucia grossularioides*) (Silva and Ronchi-Teles, 2000).

Recent research conducted in Mexico and Brazil has shown that the hymenopteran guild of native parasitoids with potential for biological control has been inadequately evaluated because of the emphasis placed on exotic parasitoids (Ovruski et al., 2000). Among native parasitoids, *Doryctobracon areolatus* is the most generalist and most frequently collected in surveys conducted in several Brazilian localities, including those of the Amazon region (Silva, 1993; Canal-Daza, 1993, Ronchi-Teles, 2000; Creão, 2003; Tregue-Costa, 2004). The predominance of *D. areolatus* is related to its effectiveness in locating fruit fly host plants, and to its long ovipositor and capacity to parasitize larvae at their initial stages of development (Matrangolo et al., 1998).

The present study aims to identify parasitoid species of frugivorous larvae and describe the tritrophic interactions of these insects with wild fruits at the Adolpho Ducke reserve.

2. Material and Methods

The study was conducted at Adolpho Ducke Forest Reserve (RFAD), Instituto Nacional de Pesquisas da Amazônia (INPA), located on the AM 010 road, Km 26, northeast of the city of Manaus (02° 53' S and 59° 59' W) (Figure 1a). Despite its proximity to Manaus, the reserve is still almost undisturbed, covered by typical dryland evergreen tropical forest. RFAD has an area of 100 km^2, with a trail network that completely covers the reserve. The mean annual temperature is 26.5 °C, with a monthly mean maximum of 38.6 °C (December) and minimum of 18.2 °C (July). The mean annual relative humidity is 82% (Araújo, 1970). The rainy period extends from November to May, with a perceptible decrease in the other months, markedly in the months of August and September (Marques Filho et al., 1981).

Collections were performed in four 1 km^2 quadrants (Figure 1b). The wild fruits were collected inside the forest on access trails to each collection area and on trails that delimited the quadrants, up to five metres on each side. The mean time required to walk through to each collection area was six hours. Fruits were collected on the ground and/or still hanging from trees and placed in plastic containers to be transported to the laboratory, where the fruits were properly identified and recorded, placed in plastic containers containing a 3.0 cm layer of vermiculite, the containers covered by thin fabric (organza) and maintained at room conditions (mean temperature of 26 °C and RH 80%) in the rearing laboratory. After one week, the vermiculite was sifted (1.5 mm mesh) every five days to separate the puparia, which were maintained

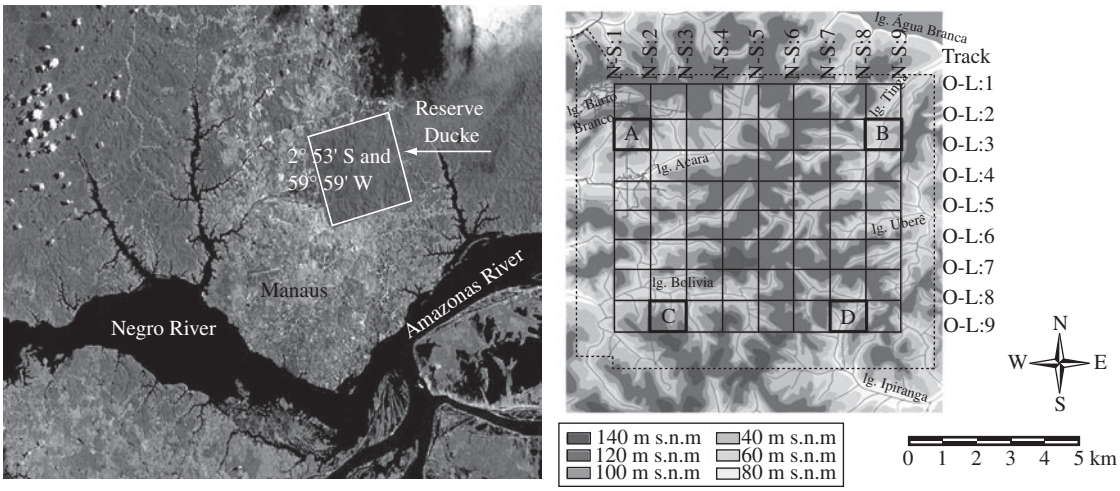

Figure 1. a) Satellite image of the city of Manaus . Detail: Adolpho Ducke Forest Reserve (Source: Inpe 1999); and b) Schematic representation of the reserve topography, indicating four collection areas. A - Acará micro-watershed, B - Tinga micro-watershed, C - Bolivia micro-watershed, D - Ipiranga micro-watershed (adapted from Ribeiro et al., 1999).

in plastic containers with a fine layer of vermiculite to obtain flies or parasitoids. Those were individualized, counted, sexed, and fixed in 70% alcohol. An association between a fly species and a parasitoid species was considered to exist when a single fly species and a single parasitoid species emerged from a given container (Leonel Jr. et al., 1996).

Parasitism percentage calculations were based on Hernández-Ortiz et al. (1994): % parasitism = number of parasitoids emerged/number of puparia obtained x 100.

Braconid identifications were based on Wharton et al. (1997) and Canal-Daza and Zucchi (2000), while figitids were identified based on Guimarães et al. (2003). Plant species were identified using the Ribeiro et al. (1999) guide and, when needed, compared with specimens at the INPA herbarium. The fly and parasitoid voucher specimens are deposited in INPA's Invertebrate Collection.

3. Results

One hundred and eighty-five hymenopteran parasitoid specimens of frugivorous larvae were collected at Adolpho Ducke Forest Reserve (69% Braconidae and 31% Figitidae). The braconids belonged to three species of Opiinae (87%): *Doryctobracon areolatus* (Szépligeti), *Utetes anastrephae* (Viereck), and *Opius* sp., and four species of Alysiinae (13%): *Asobara anastrephae* (Muesebeck), *Phaenocarpa pericarpa* Wharton and Carrejo, 1999, *Idiasta delicata* Papp, 1969, and *Asobara* sp. (Table 1)

Braconidae (Opiinae). As observed in other localities of Brazil (e.g. Canal-Daza and Zucchi, 2000), *D. areolatus* was the most frequent species and parasitized the greatest number of fly species in the reserve: *Anastrepha coronilli* Carrero and Gonzales, *A. bahiensis* Lima, *A. fractura* Stone, and three possibly new species of *Anastrepha* (*Anastrepha* sp.2, *Anastrepha* sp.7, *Anastrepha* sp.8) (Tephritidae) and two species of *Neosilba* currently under description (*Neosilba* sp.1 and *Neosilba* sp.6) (Lonchaeidae). *Opius* sp. occurred in relatively small numbers. A reduced number of this parasitoid had also been observed in the northwestern part of the reserve (Tregue-Costa, 2004). However, in some State of Amazonas countries, *Opius* sp. is as abundant as *D. areolatus* and *Opius bellus* Gahan, 1930 and, in other localities, this species is predominant in rural areas while *D. areolatus* is predominant in urbanized areas (Silva, 1993; Canal-Daza, 1993). There have been questions on whether *Opius* sp. is a new species or an intraspecific variation of *Opius bellus*; nevertheless, molecular studies are underway to clarify the identity of these specimens. *Utetes anastrephae* is recorded for the first time parasitizing *A. bahiensis* Lima, 1937 (Table 1); however, it had been previously recorded in larvae of *A. obliqua* (Macquart, 1835) and of *A. manihoti* Lima, 1934, in the State of Amazonas (Canal-Daza, 1993)

Braconidae (Alysiinae). *Asobara anastrephae* was the most frequent among the alysiines (6% over the total). This is the first record of *A. anastrephae* parasitizing *A. bahiensis* (Table 1). *Phaenocarpa pericarpa* is recorded for the first time in the Amazon region and also associated for the first time with *Neosilba* species (Table 1). The previous record of a species of *Phaenocarpa* in the State of Amazonas represents in fact an identification error of a species of *Asobara* (see Canal-Daza, 1993). *Phaenocarpa pericarpa* had only been previously associated with *A. distincta* Greene, 1934 in Venezuela (Trostle et al., 1999). *Idiasta delicata* is reported for the first time parasitizing frugivorous larvae in Brazil. It was reared from larvae on *Duckeodendro cestroides* fruits; however, it could not be associated with the host species because

Table 1. Hymenopteran parasitoids of frugivorous larvae in wild fruits at Adolpho Ducke Forest Reserve, Manaus, Amazonas, Brazil. January to July 2004.

Parasitoids	Number of specimens	Hosts (Tephritoidea)
Braconidae: Opiinae		
Doryctobracon areolatus	8	*Anastrepha fractura*
Doryctobracon areolatus	1	*Anastrepha* sp.2
Doryctobracon areolatus	1	*Anastrepha* sp.7 and *Anastrepha* sp.8
Doryctobracon areolatus	22	*Anastrepha bahiensis*
Doryctobracon areolatus	1	*Anastrepha coronilli*
Doryctobracon areolatus	23	*Anastrepha* sp.*
Doryctobracon areolatus	2	*Neosilba* sp.1
Doryctobracon areolatus	2	*Neosilba* sp.6
Doryctobracon areolatus	30	no association with a host
Utetes anastrephae	2	*Anastrepha bahiensis*
Utetes anastrephae	9	no association with a host
Opius sp.	10	no association with a host
Braconidae: Alysiinae		
Asobara anastrephae	7	*Anastrepha bahiensis*
Asobara anastrephae	1	no association with a host
Phaenocarpa pericarpa	1	*Neosilba* sp.5 e *Neosilba* sp.1
Phaenocarpa pericarpa	4	no association with a host
Idiasta delicata	2	no association with a host
Figitidae: Eucoilinae		
Aganaspis nordlanderi	2	*Anastrepha* sp.4
Aganaspis nordlanderi	6	*Anastrepha fractura*
Aganaspis nordlanderi	23	no association with a host
Aganaspis nordlanderi	1	*Neosilba* sp.1
Aganaspis pelleranoi	3	*Anastrepha fractura*
Aganaspis pelleranoi	19	no association with a host

* Male *Anastrepha* specimen.

both tephritids and lonchaeids emerged from the same rearing container. Previously, only a record has existed for an unidentified *Idiasta* species parasitizing a frugivorous larva in Venezuela (Ovruski et al., 2000).

Figitidae. *Aganaspis nordlanderi* Wharton, 1998 emerged from *A. fractura* puparia (first record) and from other host species not yet described (*Anastrepha* sp.4 and *Neosilba* sp.1). *Aganaspis pelleranoi* (Brethes, 1924) parasitized only *A. fractura* (first record) (Table 1).

3.1. Parasitism of frugivorous larvae

The general parasitism percentage on frugivorous larvae was extremely variable in the reserve: 66.67% in fruits of *Micropholis williamii* and 0.93% on *Duckeodendron cestroides* (Table 2). In four State of Amazonas countries, parasitism values also varied considerably (0.03 to 23.41%) (Canal-Daza, 1993). Great variations in parasitism percentages were also observed in reserves in Mexico (Hernández-Ortiz et al.,1994; Aluja et al., 2003). These variations, in addition to intrinsic host fruit traits (Sivinski, 1991), are also a result of peculiarities of each region (Sivinski et al., 2000).

Doryctobracon areolatus had the highest parasitism percentage (66.7%) on larvae in *M. williamii* fruits (Table 3), while in other opiines parasitism rates were: *Opius* sp. (1.63 to 3.10%) and *U. anastrephae* (4.97%) on *A. edentula*. In other localities in the State of Amazonas, *Opius* sp. has shown higher parasitism percentages, but with quite variable values (0.04%) on *Mangifera indica* (mango) and 33.3% on *Platonia insignis* (bacuri) (Canal-Daza, 1993). Among the Alysiinae, the highest parasitism percentage occurred with *P. pericarpa* on *Eschweilera atropetiolata* (Table 3).

The highest parasitism percentage by figitids was observed for *A. pelleranoi* (20%) on *O. platyspermum* fruits. These are the first data on parasitism percentages of eucoilines in the State of Amazonas (Table 3).

Table 2. Total parasitism percentage of frugivorous larvae in wild fruits at Adolpho Ducke Forest Reserve, Manaus, Amazonas, Brazil. January to July 2004.

Native host fruits		Number of puparia	Number of parasitoids	Parasitism (%)
Families	Species			
Annonaceae	*Guatteria discolor*	82	2	2.44
Duckeodendraceae	*Duckeodendro cestroides*	216	2	0.93
Lecythidaceae	*Eschweilera atropetiolata*	44	7	15.91
Leguminosae:Papilionoideae	*Dipterix odorata*	61	3	4.92
Melastomataceae	*Bellucia dicotoma*	17	1	5.88
Moraceae	*Maquira esclerofila*	306	66	21.57
Sapotaceae	*Micropholis williamii*	3	2	66.67
Siparunaceae	*Siparuna guianensis*	56	3	5.36
Ulmaceae	*Ampelocera edentula*	161	83	51.55

Table 3. Parasitism percentage of parasitoids in frugivorous larvae in wild fruits at Adolpho Ducke Forest Reserve, Manaus, Amazonas, Brazil. January to July 2004.

Native plant species	Braconidae[1]						Figitidae[2]	
	Da	O	Ua	Aa	Pp	Id	An	Ap
Guatteria discolor	2.44	-	-	-	-	-	-	-
Duckeodendro cestroides	-	-	-	0.46	-	0.46	-	-
Eschweilera atropetiolata	-	-	-	-	15.9	-	-	-
Dipterix odorata	-	-	-	-	-	-	-	4.92
Bellucia dichotoma	5.88	-	-	-	-	-	-	-
Maquira esclerofila	6.86	1.63	-	0.33	-	-	2.29	4.25
Osteophloeum platyspermum	-	-	-	-	-	-	-	20
Micropholis williamii	66.67	-	-	-	-	-	-	-
Siparuna guianensis	-	-	-	-	-	-	3.57	1.79
Ampelocera edentula	35.4	3.1	4.97	7.45	-	-	-	0.62

[1]Da = *Doryctobracon areolatus*; O = *Opius* sp.; Ua = *Utetes anastrephae;* Aa = *Asobara anastrephae*; Pp = *Phaenocarpa pericarpa*; Id = *Idiasta delicata*; [2]An = *Aganaspis nordlanderi;* and Ap = *Aganaspis pelleranoi.*

3.2. Tritrophic interactions

Braconids and figitids parasitized insect host families larvae with practically the same frequencies (around 90% on tephritids and 7 and 8%, respectively, on lonchaeids). This is the first record of parasitoids of Lonchaeidae frugivorous larvae in the Brazilian Amazon region.

The parasitoids developed in frugivorous larvae associated with eight species of fruit trees in nine plant families (Table 4). Braconids were attracted by representatives of seven plant families, demonstrating that this is a key group of frugivorous larvae parasitoids (Figure 2).

This is the first record of *D. areolatus* parasitism on *Anastrepha* spp. larvae on *Guatteria discolor* (Annonaceae), *Ampelocera edentula* (Ulmaceae), *Maquira esclerofila* (Moraceae), and *Bellucia dichotoma* (Melastomataceae) fruits. It is also the first record of *D. areolatus* on *M. williamii* (Sapotaceae) and *A. edentula* (Ulmaceae) fruits infested with two undescribed *Neosilba* species. At RFAD, *D. areolatus* also parasitizes *A. bahiensis* larvae on *Helycostylis tomentosa* (Moraceae) and *A. coronilli* larvae on *Bellucia grossularioides* (Melastomataceae) (Tregue-Costa, 2004).

Among the species of Alysiinae, only *Asobara anastrephae* could be associated with *Anastrepha bahiensis* in fruits of *Ampelocera edentula* (Table 4). *Phaenocarpa pericarpa* was obtained from *Neosilba* spp. larvae in *E. atropetiolata* fruits (Lecythidaceae) (Table 4).

In this study, five new records of figitids were obtained in frugivorous larvae associated with five fruit species: *Aganaspis nordlanderi* in larvae of *Anastrepha* sp.4 in fruits of *Siparuna guianensis* (Siparunaceae); in larvae of *Anastrepha* sp.6 in fruits of *M. esclerofila* (Moraceae); and in larvae of *Neosilba* sp.1 in fruits of Sapotaceae. According to Tregue-Costa (2004), at RFDA *Aganaspis pelleranoi* parasitizes larvae of *Anastrepha* sp.6 in fruits of *M. esclerofila* (Moraceae). *Aganaspis nordlanderi*

Table 4. Tritrophic relation between host fruits, frugivorous larvae, and their parasitoids at Adolpho Ducke Forest Reserve, Manaus, Amazonas, Brazil. January to July 2004.

Host Fruits		Frugivorous larvae	N	Parasitoids	N
Families	**Species**	**Tephritidae/ Lonchaeaidae**		**Braconidae/Figitidae**	
Annonaceae	*Guatteria discolor*	*Anastrepha* sp.*	2	*Doryctobracon areolatus*	2
Lecythidaceae	*Eschweilera atropetiolata*	*Neosilba* sp.5 and *Neosilba* sp.1	2	*Phaenocarpa pericarpa*	1
Melastomataceae	*Bellucia dichotoma*	*Anastrepha coronilli*	7	*Doryctobracon areolatus*	1
Moraceae	*Maquira esclerofila*	*Anastrepha fractura*	32	*Aganaspis nordlanderi*	6
			-	*Aganaspis pelleranoi*	3
			-	*Doryctobracon areolatus*	8
Sapotaceae	-	*Neosilba* sp.1	1	*Aganaspis nordlanderi*	1
	Micropholis williamii	*Neosilba* sp.1	1	*Doryctobracon areolatus*	2
Siparunaceae	*Siparuna guianensis*	*Anastrepha* sp.4	2	*Aganaspis nordlanderi*	2
Ulmaceae	*Ampelocera edentula*	*Anastrepha bahiensis*	12	*Asobara anastrephae*	5
			-	*Utetes anastrephae*	2
			-	*Doryctobracon areolatus*	17
			-	*Asobara anastrephae*	2
Ulmaceae	*Ampelocera edentula*	*Anastrepha* sp.7 and *Anastrepha* sp.8	2	*Doryctobracon areolatus*	1
		Anastrepha bahiensis	2	*Doryctobracon areolatus*	2
		Anastrepha bahiensis	4	*Doryctobracon areolatus*	3
		Anastrrepha sp.*	7	*Doryctobracon areolatus*	19
		Neosilba sp.6	1	*Doryctobracon areolatus*	2

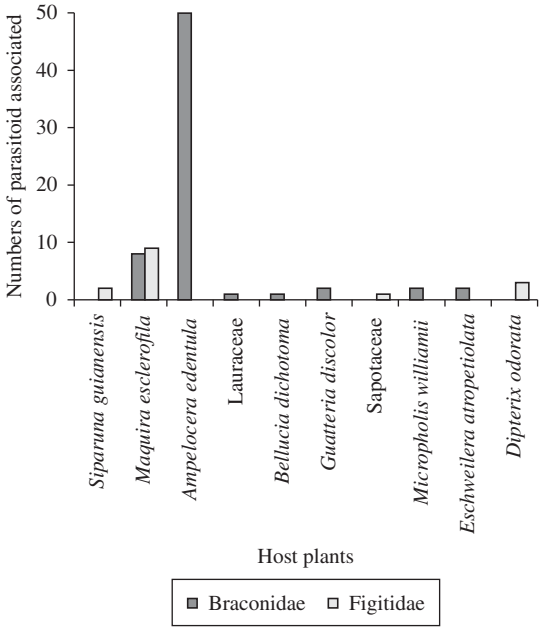

Figure 2. Number of parasitoids (Braconidae and Figitidae) on frugivorous larvae (Tephritoidea) associated with fruits at Adolpho Ducke Forest Reserve, Manaus, Amazonas, Brazil. January to July 2004.

developed in larvae of *Anastrepha coronilli* in *B. grossularioides* fruits; *Aganaspis pelleranoi* developed in larvae of *Anastrepha obliqua* in *Eugenia patrisii* (Myrtaceae), and in larvae of *Anastrepha atrigona* in *Pouteria durlandii* (Sapotaceae) fruits (Table 4).

4. Discussion

From 17 species of *Anastrepha* parasitoids recorded in Brazil (Ovruski et al., 2000), seven species occur at RFAD, that is, approximately one half of the species already recorded in the country.

Collections in areas with undisturbed native vegetation like RFAD allowed the discovery of rather uncommon fruit fly parasitoids, such as *Phaenocarpa pericarpa* and *Idiasta delicata*. New associations among parasitoids, flies, and wild fruits could also be determined (Table 4).

Knowledge of these interactions are relevant for the management of economically important flies, since they can aid the conservation of native parasitoids. Wild fruits from the Amazon region are commonly used by the local population, and the production of some of them is under expansion. Such diversity of fruits also reflects on their great potential as hosts for frugivorous insects. Of the 176 species of fruits known in the Brazilian Amazon region, one half occurs in wild environments, which

constitute natural fruit fly repositories, particularly for *Anastrepha* species (Silva, 1993).

The results obtained in this work demonstrate that *D. areolatus* parasitizes larvae in a range of wild hosts, and consequently has potential to maintain the balance of fruit fly populations in the reserve.

Aganaspis species also have a generalist behavior in the State of Amazonas, as previously observed in other states of Brazil (Guimarães et al., 2000). Probably, due to its behavior of penetrating the fruit (Ovruski, 1994; Guimarães et al., 2003), *A. pelleranoi* was more effective than the braconids in parasitizing larvae in *Siparuna guianensis* and *Dipterix odorata* fruits, which have a thick pulp, making it difficult for braconids to oviposit.

The combined effect of braconids and figitids on frugivorous insect populations may play an important role as natural enemies of fruit flies; however, the limited knowledge and scarcity of basic studies makes harder the use of these parasitoids in management programmes (Guimarães et al., 2000).

Fruit fly natural parasitism is quite variable and is affected by host fruit and host fly traits; its study is affected by collection location and timing (Canal-Daza and Zucchi, 2000). However, it is known that larvae living in relatively small fruits, with a thin pericarp and mesocarp, suffer relatively more parasitism (e.g. Hernándes-Ortiz et al., 1994). In this study, the highest parasitism percentages, as well as the greatest diversity of parasitoids were found in *Maquira esclerofila* and *Ampelocera edentula fruits*, which share these characteristics. In addition to fruit rind and pulp thickness, the length of the parasitoid ovipositor and size of the fly larva are factors that influence parasitism (Sivinski, 1991).

The larvae found in *Micropholis williamii* fruits showed a high parasitism percentage (66.67%); however, only five puparia were obtained from this host. The occurrence of several parasitoid species in the same fruit affects their spatial and temporal distribution, due to interspecific competition (Sivinski et al., 1997).

Nine parasitoid species were found at RFAD, and all 15 tritrophic associations observed are new records for the Brazilian Amazon region. Therefore, this reserve is a reference locality and important natural reservoir of Amazonian frugivorous larva parasitoids.

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