Diversity and seasonality of fruit flies (Diptera: Tephritidae and Lonchaeidae) and their parasitoids (Hymenoptera: Braconidae and Figitidae) in orchards of guava, loquat and peach

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Received April 10, 2007 – Accepted June 29, 2007 – Distributed February 38, 2009

(With 3 figures)

Abstract

This work was carried out in orchards of guava progenies, and loquat and peach cultivars, in Monte Alegre do Sul, SP, Brazil, in 2002 and 2003. Guavas and loquats were bagged and unbagged bi-weekly and weekly, respectively, for assessment of the infestation period. Peach was only bagged weekly. The assays started when the fruits were at the beginning of development, but still green. Ripe fruits were taken to the laboratory and placed individually into plastic cups. McPhail plastic traps containing torula yeast were hung from January 2002 to January 2004 to assess the fruit fly population in each orchard, but only the *Ceratitis capitata* population is here discussed. Five tephritid species were reared from the fruits: *Anastrepha bistrigata* Bezzi, *A. fraterculus* (Wiedemann), *A. obliqua* (Macquart), *A. sororcula* Zucchi, and *C. capitata*, in addition to six lonchaeid species: *Neosilba certa* (Walker), *N. glaberrima* (Wiedemann), *N. pendula* (Bezzi), *N. zadolicha* McAlpine and Steyskal, *Neosilba* sp. 4, and *Neosilba* sp. 10 (both species are in the process of being described by P. C. Strikis), as well as some unidentified *Neosilba* species. Ten parasitoid species were obtained from fruit fly puparia, of which five were braconids: *Asobara anastrephae* (Muesebeck), *Doryctobracon areolatus* (Szépligeti), *D. brasiliensis* (Szépligeti), *Opius bellus* Gahan, and *Utetes anastrephae* (Viereck), and five figitids: *Aganaspis pelleranoi* (Brèthes), *Diceratapsis grenadensis* Ashmead, *Lopheucoila anastrephae* (Rhower), *Leptopilina boulardi* (Barbotin, Carlton and Kelner-Pillaut), and *Trybliographa infuscata* Diaz, Gallardo and Uchôa. *Ceratitis capitata* showed a seasonal behavior with population density peaking at the second semester of each year. *Anastrepha* and Neosilba species remained in the orchards throughout both years.

Keywords: Anastrepha, Ceratitis capitata, Neosilba, host succession, biological control.

Diversidade e variação sazonal de moscas-das-frutas (Diptera: Tephritidae, Lonchaeidae) e seus parasitóides (Hymenoptera: Braconidae, Figitidae) em pomares de goiaba, nêspera e pêssego

Resumo

Este trabalho foi realizado em três pomares em Monte Alegre do Sul, SP, em 2002 e 2003, representados por coleção de progênies de goiabeiras, de cultivares de nespereiras e de cultivares de pessegueiros. O período de infestação foi determinado por meio de ensacamento e desensacamento quinzenal e semanal de goiabas e nêsperas, respectivamente, e pelo ensacamento semanal de pêssegos. Os ensaios iniciaram-se com os frutos verdes (princípio de desenvolvimento). Os frutos maduros foram levados ao laboratório e acondicionados individualmente em copos plásticos. A flutuação populacional de *Ceratitis capitata* (Wiedemann) foi avaliada por meio de armadilhas plásticas modelo McPhail

com torula em cada pomar, de janeiro/2002 a janeiro/2004. Dos frutos foram obtidas cinco espécies de tefritídeos: *Anastrepha bistrigata* Bezzi, *A. fraterculus* (Wiedemann), *A. obliqua* (Macquart), *A. sororcula* Zucchi e *C. capitata* e seis de lonqueídeos: *Neosilba certa* (Walker), *N. glaberrima* (Wiedemann), *N. pendula* (Bezzi), *N. zadolicha* McAlpine and Steyskal, *Neosilba* sp. 4 e *Neosilba* sp. 10, além de algumas espécies não-identificadas. Foram obtidas 10 espécies de parasitóides, cinco da família Braconidae – *Asobara anastrephae* (Muesebeck), *Doryctobracon areolatus* (Szépligeti), *D. brasiliensis* (Szépligeti), *Opius bellus* Gahan e *Utetes anastrephae* (Viereck) – e cinco da família Figitidae – *Aganaspis pelleranoi* (Brèthes), *Diceratospis grenadensis* Ashmead, *Lopheucoila anastrephae* (Rhower), *Leptopilina boulardi* (Barbotin, Carlton and Kelner-Pillaut) e *Trybliographa infuscata* Diaz, Gallardo and Uchôa. *Ceratitis capitata* apresentou comportamento sazonal com picos populacionais durante o segundo semestre dos dois anos. As espécies de *Anastrepha* e de Neosilba permaneceram nos pomares durante os dois anos.

Palavras-chave: Anastrepha, *Ceratitis capitata*, *Neosilba*, sucessão de hospedeiros, controle biológico.

1. Introduction

Plant susceptibility to insects depends on the phenological synchrony between both. In turn, a suitable plant for the development of an insect population can often escape herbivory because the insect seasonality does not coincide with the plant susceptible stage (Messina and Jones, 1990).

Knowledge about fruit fly species and their respective seasonalities related to host plant phenology is crucial to understand the population dynamics of these insects. Fruit infestation is influenced by its degree of maturation during the fruit fly oviposition period (Messina and Jones, 1990). Foraging differences can be observed, as fruit flies make incursions into fruits of a certain developmental stage. Such information can be obtained by bagging and unbagging fruits throughout their development (Dias and Vásquez, 1993).

Tephritidae and Lonchaeidae representatives present a broad array of fly species whose larvae use the pulp of fruits or even other plant tissues as substrate for their development. However, because tephritids have a higher number of species of economic importance, they are more frequently studied worldwide (Aluja and Norrbom, 2000).

In Brazil, the fruit fly species of economic importance consist basically of some *Anastrepha* species and *Ceratitis capitata* (Wiedemann). In addition to these tephritids, some lonchaeid species have also been considered primary pests in Brazil (Lourenção et al., 1996; Araujo and Zucchi, 2002; Souza-Filho et al., 2002; Uchôa-Fernandes et al., 2003; Aguiar-Menezes et al., 2004; Raga et al., 2004; Souza et al., 2005).

Fruit flies are considered key pests in guava (Gould and Raga, 2002). Ten species are associated with guava in Brazil – *A. antunesi* Costa Lima, *A. bahiensis* Costa Lima, *A. bistrigata* Bezzi, *A. fraterculus* (Wiedemann), *A. leptozona* Hendel, *A. obliqua* (Macquart), *A. sororcula* Zucchi, *A. striata* Schiner, *A. turpiniae* Stone, and *A. zenildae* Zucchi, in addition to *C. capitata* (Malavasi et al., 1980; Souza-Filho, 1999; Araujo and Zucchi, 2003). Five fruit fly species are associated with loquat in Brazil - *A. fraterculus*, *A. obliqua*, *A. sororcula*, *A. turpiniae*, and *C. capitata* (Salles, 1995; Aguiar-Menezes and Menezes, 1996; Souza-Filho, 1999). The fruit flies associated with peach in Brazil belong to four species - *A. fraterculus*, *A. sororcula*, *A. turpiniae* and *C. capitata* (Malavasi et al., 1980; Veloso, 1997; Souza-Filho, 1999). Considering these hosts, *Anastrepha fraterculus* is more important in the states of Rio Grande do Sul, Santa Catarina, and Paraná (Salles, 1998), while *C. capitata* is more important in the State of São Paulo (Souza-Filho, 1999).

The objective of this study was to verify whether fruit flies present seasonality in three contiguous orchards, relating these data to host phenology and to parasitoids.

2. Material and Methods

The study was conducted at the experiment station of the Pólo Regional de Desenvolvimento Tecnológico dos Agronegócios do Leste Paulista/Agência Paulista de Tecnologia dos Agronegócios (PRDTALP/APTA), during 2002 and 2003, in Monte Alegre do Sul, SP (22° 40' 50" S and 46° 40' 45" W; 760 m). The experiments were carried out in three orchards: a collection of guava progenies (*Psidium guajava* L.); a collection of loquat cultivars [*Eriobotrya japonica* (Thunb.) Lindl.]; and a collection of peach [*Prunus persica* (L.) Batsch] and nectarine (*P. persica* var. *nucipersica*) cultivars. No phytosanitary treatments were performed in the orchards during the assays.

2.1. Fruit fly infestation period determination

In each assay, we used three guava progenies (Guanabara, L_7P_{28}, and 252), two loquat cultivars (Campinas Early and 264-54 Early), and three peach cultivars (Aurora 2, Dourado 1, and Régis), as a measure of plant uniformity. These progenies and cultivars will be referred to by their respective common names throughout the text.

Guava: The first assay began on 11/01/2002, when the fruits of progenies Guanabara and L_7P_{28} showed mean diameters of 2.8 and 2.3 cm, respectively. The second assay began on 27/12/2002, when the fruits of progenies Guanabara and 252 showed mean diameters of 2.4 and 2.3 cm, respectively. A total of 500 guavas of each progeny were protected with small wax-coated, pleated paper bags (19.5 x 11 cm). Such large amount of bagged fruits was used to ensure the unbagging of ripe fruits. Every other week, 30 guavas (60 per evaluation) were bagged

and unbagged, and tied with color-coded strings to allow the identification of each activity by date. In addition to these identified fruits, another 30 fruits of each progeny were selected, remaining completely free from bagging, as well as 30 fruits of each progeny which remained bagged since the beginning of each assay. The number of studied fruits was not equal to the total number of marked fruits, due to losses to diseases or premature shedding. The fruits were taken to the laboratory and placed individually in 500 mL capacity plastic pots containing sand + vermiculite covered with voile fabric held in place with elastic tape. Each fruit remained in the plastic pot for approximately 20 days until the emergence of flies and/or parasitoids. The emerged insects were counted, sexed (flies only) and maintained in properly labeled vials containing 70% alcohol, for subsequent identification.

Loquat: The assay began on 29/07/2002, when the fruits of cultivars IAC-Campinas Early and 264-54 Early showed mean diameters of 1.2 and 1.1 cm, respectively. The 2003 assay began on 29/07, when fruits of the Campinas Early cultivar showed a mean diameter of 2 cm. Four hundred and 300 loquats were bagged and unbagged weekly in 2002 and 2003, respectively. Thinning was done during bagging, leaving 3 to 6 fruits in each bunch. All other procedures were identical to the guava assays; however, 250 mL capacity plastic pots were used.

Peach: The assay began on 19/08/2002, when the cultivars Aurora 2 and Dourado 1 peaches showed mean diameters of 2 and 2.1 cm, respectively. In 2003, the assay began on 12/08, when the cultivar Régis fruits showed a mean diameter of 1.9 cm. Bagging was only performed weekly, in view of the reduced number of plants per cultivar and low production of fruits. The other procedures were identical to those carried out for guavas, except for the quantity of selected fruits, i.e., 30 fruits were kept without bagging.

2.2. Identification of fruit fly and parasitoid species

The term "fruit fly" is herein employed both for Tephritidae and Lonchaeidae specimens, whose larvae are frugivorous as well. Fly identifications were based on Zucchi (2000) for *Anastrepha* species and on McAlpine and Steyskal (1982) for *Neosilba* species. As *fraterculus* complex is formed by several cryptic species (Hernández-Ortiz et al., 2004; Selivon et al., 2005), the name *A. fraterculus* is being used herein in its sensu lato. Parasitoid identifications were based on Canal and Zucchi (2000) for braconids and on Guimarães et al. (2000, 2003) for figitids. Voucher specimens were deposited in the collection of the Instituto Biológico. *Ceratitis capitata* is the unique species of the genus reported in Brazil.

2.3. C. capitata population fluctuation

Three McPhail-type plastic traps containing torula yeast were hung in each orchard, from 04/01/2002 to 16/01/2004 and they were checked weekly. Tephritids and lonchaeids were separated, counted in the laboratory, and transferred to labeled glass vials containing 70% alcohol, for identification. *Anastrepha* species were not identified because of the huge number of specimens collected (more than 90 thousand). *Ceratitis capitata* population levels in each orchard were estimated based on the number of individuals captured weekly (males and females), transformed to number of flies captured/trap/day (FTD).

3. Results and Discussion

3.1. Fruit flies

The diversity of flies in guava, loquat, and peach in Monte Alegre do Sul, SP in 2002 and 2003 consisted of Tephritidae and Lonchaeidae representatives (11 species and four genera) (Table 1).

Five species of Tephritidae were collected: *A. bistrigata* Bezzi, *A. fraterculus* (Wiedemann), *A. obliqua* (Macquart), *A. sororcula* Zucchi, and *Ceratitis capitata* (Wiedemann). *Anastrepha* species occurred in guava in 2002 and 2003, but *C. capitata* was not reared from this host. Only *A. fraterculus* and *C. capitata* occurred in loquat, in both years of studies. In peach, *A. fraterculus* and *C. capitata* infestations also occurred in 2002. In 2003, besides these two species, *A. obliqua* also occurred (Table 1). *Anastrepha fraterculus* and *C. capitata* are extremely generalist with regard to host exploitation and are the species with the greatest economic importance in Brazil (e.g. Zucchi, 2000).

Guava presented the greatest tephritid species diversity, confirming its condition of host with the highest number of fruit fly species in Brazil (Malavasi et al., 1980; Silva et al., 1996; Veloso, 1997; Souza-Filho, 1999). *Anastrepha bistrigata* is commonly associated with Myrtaceae in the genus *Psidium*, while *A. sororcula*, although generalist, infests preferentially Myrtaceae fruits (Norrbom and Kim, 1988).

Among lonchaeids, *Neosilba* species were the most numerous. Four species were identified: *N. certa* (Walker), *N. glaberrima* (Wiedemann), *N. pendula* (Bezzi), *N. zadolicha* McAlpine and Steyskal, besides two species still being described - *Neosilba* sp. 4 and *Neosilba* sp. 10 and other unidentified species (*Neosilba* spp.). Only *N. certa* occurred in the three hosts in both years of study. *Neosilba* sp. 4 and *Neosilba* sp. 10 only occurred in peach and guava, respectively. Occurrence of the other species varied with regard to the exploitation of fruits in both years; nevertheless, polyphagy was also observed (Table 1).

Recently Souza et al. (2005) reported *N. certa*, *N. glaberrima*, *N. pendula*, and *Neosilba* sp. 10 infesting arabica coffee in Valença, RJ. So, probably the coffee growing areas around the three orchards are important as repositories for lonchaeid host succession. *Neosilba pendula* is a primary acerola invader in the Mossoró, RN region; but it is a polyphagous species as it infests another seven species of fruits, including guava (Araujo and

Table 1. Seasonal variation in fly (Tephritidae and Lonchaeidae) and parasitoid diversity (Braconidae and Figitidae) in guava, loquat, and peach in Monte Alegre do Sul, SP, 2002-2003.

Fruit flies	**2002**			**2003**		
	Feb.-Apr.	**Sept.**	**Sept.-Oct.**	**Feb. - Apr.**	**Aug.-Sept.**	**Sep.-Nov.**
	Guava	**Loquat**	**Peach**	**Guava**	**Loquat**	**Peach**
TEPHRITIDAE						
A. bistrigata	✓	-	-	✓	-	-
A. fraterculus	✓	✓	✓	✓	✓	✓
A. obliqua	✓	-	-	✓	-	✓
A. sororcula	✓	-	-	✓	-	-
C. capitata	-	✓	✓	-	✓	✓
LONCHAEIDAE						
Neosilba spp.	✓	✓	✓	✓	✓	✓
N. certa	✓	✓	✓	✓	✓	✓
N. glaberrima	✓	-	-	✓	-	✓
N. pendula	✓	-	✓	✓	✓	✓
N. zadolicha	✓	✓	✓	✓	-	✓
Neosilba sp. 4	-	-	✓	-	-	✓
Neosilba sp. 10	✓	-	-	-	-	-
Lonchaea spp.	✓	-	-	-	-	✓
Parasitoids	**Guava**	**Loquat**	**Peach**	**Guava**	**Loquat**	**Peach**
BRACONIDAE						
A. anastrephae	-	-	-	✓	-	-
D. areolatus	✓	-	✓	✓	-	✓
D. brasiliensis	✓	-	✓	✓	-	✓
Opius bellus	-	-	✓	-	-	-
U. anastrephae	-	-	✓	-	-	-
FIGITIDAE						
A. pelleranoi	-	-	-	✓	-	-
D. grenadensis[1]	-	-	-	✓	-	-
L. anastrephae	✓	-	-	✓	-	-
L. boulardi[1]	-	-	-	✓	-	-
T. infuscata	-	-	-	✓	-	-

[1]Parasitoids associated with Drosophilidae.

Zucchi, 2002). *Neosilba zadolicha* is also polyphagous and has a great niche exploitation capacity, as it has been observed attacking *Spondias* sp. fruits (Anacardiaceae) and passion fruit vine flower buds and fruits (Uchôa-Fernandes et al., 2002; Aguiar-Menezes et al., 2004; Santos et al., 2004).

The genus Lonchaea Fallén was represented by a reduced number of unidentified specimens, obtained from guava and peach (Table 1). On the latter host, a record exists for *L. chalybea* Wiedemann and for another unidentified species in the State of Paraná (Fehn, 1981).

3.2. Relation between tephritids x hosts

Due to the proximity between the guava, loquat, and peach orchards, we could establish the distribution of fruit fly species in shared fruits with time, by means of fruit bagging (Figures 1 and 2). Loquat has two fruiting periods per year; however, the infestation studies were conducted in the second fruiting period, in the second semester of 2002 and 2003.

Anastrepha fraterculus in guava showed a population increase tendency in March, when full fruits were completely ripe, and another tendency of increase starting in August and continuing until September, comprising the loquat and peach fruiting periods (Figures 1 and 2). In another county of the State of São Paulo, *A. fraterculus* adult population peak occurred only in the end of the host fruit season (Malavasi and Morgante, 1981). In the State of Rio de Janeiro, *A. fraterculus* also has two population peaks, from March to April and from September (Aguiar-Menezes and Menezes, 1996). According to all these data, *A. fraterculus* population peaks is influenced by the host fruiting periods.

The population of *A. obliqua* occurred at the guava fruiting season (March) and again in September, coming

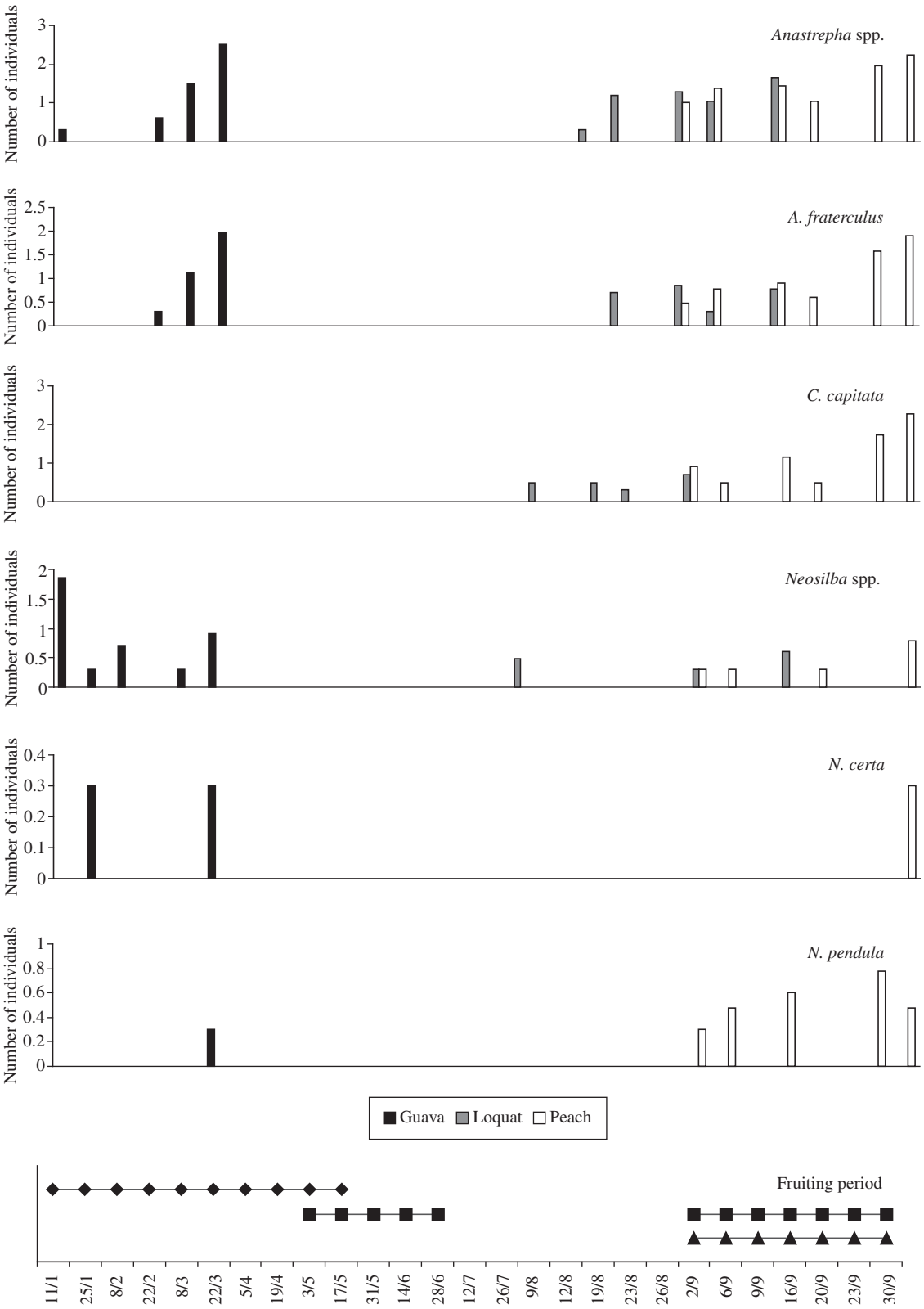

Figure 1. Fly seasonality in guava (lozenge), loquat (square), and peach (triangle), related to the period of exposure of fruits after bagging, in Monte Alegre do Sul, SP, 2002. Fly numbers were transformed to Log_{10} (n+1).

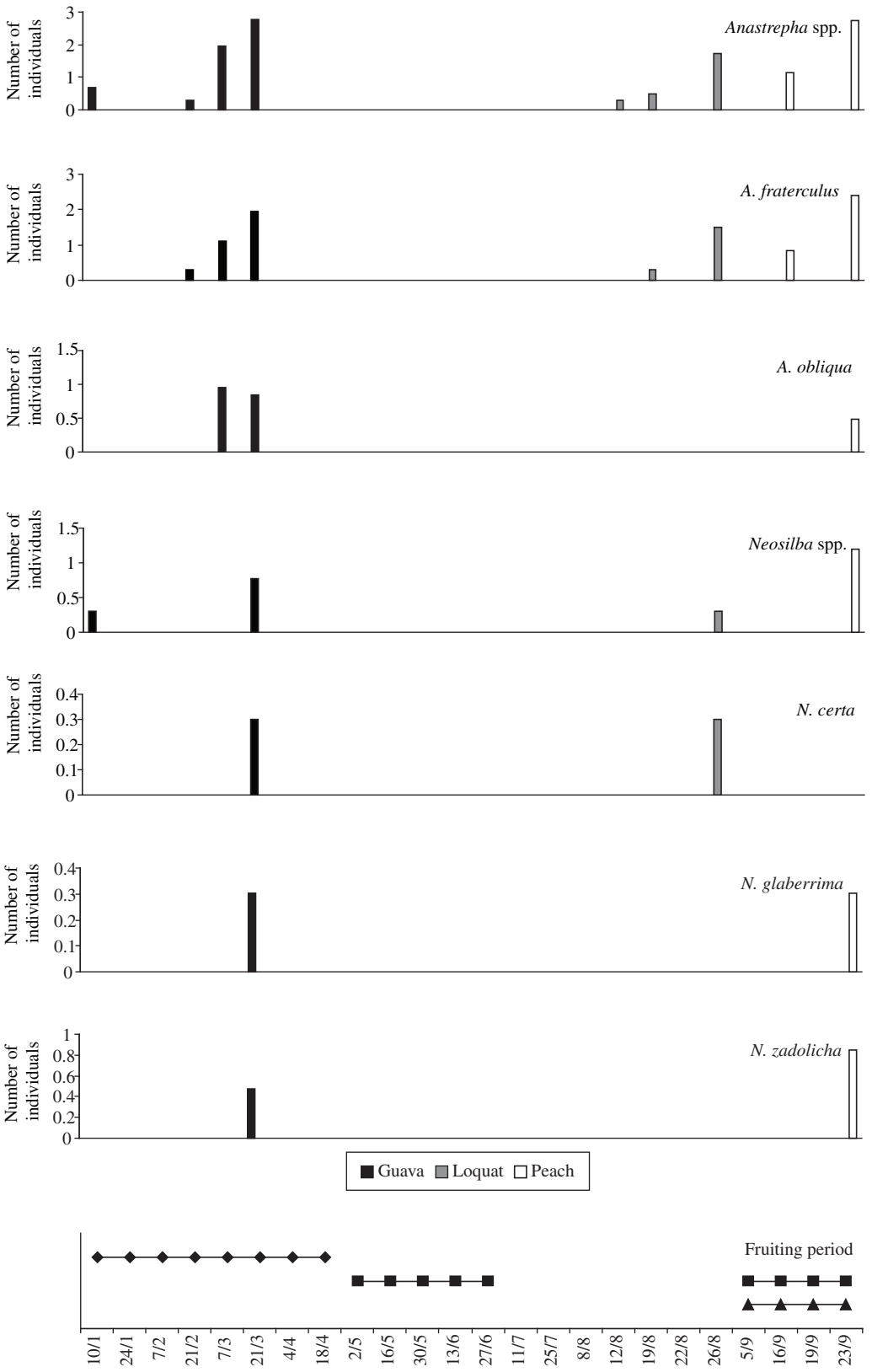

Figure 2. Fly seasonality in guava (lozenge), loquat (square), and peach (triangle), related to the period of exposure of fruits after bagging, in Monte Alegre do Sul, SP, 2003. Fly numbers were transformed to Log_{10} (n+1).

from peaches of the 2003 cropping season (Figure 2). Although it was not obtained from loquat in both fruiting seasons of the year, *A. obliqua* had already been reported on this host in the State of São Paulo (Souza-Filho et al., 2000). It is likely that host availability throughout the year may have helped to maintain this species in the area where the orchards were located. Considering that around Monte Alegre do Sul, SP there are cultivated and spontaneous mango plants (*Mangifera indica* L.), probably this fruit tree contributed toward *A. obliqua* host succession.

Ceratitis capitata infested loquat and peach in August and September 2002, when there was a tendency of population increase (Figure 1). The fluctuation data reinforce this evidence, with population peaks in September, in the full fruiting period of these Rosaceae (Figure 3). The Mediterranean fruit fly was practically absent from January to July in the three orchards, and a single population peak occurred in each year (Figure 3). Therefore, the *C. capitata* population has a defined seasonality, since even in loquat trees, which have two fruiting seasons per year, the number of specimens collected in the first fruiting period (May through July) was minimal (Figure 3). On the other hand, the population peaks of *C. capitata* in loquat and peach occurred during the fruiting season observed in the second half of the year (September and October) (Figure 3). Consequently there was an incursion of *C. capitata* into these orchards, as exemplified in observations of Israely et al. (1997). The *C. capitata* population parameters are substantially influenced by the hosts, which act mainly as breeding and refuge substrates (Katsoyannos et al., 1998). These authors also considered that breeding within the population activity period (abundance) seems to be closely associated with the seasonal maturation of the most important host in the area. *Ceratitis capitata* seasonality also became evident in the guava orchard from the end of February to the end of April, when no flies were captured even at full fruiting (Figure 3). Considering the *C. capitata* preference for coffee and peach (Souza-Filho, 1999), it is possible to infer that the seasonality in this study resulted from the coffee harvest in the surroundings of Monte Alegre do Sul. Other population fluctuation studies in the State of São Paulo have also demonstrated this tendency (e.g. Puzzi and Orlando, 1965). Even in tropical regions, *C. capitata* occurs more frequently on introduced hosts (Malavasi et al., 1980). The population peak in the guava orchard in the period without fruits, vegetative stage, and beginning of flowering (Figure 3) demonstrates that the *C. capitata* population exploited the site to obtain food and shelter (Hendrichs and Hendrichs, 1990).

3.3. Relation between lonchaeids x hosts

In general, the *Neosilba* species occurred in the orchards throughout the two years of studies (Figures 1 and 2). *Neosilba certa*, *Neosilba* sp. 4, and *Neosilba* sp. 10 occurred in both years and exploited the three hosts. In 2002, *N. pendula* exploited guava and peach, while in 2003 *N. glaberrima* and *N. zadolicha* also occurred in guava and peach. These species use a commercial guava orchard as copulation site (Strikis and Souza-Filho, 2004).

The *Neosilba* specimens obtained directly from fruits not previously attacked by tephritids confirm that these flies also are primary invaders of fruits. In this work, this fact was observed for *N. certa* and unidentified species (*Neosilba* spp.) in guava, on two occasions (end of January and beginning of February, 2002) (Figure 1). In Brazil, there are records for *N. certa* and *N. zadolicha* in peach (Fehn, 1981; McAlpine and Steyskal, 1982) and *N. pendula* in guava (Araujo and Zucchi, 2002). However, *Neosilba* species are also primary invaders of citrus in Brazil (Uchôa-Fernandes et al., 2002; Raga et al., 2004). The records obtained in this work for *N. certa* and *N. zadolicha* in guava and loquat and for *N. glaberrima* in guava and peach are unprecedented.

3.4. Parasitoids

Ten parasitoid species were collected. The braconids belonged to five species – *Asobara anastrephae* (Muesebeck), *Doryctobracon areolatus* (Szépligeti), *D. brasiliensis* (Szépligeti), *Opius bellus* Gahan, and *Utetes anastrephae* (Viereck) (Table 1). *Doryctobracon areolatus*, *D. brasiliensis*, and *U. anastrephae* can be highlighted as the most important parasitoids in the State of São Paulo, parasitizing fly larvae on practically all known host plants (Souza-Filho et al., 2000).

Figitids were retrieved from larvae attacking only guava – *Aganaspis pelleranoi* (Brèthes), *Diceratasphis grenadensis* Ashmead, *Lopheucoila anastrephae* (Rhower), *Leptopilina boulardi* (Barbotin, Carlton and Kelner-Pillaut), and *Trybliographa infuscata* Diaz, Gallardo and Uchôa (Table 1). With the exception of *D. grenadensis* and *L. boulardi*, which are parasitoids on drosophilids, the other figitids parasitize Tephritoidea larvae (Guimarães et al., 2004).

At the end of the maturation stage, some fruits harvested from the trees showed cracks or were damaged by insects or birds. These fruits became attractive to drosophilids and, consequently, emergence of *D. grenadensis* and *L. boulardi* was observed, since these parasitoids are more attracted by rotting guava volatiles infested with drosophilid larvae (Guimarães and Zucchi, 2004). Myrtaceae fruits are more attractive to figitids (Guimarães et al., 2004). Thus, only larvae in guava were parasitized.

Most braconid species developed on tephritid larvae in peach in 2002, but only *Doryctobracon* species – *D. areolatus* and *D. brasiliensis* – were also obtained in 2003 (Table 1). Larvae in loquat were not parasitized (Table 1). However, there are records of high parasitism rates of larvae in this host (Souza-Filho, 1999).

The parasitoids occurred in periods when the flies are more abundant (Table 1), that is, in the fruiting season of host plants (Figures 1 and 2). In this period, the fruits show characteristics that favor the action of parasitoids, such as increased attractiveness and easier detection of the host larva for oviposition (Ovruski et al., 2000).

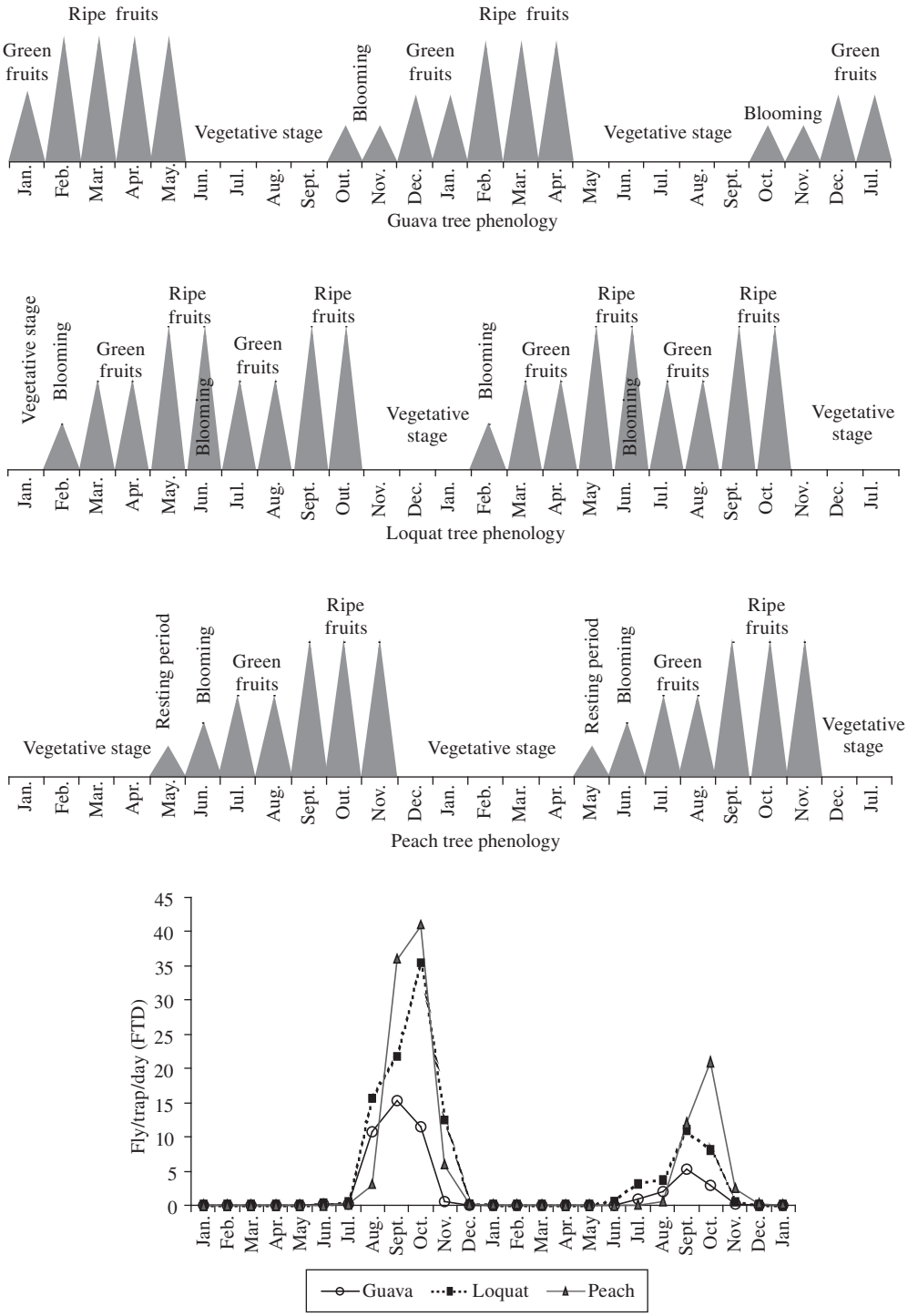

Figure 3. Guava, loquat, and peach tree phenology, and *Ceratitis capitata* population fluctuation in three orchards from January/2002 to January/2004, in Monte Alegre do Sul, SP, January/2002 to January/2004.

4. Final Considerations

Considering the regional approach of this study, it was observed that fly populations, such as *Anastrepha fraterculus*, *A. obliqua*, *Neosilba certa*, *N. glaberrima*, *N. pendula*, *N. zadolicha* co-occurred in the three orchards in the two year-round of sampling (exploitation and host succession), while *Ceratitis capitata* occurred exclusively during the second semester of each year.

Based on phenological data it was also possible to verify the relative abundance and the population growth dynamics of fruit fly populations during the research period as well as when these populations begin their respective peaks. The parasitoid populations showed great diversity and potential to be used in biological control. This information will be of great importance for the implementation of an integrated pest management of the fruit flies in the studied area.

Acknowledgements — The authors are grateful to Márcio Roberto Ortiz de Souza, Luiz Henrique Chorfi Berton, Anderson Alves Siqueira Pedro and Guilherme de Melo for their collaboration in the field work and laboratory; and to Dr. Thomas Michael Lewinsohn (Universidade Estadual de Campinas/UNICAMP) for his suggestions to improve an earlier version of the manuscript.

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