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New findings on Lonchaeidae (Diptera: Tephritoidea) in the Brazilian Amazon

Lailson do Nascimento Lemos¹, Ricardo Adaime^{2,*}, Salustiano V. Costa-Neto³, Ezequiel da Glória de Deus¹, Cristiane Ramos de Jesus-Barros², and Pedro Carlos Strikis⁴

Abstract

Distribution and host data of Lonchaeidae species (Diptera: Tephritoidea) in the state of Amapá, Brazil, are presented. Adults of 10 species in the genera *Neosilba*, *Dasiops*, and *Lonchaea* were reared from 23 plant species in 18 families. *Neosilba laura* Strikis and *Neosilba parapeltae* Strikis are reported for the first time in the Amazon, and *Dasiops inedulis* Steyskal and *Neosilba perezii* Romero & Ruppel are reported for the first time in Amapá State. Additionally, 24 new host associations are documented.

Key Words: *Neosilba*; infestation; orchard

Resumo

Dados de distribuição e hospedeiros de espécies de Lonchaeidae (Diptera: Tephritoidea) no estado do Amapá, Brasil, são apresentados. Adultos de 10 espécies nos gêneros *Neosilba*, *Dasiops* e *Lonchaea* foram obtidos de 23 espécies de plantas em 18 famílias. *Neosilba laura* Strikis e *N. parapeltae* Strikis são reportadas pela primeira vez na Amazônia, e *Dasiops inedulis* Steyskal e *Neosilba perezii* Romero & Ruppel são reportadas pela primeira vez no estado do Amapá. Adicionalmente, 24 novas associações com hospedeiros são documentadas.

Palavras Chave: *Neosilba*; infestação; fruticultura

Lonchaeids (Diptera: Lonchaeidae), commonly known as lance flies, are minute insects (3–6 mm long) with glossy, dark blue bodies and hyaline or very pale brown wings, found mainly in humid or shaded places. Larvae are associated with decomposing organic matter, mainly wood, flowers, and fruits. However, some species are primary invaders of fruits and flower buds (McAlpine 1961; Norrbom & McAlpine 1997) and may have a significant economic impact on fruit crops (MacGowan & Okamoto 2013).

Lonchaeidae contain approximately 545 species, grouped into 2 subfamilies (Dasiopinae and Lonchaeinae) and 8 genera (*Chaetolonchaea* Czerny, *Dasiops* Rondani, *Earomyia* Zetterstedt, *Lamprolonchaea* Bezzi, *Lonchaea* Fallén, *Neosilba* McAlpine, *Protearomyia* McAlpine, and *Silba* Macquart). The subgenus *Setisquamalonchaea* Morge is currently considered synonymous with *Silba* (MacGowan & Okamoto 2013; MacGowan 2015).

Tephritidae and Lonchaeidae are the most and second-most, respectively, economically important dipteran families in South America, and some species of *Dasiops* and *Neosilba* are primary pests of fruit crops. For plant species of economic importance, including citrus (*Citrus* species; Sapindales: Rutaceae), ambarella (*Spondias dulcis* Soland. ex Forst. f.; Sapindales: Anacardiaceae), and passionfruit (*Passiflora* species; Malpighiales: Passifloraceae), lonchaeids can be more abundant and more important as pests than Tephritidae (Uchôa 2012).

Although infestations of fruits of economic importance by lonchaeids have been reported in Brazil since the 1930s, these insects generally were neglected in surveys of fruit flies, mainly due to a lack of taxonomic knowledge. In the 1990s, the large number of lonchaeid puparia obtained in these surveys renewed interest in lonchaeid research, especially in southeastern Brazil (Araújo & Zucchi 2002). Recently, a number of studies on Lonchaeidae species have been conducted in Brazil, motivated by advances in taxonomic knowledge of Brazilian species. The species reported in Brazil belong to the genera *Dasiops*, *Lonchaea*, and *Neosilba*.

These studies have revealed that species of *Neosilba* are primary pests of certain crops, including cassava (*Manihot esculenta* Crantz; Malpighiales: Euphorbiaceae) (Lourenção et al. 1996); acerola (*Malpighia emarginata* [Moc. & Sessé] ex. DC; Malpighiales: Malpighiaceae) (Araújo & Zucchi 2002); citrus (*Citrus* species) (Uchôa-Fernandes et al. 2002, 2003); coffee (*Coffea arabica* L.; Gentianales: Rubiaceae) (Aguiar-Menezes et al. 2007); and tangerine (*Citrus reticulata* Blanco; Sapindales: Rutaceae) (Lopes et al. 2008). *Dasiops friesei* Norrbom & McAlpine has been reported to damage fruits of sour passionfruit (*Passiflora edulis* Sims; Malpighiales: Passifloraceae) (Souza-Filho et al. 2002), and *Dasiops inedulis* Steyskal has been reported to damage passionfruit flower buds (Lunz et al. 2006).

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Lonchaeids were first reported in the Brazilian Amazon in the state of Amazonas by Silva (1993), who reported species of *Neosilba* associated with 19 fruit-bearing species. Costa (2005) subsequently reported *Neosilba major* (Malloch), *Neosilba zadolicha* McAlpine & Steyskal, and *Neosilba* sp. in a study conducted at the Adolpho Ducke Forest Reserve, in the city of Manaus. New studies were completed more recently, contributing significantly to knowledge on Lonchaeidae in the Amazon (Querino et al. 2010; Strikis et al. 2011; Adaime et al. 2012; Deus et al. 2013).

Lonchaeids have numerous native and exotic hosts in the Brazilian Amazon, many species of which are found exclusively in forest environments. *Neosilba glaberrima* (Wiedemann) and *N. zadolicha* are the most polyphagous and widely distributed lonchaeid species in this region (Strikis et al. 2011). Despite an increase in research, little is known about the ecology and biology of lonchaeids. This study reports new findings on the distribution of Lonchaeidae species and their hosts in the Brazilian Amazon.

Materials and Methods

STUDY SITE

We conducted this study on 3 farms located in the municipalities of Mazagão, Porto Grande, and Santana, state of Amapá, Brazil (Fig. 1).

All 3 properties contained commercial orchards with adjoining areas of native forest.

The area in Mazagão (0.1°S, 51.25°W) exhibits native floodplain forest vegetation, which undergoes daily flooding due to tides. Common species include *Platymiscium duckei* Huber (Fabales: Fabaceae), *Virola surinamensis* (Rolander) Warb. (Magnoliales: Myristicaceae), *Calycophyllum spruceanum* (Benth.) Hook.f. ex K. Schum. (Gentianales: Rubiaceae), and *Carapa guianensis* Aubl. (Sapindales: Meliaceae). The commercial orchard area occupies an area of approximately 10 ha, with cultivated fruit trees including tahiti lime (*Citrus aurantifolia* Swingle var. 'Tahiti'; Sapindales: Rutaceae), passionfruit (*P. edulis*), and soursop (*Annona muricata* L.; Magnoliales: Annonaceae), grown for the manufacture of fruit concentrate or to be sold in natura.

The area in Porto Grande (0.6°N, 51.45°W) exhibits dense forest vegetation, with numerous tree species, including *Protium* species (Sapindales: Burseraceae), *Caryocar villosum* (Aubl.) Pers. (Malpighiales: Caryocaraceae), and *Dipteryx odorata* (Aubl.) Willd. (Fabales: Fabaceae). The property is approximately 100 ha, of which 30% is used for the cultivation of fruit trees, mainly hog plum (*Spondias mombin* Jacq.; Sapindales: Anacardiaceae), araza (*Eugenia stipitata* McVaugh; Myrtales: Myrtaceae), and soursop (*A. muricata*).

The area in Santana (0.03°S, 51.21°W) exhibits secondary forest vegetation, with *Eschweilera tenuifolia* Miers (Ericales: Lecythidaceae), *Ficus pertusa* L.f., (Rosales: Moraceae), and *Pourouma guianensis* Aubl. (Rosales: Urticaceae) as predominant species. The commercial orchard

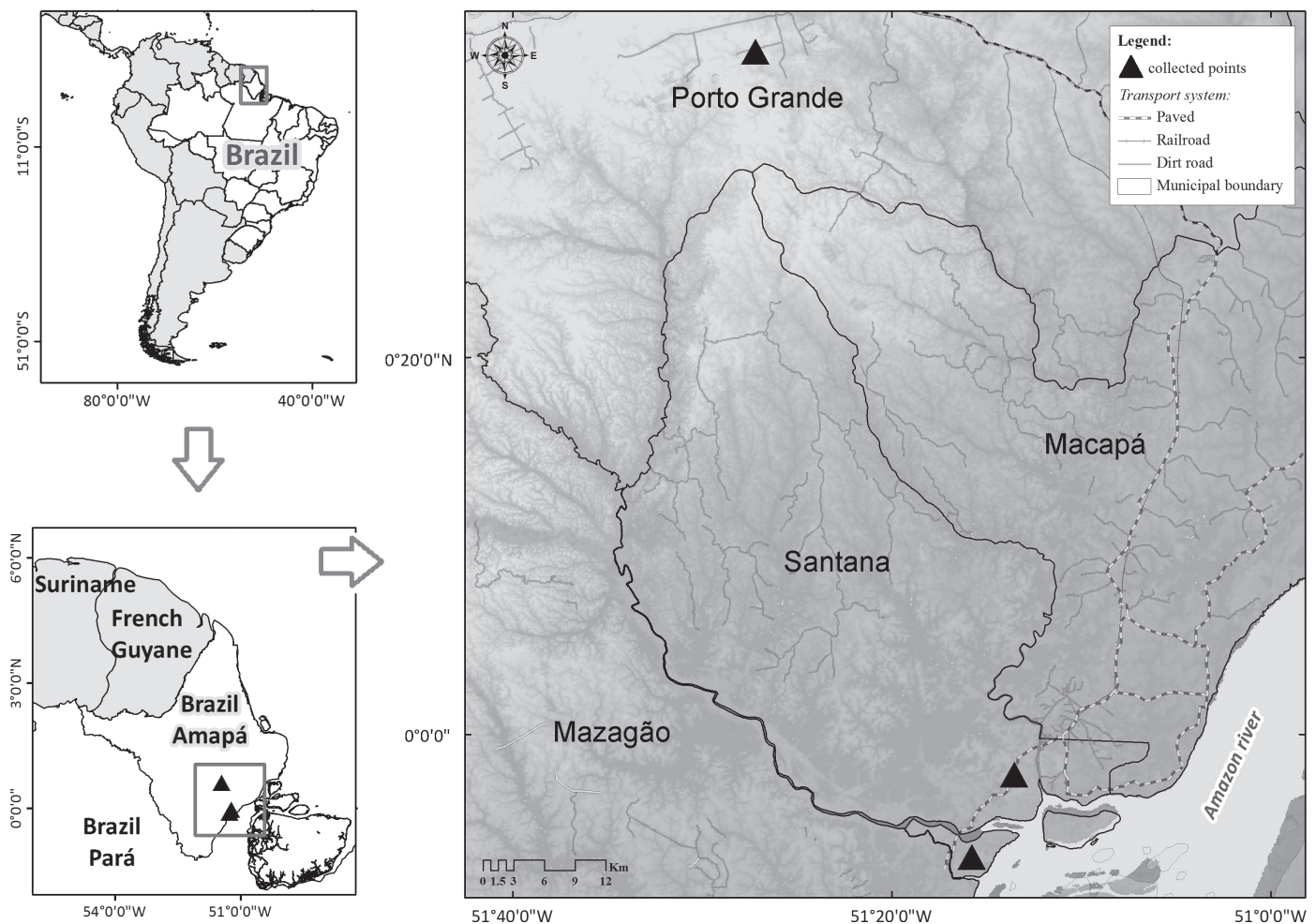


Fig. 1. State of Amapá with markers (black triangles) indicating the sampling site locations.

is approximately 20 ha, and the main species are acerola (*M. emarginata*), guava (*Psidium guajava* L.; Myrtales: Myrtaceae), and passionfruit (*P. edulis*). As classified by Köppen, the climate type at the study sites is Am, characterized as hot and humid with a short dry season in the spring. Rainfall is distributed between 2 well-defined periods: a rainy season (Jan to Jul), which receives about 80% of all annual rainfall in the area, and a dry season (Aug to Dec). Temperatures are elevated throughout the year, with an annual average of 25 to 27 °C (low of 22 °C and high of 34 °C) (IBGE 2010).

FRUIT COLLECTION AND PROCESSING

Every fruit tree species in the orchards was sampled. Within the native vegetation areas, 1 parcel of 40 × 250 m (1 ha) was delimited in each area. Once per month from Jan to Dec 2012, fruits were collected from various plant species, either directly from the plant or by retrieving recently fallen fruit. Samples were transported in stackable plastic crates to the Entomology Laboratory at Embrapa Amapá, where the fruits were weighed on a digital scale. For preparation of the samples, the fruits were processed and individualized according to the sample size criterion established by Silva et al. (2011): 15 units, for small fruit; 10 units, for medium-sized fruit; and 3 units, for large or elongated fruit. In each sample, each individual fruit was considered as 1 sub-sample.

The collected fruits were placed either individually into tubular, transparent plastic vials (8 cm diameter × 6 cm height), with vented lids lined with organza; or, in the case of large or elongated fruit, on rectangular plastic trays (33 × 18 × 6 cm LWH), also covered with organza held in place by rubber bands. Both types of containers included a thin layer of sterilized sand as a substrate for pupation.

ACQUISITION OF PUPARIA AND ADULT INSECTS

Every 3 d, the sand was examined and lonchaeid puparia were removed with spatulas. The puparia were transferred into transparent plastic vials (8 cm diameter), with vented lids covered with organza, containing a thin layer of moistened vermiculite. The adult insects that emerged were killed, transferred to Eppendorf tubes containing 70% ethanol, and labeled for subsequent identification.

Identification of Insects

Specimens obtained were identified according to McAlpine & Steyskal (1982) and Strikis (2011).

Identification of Botanical Material

Branches with attached reproductive structures (flowers and/or fruits), were collected and vouchered as herbarium specimens using typical mounting and preservation techniques (Fidalgo & Bononi 1984). Plant species was identified with identification keys and by comparison with specimens available at the Herbário Amapaense, the herbarium at the Amapá State Institute for Scientific and Technological Research.

DATA ANALYSES

The following infestation rates were calculated: 1) percentage of fruits infested = (number of fruits infested ÷ number of fruits collected) × 100; 2) number of puparia per fruit = number of puparia obtained ÷ number of infested fruits in the sample.

Results

In total, 412 plant samples were collected (78 plant species in 32 families, 4,554 fruits, 323.4 kg) (Table 1). Infestation was observed in 50 of the samples (12.1%), representing 23 plant species (18 families; Table 1). In total, 856 Lonchaeidae puparia were obtained, from which emerged specimens of 10 species in the genera *Neosilba*, *Dasiops*, and *Lonchaea*.

MAZAGÃO

In total, 129 samples were collected, consisting of 1,495 fruits of 42 species (20 families; Table 1). Infestation by lonchaeids was observed in 15 samples: 59 fruits of 7 plant species (7 families), from which 457 puparia were obtained (Tables 1 and 2). *Metrodorea flavida* K. Krause (Sapindales: Rutaceae) showed the highest percentage of infested fruits (70.0%), and *A. muricata* had the highest infestation load (39 puparia/fruit) (Table 2).

Seven species of Lonchaeidae were obtained: *N. glaberrima*, *N. laura* Strikis, *N. pendula* (Bezzi), *N. pseudozadolicha* Strikis, *N. zadolicha*, *D. inedulis*, and 1 *Lonchaea* species (Table 2) that was in poor condition and unidentifiable. *Neosilba zadolicha* was the most abundant species (66 specimens), occurring from Apr to Jul and infesting 5 host species (Table 2).

PORTO GRANDE

In total, 154 samples were collected, consisting of 1,524 fruits of 41 species (24 families). Infestation by lonchaeids was observed in 16 samples: 41 fruits of 8 plant species (7 families), from which 176 puparia were obtained (Tables 1 and 3). *Artocarpus altilis* (Parkinson) Forsberg (Rosales: Moraceae) showed the highest percentage of infested fruits (66.7%), and *A. muricata* had the highest infestation load (11 puparia/fruit) (Table 3).

Six species were reared: *N. glaberrima*, *N. laura*, *N. pendula*, *N. pseudozadolicha*, *N. zadolicha*, and 1 unidentified *Lonchaea* species (Table 3). *Neosilba glaberrima* infested the greatest number of hosts (6), followed by *N. zadolicha* and *N. pseudozadolicha* (3). *Neosilba zadolicha* was the most abundant species (31 specimens). In total, 44 specimens of *Neosilba* were obtained from *E. stipitata*, specifically 20 specimens of *N. zadolicha*, 3 of *N. glaberrima*, 1 of *N. pseudozadolicha*, and 20 females (Table 3). Except for Oct and Nov, specimens were obtained from at least 1 sampled host in all other months (Table 3).

SANTANA

In total, 129 samples were collected, consisting of 1,535 fruits of 40 plant species (23 families). Infestation was observed in 19 samples: 43 fruits of 12 plant species (12 families), from which 223 puparia were obtained (Tables 1 and 4). *Inga edulis* Mart. (Fabales: Fabaceae) showed the highest percentage of infested fruits (100%) (Table 4). The highest infestation load was observed on shoots of *M. esculenta* (11 puparia/shoot) (Table 4).

Eight species were reared: *Neosilba bella* Strikis, *N. glaberrima*, *N. parapeltae* Strikis, *N. pendula*, *N. perezi* Romero & Ruppel, *N. pseudozadolicha*, *N. zadolicha*, and *D. inedulis*. *Neosilba zadolicha* infested the greatest number of hosts (5), followed by *N. glaberrima* (4). *Neosilba zadolicha* was the most abundant species (59 specimens). The fruits of *P. guajava* yielded specimens from 3 species of *Neosilba* (*N. glaberrima*, *N. pseudozadolicha*, and *N. zadolicha*) in 6 mo of the year (Table 4).

Table 1. Number of samples and fruits collected and infested by Lonchaeidae in 3 municipalities of the state of Amapá, Brazil, Jan to Dec 2012.

Fruit tree species/families sampled	Scientific name	Common name	Family	Origin native (N), introduced (I)	Municipality											
					Mazagão				Porto Grande				Santana			
					NSC	NFC	NSI	NFI	NSC	NFC	NSI	NFI	NSC	NFC	NSI	NFI
<i>Alibertia edulis</i> (L. C. Rich.) A. Rich. ex DC		Puruí	Rubiaceae	N	0	0	0	0	2	30	0	0	0	0	0	0
<i>Anacardium occidentale</i> L.		Cashew	Anacardiaceae	I	1	10	0	0	0	0	0	0	0	2	20	0
<i>Annona muricata</i> L.		Soursop	Annonaceae	I	1	3	1	1	4	12	3	3	2	6	1	2
<i>Artocarpus altilis</i> (Parkinson) Fosberg		Breadfruit	Moraceae	I	0	0	0	0	4	12	2	4	0	0	0	0
<i>Artocarpus heterophyllus</i> Lam.		Jackfruit	Moraceae	I	0	0	0	0	2	6	0	0	3	9	0	0
<i>Astrocaryum aculeatum</i> G. Mayer		Tucumã	Arecaceae	N	0	0	0	0	0	0	0	0	1	15	0	0
<i>Astrocaryum murumuru</i> Mart.		Murumuru	Arecaceae	N	6	60	0	0	0	0	0	0	0	0	0	0
<i>Attalea phalerata</i> Mart. ex Spreng.		Urucuri	Arecaceae	N	7	70	0	0	0	0	0	0	0	0	0	0
<i>Averrhoa carambola</i> L.		Star fruit	Oxalidaceae	I	0	0	0	0	9	90	3	14	0	0	0	0
<i>Bactris gasipaes</i> Kunth.		Peach-palm	Arecaceae	N	0	0	0	0	2	30	0	0	0	0	0	0
<i>Bactris maraja</i> Mart.		Maraja	Arecaceae	N	1	15	0	0	0	0	0	0	0	0	0	0
<i>Bellucia grossularioides</i> (L.) Triana		Golaba-de-anta	Melastomataceae	N	0	0	0	0	2	30	0	0	0	0	0	0
<i>Byrsonima crassifolia</i> (L.) HBK		Nance	Malpighiaceae	N	0	0	0	0	0	0	0	0	5	75	0	0
<i>Capsicum chinense</i> Jacq.		Yellow lantern chili	Solanaceae	I	8	120	0	0	1	15	1	4	3	45	0	0
<i>Calophyllum brasiliense</i> Cambess.		Jacareuba	Calophyllaceae	N	1	15	1	1	0	0	0	0	0	0	0	0
<i>Carica papaya</i> L.		Papaya	Caricaceae	I	1	3	0	0	5	15	0	0	6	90	0	0
<i>Caryocar glabrum</i> (Aubl.) Pers.		Water sawari	Caryocaraceae	N	0	0	0	0	1	10	0	0	0	0	0	0
<i>Cayaponia ferruginea</i> Gomes-Klein		Fruta de cutia	Cucurbitaceae	N	0	0	0	0	0	0	0	0	1	15	0	0
<i>Cheiloclinium cognatum</i> (Miers) A.C. Sm.		Bacupari	Celastraceae	N	2	30	0	0	0	0	0	0	3	45	0	0
<i>Cissou amapaenses</i> Lombardi		Uva-do-mato	Vitaceae	N	0	0	0	0	0	0	0	0	2	30	0	0
<i>Citrus aurantifolia</i> Swingle var. 'Tahiti'		Tahiti lime	Rutaceae	I	9	90	0	0	0	0	0	0	3	30	0	0
<i>Citrus aurantium</i> L.		Bitter orange	Rutaceae	I	0	0	0	0	10	100	0	0	0	0	0	0
<i>Citrus latifolia</i> Tanaka		Tahiti lime	Rutaceae	I	0	0	0	0	0	0	0	0	2	20	0	0
<i>Citrus limonia</i> Osbeck		Rangpur	Rutaceae	I	8	80	0	0	8	80	0	0	11	110	1	1
<i>Citrus reticulata</i> Blanco		Tangerine	Rutaceae	I	2	20	0	0	4	40	0	0	5	50	0	0
<i>Citrus sinensis</i> (L.) Osbeck		Orange	Rutaceae	I	4	40	0	0	0	0	0	0	1	10	0	0
<i>Coffea arabica</i> L.		Coffee	Rubiaceae	I	0	0	0	0	0	0	0	0	3	45	1	1
<i>Combretum laxum</i> Jacq.		Pombeiral	Combretaceae	N	0	0	0	0	2	30	0	0	0	0	0	0
<i>Conceveiba guianensis</i> Aubl.		Arraieira	Euphorbiaceae	N	0	0	0	0	0	0	0	0	1	15	0	0
<i>Cucumis anguria</i> L.		Bur cucumber	Cucurbitaceae	N	5	75	0	0	1	15	0	0	1	15	0	0
<i>Cucumis sativus</i> L.		Cucumber	Cucurbitaceae	I	5	15	0	0	0	0	0	0	1	3	1	1
<i>Eschweilera tenuifolia</i> Miers		Matá-matá (flower bud)	Lecythidaceae	N	0	0	0	0	0	0	0	0	4	60	1	1
<i>Eugenia stipitata</i> McVaugh		Araza	Myrtaceae	N	0	0	0	0	11	110	3	11	0	0	0	0
<i>Ficus pertusa</i> L.f.		Apuí	Moraceae	N	2	30	0	0	2	30	0	0	1	15	0	0
<i>Geissospermum sericeum</i> Miers		Quinarana	Apocynaceae	N	0	0	0	0	2	20	0	0	0	0	0	0
<i>Guarea guidonia</i> (L.) Sleumer		American muskwood	Meliaceae	N	0	0	0	0	1	15	0	0	0	0	0	0
<i>Gustavia augusta</i> L.		Jenipaparana	Lecythidaceae	N	0	0	0	0	0	0	0	0	1	10	0	0
<i>Inga edulis</i> Mart.		Ice-cream-bean	Fabaceae	N	2	6	0	0	0	0	0	0	5	15	2	6
<i>Licania macrophylla</i> Benth.		Anoerá	Chrysobalanaceae	N	5	45	0	0	0	0	0	0	1	15	1	2
<i>Malpighia emarginata</i> Moc. & Sessé ex. DC		Acerola	Malpighiaceae	I	1	15	0	0	4	60	0	0	9	135	0	0

NSC, number of samples collected; NFC, number of fruits collected; NSI, number of samples infested; NFI, number of fruits infested.

Table 1. (Continued) Number of samples and fruits collected and infested by Lonchaeidae in 3 municipalities of the state of Amapá, Brazil, Jan to Dec 2012.

Fruit tree species/families sampled Scientific name	Common name	Family	Origin native (N), introduced (I)	Municipality													
				Mazagão				Porto Grande				Santana					
				NSC	NFC	NSI	NFI	NSC	NFC	NSI	NFI	NSC	NFC	NSI	NFI		
<i>Mammea americana</i> L.	Apricot	Clusiaceae	I	0	0	0	0	3	30	0	0	0	0	0	0	0	0
<i>Mangifera indica</i> L.	Common mango	Anacardiaceae	I	2	20	0	0	1	10	0	0	2	20	0	0	0	0
<i>Mangifera indica</i> L. var. 'Tommy Atkins'	Tommy Atkins mango	Anacardiaceae	I	0	0	0	0	7	21	0	0	0	0	0	0	0	0
<i>Manicaria saccifera</i> Gaertn.	Wine palm	Areaceae	N	1	15	0	0	0	0	0	0	0	0	0	0	0	0
<i>Manihot esculenta</i> Crantz	Cassava (sprout)	Euphorbiaceae	N	0	0	0	0	1	15	0	0	1	15	1	2	0	0
<i>Manilkara huberi</i> (Ducke) A. Chev.	Manilkara	Sapotaceae	N	2	30	0	0	0	0	0	0	0	0	0	0	0	0
<i>Manilkara zapota</i> (L.) P. Royen	Sapodilla	Sapotaceae	N	0	0	0	0	12	120	0	0	0	0	0	0	0	0
<i>Maximiliana maripa</i> (Aubl.) Mart.	American oil palm	Areaceae	N	0	0	0	0	1	15	0	0	0	0	0	0	0	0
<i>Metrodorea flavida</i> K. Krause	Laranjinha	Rutaceae	N	4	60	2	14	0	0	0	0	0	0	0	0	0	0
<i>Myrciaria jaboticaba</i> (Vell.) Berg.	Jaboticaba	Myrtaceae	N	0	0	0	0	1	15	0	0	0	0	0	0	0	0
<i>Myriaspora egensis</i> DC	Verde-peludo	Melastomataceae	N	0	0	0	0	3	45	0	0	4	60	0	0	0	0
<i>Oenocarpus bacaba</i> Mart.	Bacaba	Areaceae	N	1	15	0	0	1	15	0	0	6	90	0	0	0	0
<i>Parinari excelsa</i> Sabine	Guinea plum	Chrysobalanaceae	N	1	15	0	0	0	0	0	0	0	0	0	0	0	0
<i>Passiflora edulis</i> Sims	Passionfruit (flower bud)	Passifloraceae	N	5	75	3	8	0	0	0	0	3	45	1	1	0	0
<i>Passiflora edulis</i> Sims	Passionfruit (fruit)	Passifloraceae	N	8	80	1	2	0	0	0	0	2	20	0	0	0	0
<i>Persea americana</i> Mill	Avocado	Lauraceae	I	0	0	0	0	4	12	0	0	4	12	0	0	0	0
<i>Physalis angulata</i> L.	Lanceleaf groundcherry	Solanaceae	I	1	15	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pourouma guianensis</i> Aubl.	Mapatirana	Urticaceae	N	0	0	0	0	1	15	0	0	0	0	0	0	0	0
<i>Pouteria caimito</i> Radlk.	Abiu	Sapotaceae	N	1	10	0	0	0	0	0	0	1	10	0	0	0	0
<i>Pouteria gardneri</i> (Mart. & Miq.) Baehni	Agua-lua	Sapotaceae	N	0	0	0	0	1	15	0	0	0	0	0	0	0	0
<i>Pouteria macrophylla</i> (Lam.) Eyma	Cutite	Sapotaceae	N	0	0	0	0	4	40	1	1	0	0	0	0	0	0
<i>Protium heptaphyllum</i> (Aubl.) Marchand	Brazil resintree	Burseraceae	N	1	15	0	0	0	0	0	0	0	0	0	0	0	0
<i>Protium</i> sp. Sandwith	Resintree	Burseraceae	N	1	15	0	0	1	15	0	0	0	0	0	0	0	0
<i>Psidium guajava</i> L.	Guava	Myrtaceae	I	4	40	3	8	0	0	0	0	12	120	7	13	0	0
<i>Quararibea guianensis</i> Albl.	Guyanass swizzlestick tree	Malvaceae	N	3	45	3	23	0	0	0	0	0	0	0	0	0	0
<i>Rollinia mucosa</i> (Jacq.) Baill.	Biribá	Annonaceae	N	0	0	0	0	3	9	0	0	0	0	0	0	0	0
<i>Solanum gilo</i> L.	Scarlet eggplant	Solanaceae	I	3	30	1	2	0	0	0	0	0	0	0	0	0	0
<i>Solanum paniculatum</i> L.	Jurubeba	Solanaceae	N	0	0	0	0	1	15	0	0	4	60	1	2	0	0
<i>Spondias dulcis</i> Parkinson	Ambarella	Anacardiaceae	I	0	0	0	0	11	110	2	3	0	0	0	0	0	0
<i>Spondias mombin</i> L.	Hog plum	Anacardiaceae	N	3	45	0	0	6	90	0	0	5	75	0	0	0	0
<i>Spondias purpurea</i> L.	Purple mombin	Anacardiaceae	I	7	105	0	0	9	135	0	0	0	0	0	0	0	0
<i>Strychnos asperula</i> Sprague & Sandwith	Gogó-de-guariba	Loganiaceae	N	0	0	0	0	0	0	0	0	1	15	1	11	0	0
<i>Symphonia globulifera</i> L.f.	Chewstick	Clusiaceae	N	3	45	0	0	0	0	0	0	0	0	0	0	0	0
<i>Syzygium jambolanum</i> Skeels	Java plum	Myrtaceae	I	1	15	0	0	0	0	0	0	1	15	0	0	0	0
<i>Syzygium malaccense</i> (L.) Merr. & L. M. Perry	Malay apple	Myrtaceae	I	3	30	0	0	2	20	1	1	2	20	0	0	0	0
<i>Tapirira obtusa</i> (Benth.) J. D. Mitch.	Fruto de pombo	Anacardiaceae	N	0	0	0	0	0	0	0	0	3	45	0	0	0	0
<i>Theobroma cacao</i> L.	Cacao	Malvaceae	I	1	3	0	0	4	12	0	0	0	0	0	0	0	0
<i>Trattinnickia rhoifolia</i> Willd.	Amesclão	Burseraceae	N	0	0	0	0	0	0	0	0	1	15	0	0	0	0
<i>Trichilia rubra</i> C. DC	Cachuá	Meliaceae	N	1	15	0	0	0	0	0	0	0	0	0	0	0	0
<i>Trymatococcus amazonicus</i> Poepp. & Endley	Inharé	Moraceae	N	1	15	0	0	0	0	0	0	0	0	0	0	0	0
No. of species = 78	No. of families = 32			129	1,495	15	59	154	1,524	16	41	129	1,535	19	43		

NSC, number of samples collected; NFC, number of fruits collected; NSI, number of samples infested; NFI, number of fruits infested.

Table 2. Lonchaeidae host plants, infestation rates of fruits, and months of occurrence in Mazagão, Amapá, Brazil, Jan to Dec 2012.

Plant species	Fruits (n)	C/l	Mass (g)	C/l	P (n)	Infestation rates			Month of occurrence												Lonchaeidae (n)
						% FI	P/F ^a		J	F	M	A	M	J	J	A	S	O	N	D	
<i>Psidium guajava</i>	30/8		1,538.3/404.9		86	26.7	10.8					x	x	x	x						<i>N. zadolicha</i> (22) <i>N. glaberrima</i> (2) females (26)
<i>Annona muricata</i>	3/1		3,654.6/1,554.9		39	33.3	39.0					x									<i>N. zadolicha</i> (3) <i>Lonchaea</i> sp.1 (11) females (18)
<i>Quararibea guianensis</i>	45/23		504.7/71.8		118	51.1	5.1					x	x	x							<i>N. zadolicha</i> (11) females (27)
<i>Calophyllum brasiliensis</i>	15/1		441.7/27.9		4	6.7	4.0												x		<i>N. pseudozadolicha</i> (1)
<i>Solanum gilo</i>	10/2		431.1/70.9		11	20.0	5.5							x	x						<i>N. glaberrima</i> (2) <i>N. pendula</i> (1) females (6)
<i>Metrodorea flavida</i>	20/14		240.6/193.8		148	70.0	10.6							x	x	x					<i>N. zadolicha</i> (26) <i>N. pseudozadolicha</i> (2) <i>N. laura</i> (1) females (44)
<i>Passiflora edulis</i> (fruit)	10/2		1,180.5/190.9		16	20.0	8.0							x							<i>N. zadolicha</i> (4) females (8)
<i>Passiflora edulis</i> (flower bud)	45/8		201.8/36.0		35	17.8	4.4			x				x	x						<i>D. inedulis</i> (15) females (9)
Total	178/59		8,193.3/2,551.1		457																

C, collected; I, infested; P, puparia; % FI, percentage of fruits infested; P/F, puparia/fruit.
^aCalculation based exclusively on infested fruits.

Table 3. Lonchaeidae host plants, infestation rates of fruits, and months of occurrence in Porto Grande, Anapá, Brazil, Jan to Dec 2012.

Plant species	Fruits (n) C/I	Mass (g) C/I	P (n)	Infestation rates			Month of occurrence												Lonchaeidae (n)
				% FI	P/F*		J	F	M	A	M	J	J	A	S	O	N	D	
<i>Eugenia stipitata</i>	30/11	5,448.6/1,578.2	92	36.7	8.4		x	x							x				<i>N. glaberrima</i> (3) <i>N. zadolicha</i> (20) <i>N. pseudozadolicha</i> (1) females (20)
<i>Spondias dulcis</i>	20/3	1,431.9/290.7	8	15.0	2.7							x			x				<i>N. glaberrima</i> (2) <i>N. pseudozadolicha</i> (1) <i>N. zadolicha</i> (3)
<i>Averrhoa carambola</i>	30/14	898.7/170.9	19	46.7	1.4							x							<i>N. bella</i> (1) <i>N. glaberrima</i> (1)
<i>Pouteria macrophylla</i>	10/1	412.6/39.5	2	10.0	0.5													x	<i>N. glaberrima</i> (2)
<i>Artocarpus altalis</i>	6/4	8,100.5/5,260.0	17	66.7	4.3					x	x								<i>N. glaberrima</i> (7)
<i>Annona muricata</i>	9/3	7,851.0/1,596.4	33	33.3	11.0				x									x	<i>N. zadolicha</i> (8) <i>N. glaberrima</i> (2) <i>Lonchaea</i> sp.1 (5)
<i>Syzygium malaccense</i>	15/1	683.9/30.6	1	6.7	1.0													x	<i>N. pendula</i> (1)
<i>Capsicum chinense</i>	15/4	122.3/12.0	4	26.7	1.0			x											<i>N. pseudozadolicha</i> (1)
Total	135/41	24,949.5/8,978.3	176																

C, collected; I, infested; P, puparia; % FI, percentage of fruits infested; P/F, puparia/fruit.
*Calculation based exclusively on infested fruits.

Table 4. Lonchaeidae host plants, infestation rates of fruits, and months of occurrence in Santana, Amapá, Brazil, Jan to Dec 2012.

Plant species	Fruits (n) C/I	Mass (g) C/I	P (n)	Infestation rates		Month of occurrence												Lonchaeidae (n)
				% FI	P/F ^a	J	F	M	A	M	J	J	A	S	O	N	D	
<i>Licania macrophylla</i>	15/2	76.4/16.9	1	13.3	0.5				x									<i>N. bella</i> (1)
<i>Coffea arabica</i>	15/1	18.0/0.9	1	6.7	1.0					x								<i>N. bella</i> (1)
<i>Strychnos asperula</i>	15/11	99.4/74.1	55	73.3	5.0	x												<i>N. zadolicha</i> (22) females (24)
<i>Psidium guajava</i>	70/13	5,645.7/1,324.9	57	18.6	4.4	x	x	x	x	x	x	x	x		x			<i>N. zadolicha</i> (16) <i>N. glaberrima</i> (2) <i>N. pseudozadolicha</i> (2) females (13)
<i>Annona muricata</i>	3/2	1,191.1/562.9	7	66.7	3.5	x												<i>N. glaberrima</i> (1) females (1)
<i>Inga edulis</i>	6/6	4,446.2/2,492.8	57	100.0	9.5		x		x									<i>N. zadolicha</i> (9) <i>N. glaberrima</i> (10) females (18)
<i>Solanum paniculatum</i>	15/2	14.9/1.2	2	13.3	1.0							x						<i>N. pendula</i> (1)
<i>Citrus limonia</i>	10/1	996.5/149.5	8	10.0	8.0	x												<i>N. glaberrima</i> (3) <i>N. zadolicha</i> (10) females (4)
<i>Passiflora edulis</i> (flower bud)	15/1	94.0/5.3	3	6.7	3.0	x												<i>D. inedulis</i> (2)
<i>Eschweilera tenuifolia</i> (flower bud)	15/1	59.2/4.2	1	6.7	1.0			x										<i>N. parapeltae</i> (1)
<i>Manihot esculenta</i> (sprout)	15/2	45.7/9.3	22	13.3	11.0		x											<i>N. perezi</i> (4) females (2)
<i>Cucumis sativus</i>	3/1	473.3/146.9	9	33.3	9.0					x								<i>N. zadolicha</i> (2)
Total	197/43	13,160.4/4,788.9	223															

C, collected; I, infested; P, puparia; % FI, percentage of fruits infested; P/F, puparia/fruit.
^aCalculation based exclusively on infested fruits.

Discussion

Our results contribute significantly to the knowledge of Lonchaeidae species that occur in the Amazon and their plant hosts, and we document 2 new records in the Amazon (*N. laura* and *N. parapeltae*) and 2 records in the state of Amapá (*D. inedulisa* and *N. perezi*). We also report 24 new associations between lonchaeid species and hosts in the Amazon (Table 5), contributing towards a better understanding of Lonchaeidae–host relationships in this region of Brazil.

Neosilba species are polyphagous, and Uchôa (2012) reported that 5 species of *Neosilba* were of economic importance to the continent: *N. zadolicha*, *N. pendula*, *N. glaberrima*, *N. perezi*, and *N. inesperata* Strikis & Prado. In our study, the species that infested the greatest

numbers of hosts were *N. zadolicha* (11 plant species in 9 families) and *N. glaberrima* (10 plant species in 9 families). These are the most polyphagous and most widely distributed lonchaeids in the Amazon region (Strikis et al. 2011), and are among the species with the highest economic importance for South America (Uchôa 2012).

Neosilba laura and *N. parapeltae* were described only recently (Strikis 2011), and there is no information about their biology. *Neosilba laura* was obtained from a fruit of *M. flavida* in Mazagão, a lonchaeid–host association reported for the first time here (Table 2). *Neosilba parapeltae* was obtained from a flower bud of *E. tenuifolia* in Santana, and this is possibly the first report of this host plant being used by the lonchaeid species (Table 2).

Neosilba perezi was obtained from sprouts of *M. esculenta* in Santana (Table 4). *Neosilba perezi* is a pest of cassava crops, with oc-

Table 5. Lonchaeidae species and their hosts in 3 municipalities of the state of Amapá, Brazil, Jan to Dec 2012.

Lonchaeidae	Host		Municipality
	Family	Species	
<i>Daslops inedulisa</i> *	Passifloraceae	<i>Passiflora edulis</i>	Santana and Mazagão
<i>Lonchaea</i> sp.1	Annonaceae	<i>Annona muricata</i>	Mazagão and Porto Grande
<i>Neosilba bella</i>	Chrysobalanaceae	<i>Licania macrophylla</i> ***	Santana
	Oxalidaceae	<i>Averrhoa carambola</i> ***	Porto Grande
	Rubiaceae	<i>Coffea arabica</i> ***	Santana
<i>Neosilba glaberrima</i>	Anacardiaceae	<i>Spondias dulcis</i> ***	Porto Grande
	Annonaceae	<i>Annona muricata</i>	Santana and Porto Grande
	Fabaceae	<i>Inga edulis</i>	Santana
	Moraceae	<i>Artocarpus altilis</i>	Porto Grande
	Myrtaceae	<i>Eugenia stipitata</i> ***	Porto Grande
		<i>Psidium guajava</i>	Santana and Mazagão
	Oxalidaceae	<i>Averrhoa carambola</i>	Porto Grande
	Rutaceae	<i>Citrus limonia</i> ***	Santana
	Sapotaceae	<i>Pouteria macrophylla</i>	Porto Grande
	Solanaceae	<i>Solanum gilo</i> ***	Mazagão
<i>Neosilba laura</i> **	Rutaceae	<i>Metrodorea flavida</i> ***	Mazagão
<i>Neosilba parapeltae</i> **	Lecythidaceae	<i>Eschweilera tenuifolia</i> ***	Santana
<i>Neosilba pendula</i>	Myrtaceae	<i>Syzygium malaccense</i> ***	Porto Grande
	Solanaceae	<i>Solanum gilo</i> ***	Mazagão
		<i>Solanum paniculatum</i> ***	Santana
<i>Neosilba perezi</i> *	Euphorbiaceae	<i>Manihot esculenta</i>	Santana
<i>Neosilba pseudozadolicha</i>	Anacardiaceae	<i>Spondias dulcis</i> ***	Porto Grande and Santana
	Calophyllaceae	<i>Calophyllum brasiliensis</i> ***	Mazagão
	Myrtaceae	<i>Eugenia stipitata</i> ***	Porto Grande
		<i>Psidium guajava</i> ***	Santana
	Rutaceae	<i>Metrodorea flavida</i> ***	Mazagão
	Solanaceae	<i>Capsicum chinense</i> ***	Porto Grande
<i>Neosilba zadolicha</i>	Anacardiaceae	<i>Spondias dulcis</i> ***	Porto Grande
	Annonaceae	<i>Annona muricata</i>	Mazagão and Porto Grande
	Cucurbitaceae	<i>Cucumis sativus</i> ***	Santana
	Fabaceae	<i>Inga edulis</i>	Santana
	Loganiaceae	<i>Strychnos asperula</i> ***	Santana
	Malvaceae	<i>Quararibea guianensis</i>	Mazagão
	Myrtaceae	<i>Eugenia stipitata</i> ***	Porto Grande
		<i>Psidium guajava</i>	Santana and Mazagão
	Passifloraceae	<i>Passiflora edulis</i> ***	Mazagão
	Rutaceae	<i>Citrus limonia</i> ***	Santana
		<i>Metrodorea flavida</i>	Mazagão

*First report in Amapá.

**New report in the Brazilian Amazon.

***New association with host for this lonchaeid species in the Amazon.

currence varying by region and time of year (Lourenção et al. 1996). In the Amazon, *N. perezi* has been reported in the state of Rondônia (Oliveira 1987), under the name *Silba pendula*. Cassava is a significant social and economic species as a food staple and source of family income, but damage from this pest has not yet been quantified; this is the first report of *N. perezi* in the state of Amapá.

Dasiops inedulius was obtained from flower buds of *P. edulis*, a new distribution record for this species in the state of Amapá. *Dasiops inedulius* is an important pest of *Passiflora* flower buds in South America (Peñaranda et al. 1986; Uchôa-Fernandes et al. 2002). In the state of Pará, it is considered the most important pest of passionfruit plants, causing production losses of up to 100% (Lemos 2009).

Specimens of *Lonchaea* sp.1 were reared from fruits of *A. muricata* only. An additional unidentified of *Lonchaea* species has already been reported in the states of Amazonas and Amapá. In Brazil, only localized reports of *Lonchaea* have been made, with no information about its biology and ecology, indicating a need for new surveys to discover additional potential hosts (Strikis et al. 2011).

Infestation rates varied widely (Tables 2–4). The greatest percentages of infested fruits were observed on fruits of native species, such as *I. edulis*, in Santana (Table 4). In previous studies conducted in the Amazon region, Silva et al. (2010) and Deus et al. (2013) reported infestation by lonchaeids of this plant species. The largest infestation (i.e., number of puparia/fruit) was observed on fruits of *A. muricata* in Mazagão (Table 2). This plant species represents a significant source of income for inhabitants of the Amazon region, who use it to make soursop concentrate.

We did not rear any parasitoids in this work, although 8 species of parasitoid Eucilinae (Figitidae) are associated with larvae of *Neosilba* in Brazil (Uchôa 2012). Figitid parasitoids search for host larvae located inside fruits that have already fallen to the ground and that have an orifice for entry, as the females of these parasitoids have short ovipositors (Uchôa 2012). Because fruits were collected directly from host plants, figitid parasitoids may not have had an opportunity to parasitize larvae. An interesting finding in this study was the wide diversity of Lonchaeidae host plants sampled in native forest areas. Of the 10 species we reared, 6 were associated with hosts located in native forest areas. In addition, the 2 new reports for the Brazilian Amazon were associated with native hosts (Table 5).

Because some lonchaeid species are pest species, researchers have become increasingly interested in studying these flies. However, little is known about the ecology and biology of lonchaeid flies in Brazil. This work identifies the state of Amapá as a region with the greatest recorded lonchaeid species richness in the Amazon, and suggests that additional survey and rearing work be conducted.

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