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HOST RANGES AND INFESTATION INDICES OF FRUIT FLIES (TEPHRITIDAE) AND LANCE FLIES (LONCHAEIDAE) IN SÃO PAULO STATE, BRAZIL

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ABSTRACT

The knowledge of the status of the different fruit fly species and their hosts is essential to manage these insects. This work reports the associations of tephritoid fly species (Tephritidae and Lonchaeidae) with fruits collected from 67 municipalities in São Paulo State, Brazil. From Mar 1997 to Sep 2003, a total of 536 fruit samples was collected from 63 plant species in 28 botanical families. From overall collections, the average infestation index ranged from 0.01 to 22.98 pupae per fruit. The highest infestation was observed in *Cucurbita moschata* (Dusc.) Poir, followed by *Mangifera indica* Linnaeus and *Passiflora alata* Curtis, with 107.14, 59.00, and 38.50 pupae/fruit, respectively. The pupae/kg of fruit index ranged from 0.01 in *Manihot esculenta* Crantz to 277.91 in *Citharexylum myrianthum* Cham. In total 43,104 pupae and 26,368 adults of Tephritoidea were recovered from all collections. The following Tephritoidea adults were observed: *Anastrepha amita* Zucchi, *Anastrepha bahiensis* Lima, *Anastrepha distincta* Greene, *Anastrepha. fraterculus* (Wied.), *Anastrepha grandis* (Macquart), *Anastrepha leptozona* Hendel, *Anastrepha obliqua* (Macquart), *Anastrepha pseudoparallela* (Loew), *Anastrepha serpentina* (Wied.), *Anastrepha sororcula* Zucchi, *Ceratitis capitata* (Wied.) and Lonchaeidae. All host species infested by *C. capitata* or *Anastrepha* spp. also were infested by Lonchaeidae.

Key Words: Tephritoidea, *Ceratitis capitata, Anastrepha*, host plant, ecology

RESUMEN

El conocimiento del estatus de hospedero es fundamental para el éxito del manejo de las especies de moscas de las frutas. Este trabajo reporta la asociación de moscas de las frutas (Tephritidae and Lonchaeidae) con huéspedes colectados en 67 municipios del estado de São Paulo, Brasil. Desde marzo de 1997 a septiembre de 2003, fueran obtenidos en total de 536 muestras de frutas de 63 especies botánicas, pertenecientes a 28 familias. Del total de las muestras infestadas, los índices de infestación promedio fluctuaron entre 0.01 a 22.98 pupas por fruta. El máximo promedio de infestación fue encontrado en *Cucurbita moschata* (Dusc.) Poir, seguido por *Mangifera indica* L. y *Passiflora alata* Curtis, con107.14, 59.00 y 38.50 pupas/fruto, respectivamente. En términos de puparío/Kg de fruta, los índices fluctuaron entre 0.01 (*Manihot esculenta*) a 277.91 (*Citharexylum myrianthum*). Se obtuvo un total de 43,104 puparios y 26,368 adultos de Tephritoidea. Adultos de Tephritoidea obtenidos fueron: *Anastrepha amita* Zucchi, *Anastrepha bahiensis* Lima, *Anastrepha distincta* Greene, *Anastrepha. fraterculus* (Wied.), *Anastrepha grandis* (Macquart), *Anastrepha leptozona* Hendel, *Anastrepha obliqua* (Macquart), *Anastrepha pseudoparallela* (Loew), *Anastrepha serpentina* (Wied.), *Anastrepha sororcula* Zucchi, *Ceratitis capitata* (Wied.) y Lonchaeidae. En todos los hospederos infestados por *C. capitata* o *Anastrepha* spp. también se registro la presencia de especimenes de Lonchaeidae.

Translation provided by authors.

In many countries, tephritid species have caused tremendous losses in fruit production and imposed limits on the export market (Aluja & Mangan 2008). There are relatively few records of fruit flies on native plant species because the majority of publications report data from commercial orchards (Norrbom & Korytkowski 2009). However, current restrictions include fruit species for which there is scant information regarding fruit fly host status (Rengifo et al. 2011). In Brazil, the main fruit fly pests are native *Anastrepha* species and the exotic medfly, *Ceratitis capitata* (Wiedemann).

Anastrepha Schiner is the largest and most economically important genus of Tephritidae in the Americas (Norrbom et al. 2000). Of the 235 described species of *Anastrepha*, about 104 are reported in Brazil (Uchôa-Fernandes & Nicácio 2010), and the majority of these has unknown hosts. *Anastrepha* species in Brazil are associated with fruit bearing trees of 29 families. Of the 41 *Anastrepha* species associated with host plants, 37% feed on Myrtaceae and 24% on Sapotaceae (Zucchi 2000a).

The genus *Ceratitis* comprises approximately 65 species, found mostly in tropical Africa. Yet, one of its species, *C. capitata* (Mediterranean fruit fly) is dispersed throughout almost all tropical and temperate warm areas of the planet. It is considered the most cosmopolitan and harmful of all fruit flies, an invader which causes more dam-

ages to crops than any other species (Garcia 2009). The host range of *C. capitata* includes more than 350 fruit and vegetables around the world, and this pest has shown a preference for ripe and succulent fruits (Liquido et al. 1991). Zucchi (2001) has listed 59 hosts for medfly in Brazil with a wide distribution around the country. Souza-Filho et al. (2000) reported medfly and 35 *Anastrepha* species in São Paulo State of which only 20 have known hosts.

In São Paulo State, there are 248,809 square kilometers planted with a high diversity of commercial crops, many of which are hosts of fruit flies (Tephritidae). Due to intensive urbanization in the State, the fruit fly distribution and infestation period have changed with implications for the ecology of fruit flies and the strategies of IPM Programmes.

Lonchaeidae species have also been commonly recovered from fruit samples or McPhail traps (Raga et al. 2005, 2006), but in some cases without association with previous tephritid infestation (Uchôa-Fernandes & Nicácio 2010).

The capacity of tephritids to infest so many distinct hosts under different ecosystems has important implications in ecology and pest management. Indeed there are requirements for information on spatial and temporal distribution (Uchôa-Fernandes & Nicácio 2010) and competition among the fruit fly. Tephritid diversity is related to the host phenology in a complex manner, but knowledge thereof is crucial to understand the population dynamics of fruit flies (Souza-Filho et al. 2009), and for implementation of quarantine restrictions and management and control programs (McPheron 2000).

The present work reports the fruit fly and lance fly species (Tephritoidea) associated with fruits in natural conditions, collected from several localities in São Paulo State, Brazil.

Materials and Methods

From Mar 1997 to Sep 2003, a total of 536 fruit samples of 63 species in 28 botanical families (Table 1) were collected from 67 municipalities of all regions of São Paulo State, Brazil. A total of 117,396 fruits (2,130.70 kg) were collected randomly from the canopies and from the ground beneath the trees (Table 1). Samples were obtained from unsprayed trees and brought to the Laboratory of Economic Entomology, Instituto Biológico, located in the municipality of Campinas, São Paulo State. The fruits were counted, weighed and placed in fruit-holding boxes containing sterilized sand at the bottom and a piece of cotton cloth at the top. About 15-20 d later, the sand in the boxes was sieved to remove Tephritoidea pupae, which were counted and transferred to a glass cage (6,000 cc) with a small amount of dry sand at the bottom and kept at 25 ± 2 °C and 70 ± 10% relative humidity for 25 d to allow adult emergence. Adults were fed with a mixture of sugar/yeast extract (3:1) and water. Adults were killed in a freezer and placed in labeled vials with 70% ethanol for identification. Tephritidae adults were separated by sexes and the *Anastrepha* females were identified based on Stone (1942), Steyskal (1977) and Zucchi (2000b). Specimens of Lonchaeidae were not identified below family level. Infestation indices of Tephritoidea from each fruit species were measured by pupae per fruit and pupae per kg of fruits.

Results and Discussion

From overall infested collections the infestation average indices ranged from 0.01 to 22.98 pupae per fruit, obtained respectively from *Manihot esculenta* Crantz and *Cucurbita moschata* Duch. ex Poir. (Table 1). The maximum average infestations in samples were recovered from *C. moschata* (107.1 pupae), followed by *Mangifera indica* L. and sweet passion fruit, *Passiflora alata* Curtis, with 107.1, 59.0, and 38.5 pupae/fruit, respectively. In terms of pupae/kg of fruit, the average indices ranged from 0.01 (*M. esculenta*) to 277.9 (*Citharexylum myrianthum* Cham.). The maximum average infestations in samples were recovered from *C. myrianthum* (1,217.6), *Schinus terebenthifolius* Raddi (520.0), *Eriobotrya japonica* (Thunb.) Lindl. (430.6), *P. alata* (342.2), peach *Prunus persica* (L.) Batsch (418.2), passion fruit, *Passiflora edulis* Sims (287.5), and mango *M. indica* (283.3). According to Raga et al. (2004), some samples of 'Kumquat' and 'Cravo' mandarin collected in the state of São Paulo reached 64.0 and 37.9 pupae/kg of fruits, respectively. In the present work, only 17 plant species showed no fruit samples infested with fruit flies (Tephritoidea).

Considering all collections, we obtained 43,104 pupae and 26,368 adults of Tephritoidea (Table 2). The following frequencies of Tephritoidea adults were obtained during the experiment: 79.2% Tephritidae (63.5% *Anastrepha* spp. and 15.7% *C. capitata*) and 20.8% Lonchaeidae. No adult fly was obtained in 22 botanical species (Table 2) of which 6 had been reported to be hosts of *Anastrepha* spp. or *C. capitata* in the remaining Brazilian states (Zucchi 2001). Only *C. capitata* emerged from *Annona muricata* L. samples. The following hosts were only infested by Lonchaeidae: atemoya (*A. squamosa* L. × *A. cherimola* Mill.), *Annona reticulata* L., *Capsicum* sp., *Carica papaya* L., *Gossypium hirsutum* L., *P. edulis*, avocado (*Persea americana* Mill.), *Rollinia mucosa* (Jacq.) Baill., *S. terebinthifolius* and *Swartzia langsdorfii* Raddi. Only 5 hosts showed infestation by *Anastrepha* spp.: *Cryptocarya aschersoniana* Mez, *Cucurbita maxima* (Duchesne), *Picramnia* sp., *Punica granatum* Linnaeus, and *Rubus ulmifolius* Schott.

TABLE 1. HOST PLANTS OF TEPHRITOIDEA AND RESPECTIVE INFESTATION INDICES FROM SAMPLES COLLECTED IN THE STATE OF SÃO PAULO, BRAZIL (MAR 1997 TO SEP 2003).

Plant species	Total number of pupae	Pupae fruit^{-1} (minimum; maximum)	Pupae kg^{-1} (minimum; maximum)
Aleurites moluccana (L.) Willd.	1	0.08	1.08
Averrhoa carambola L.	5163	1.49 (0.00;5.39)	31.22 (0.00;227.39)
Capsicum sp.	35	0.25 (0.03;0.31)	56.45 (10.00;65.38)
Carica papaya L.	26	2.89 (0.00;26.00)	0.46 (0.00;16.05)
Citharexylum myrianthum Cham.	3143	0.2 (0.00;0.81)	277.91 (0.00;1217.57)
Clausena lansium (Lour.) Skeels	5	0.02	5.78
Cryptocarya aschersoniana Mez	52	0.19	23.64
Cucurbita moschata Duch. ex Poir.	1471	22.98 (0.00;107.14)	0.11 (0.00;28.16)
Diospyros kaki L.f.	75	0.04 (0.00;1.17)	0.37 (0.00;5.71)
Eriobotrya japonica (Thunb.) Lindl.	12721	1.35 (0.00;8.74)	109.35 (0.00;430.59)
Fragaria ananassa (Wetson) Duchesne	275	0.50 (0.00;0.67)	57.53 (0.00;91.82)
Garcinia brasilensis Mart.	128	0.05 (0.00;0.19)	6.49 (0.00;29.63)
Gossypium hirsutum L.	382	0.34 (0.00;093)	16.32 (0.00;61.73)
Inga spp.	2123	0.31 (0.00;2.86)	26.42 (0.00;235.43)
Malpighia emarginata Sessé & Moc ex DC.	1383	0.09 (0.00;0.95)	21.78 (0.00;169.37)
Malus domestica L.	106	0.02 (0.00;0.56)	40.59 (0.00;13.27)
Mangifera indica L.	1161	0.60 (0.00;59.00)	2.76 (0.00;283.33)
Manihot esculenta Crantz	5	0.01 (0.00;0.007)	0.01 (0.00;8.62)
Manilkara zapota (L.) P. Royen	232	0.91 (0.00;3.08)	23.41 (0.00;84.38)
Mimusops commersonii (G. Don) Engl.	48	0.36 (0.00;0.76)	15.14 (0.00;36.54)
Musa x paradisiaca L. (cv. Prata)	4	0.15 (0.00; 0.29)	1.07 (0.00;2.25)
Passiflora alata Curtis	914	4.11 (0.00;38.50)	45.48 (0.00;342.22)
Passiflora edulis Sims	161	0.69 (0.00;23.00)	6.56 (0.00;287.50)
Persea americana Mill.	112	2.67 (0.00;3.50)	4.07 (0.00;5.53)
Picramnia sp.	4	0.03	32.00
Pouteria caimito (Ruiz & Pav.) Radlk.	550	0.81 (0.00;3.08)	17.67 (0.00;121.25)
Prunus domestica L.	97	0.28 (0.00;2.11)	7.3 (0.00;81.83)
Prunus mume Siebold & Zucc.	1435	0.74 (0.00;2.51)	56.72 (0.00;264.63)
Prunus persica (L.) Batsc.	4996	2.94 (0.00;9.40)	77.52 (0.00;418.18)
Punica granatum L.	1	0.09	0.61
Pyrus communis L.	36	0.14 (0.00;0.35)	1.47 (0.00;28.08)
Rollinia mucosa (Jacq.) Baill.	26	0.96 (0.60/1.33)	0.12 (1.50;5.00)
*Rollinia sericea (*R.E. Fries) R.E. Fries	232	5.40 (0.00;8.92)	4.42 (0.00;246.81)
Rubus ulmifolius Schott	1	0.00 (0.00;0.20)	0.68 (0.00;15.27)
Schinus terebinthifolius Raddi	78	4.88	520.00
Solanum gilo Radd.	131	0.57 (0.00;11.00)	16.3 (0.00;253.85)
Solanum lycocarpum St.Hil.	7	0.24(0.00;0.33)	0.77 (0.00;0.96)
Solanum sp.	16	0.04 (0.00;0.08)	24.81 (0.00;40.00)
Spondias dulcis Parkinson	631	0.57 (0.00;2.45)	8.96 (0.00;81.84)
Spondias purpurea L.	1712	0.48 (0.02;2.09)	49.01 (1.62;256.00)
Swartzia langsdorfii Raddi	29	0.13 (0.00;0.32)	1.55 (0.00;4.05)
Terminalia catappa L.	2405	0.40 (0.00;2.89)	15.29 (0.00;125.00)

In all the hosts infested by *C. capitata* or *Anastrepha* spp. in the present work we also registered Lonchaeidae infestations (Table 2). Medfly and Lonchaeidae infestations were observed exclusively in *Solanum gilo* Radd. Eight plant species were considered hosts for both *Anastrepha* spp. and Lonchaeidae. Seventeen hosts showed infestation by *C. capitata* and *Anastrepha* species. Medfly and Lonchaeidae were recovered from 12 hosts while *Anastrepha* spp. and Lonchaeidae were recovered from 24 hosts.

We observed infestations by *C. capitata, Anastrepha* spp. and infestations by Lonchaeidae in the following 16 host plant species: *Averrhoa carambola* L., *C. myrianthum*, *Dyospyros kaki* L. f., *E. japonica*, *Garcinia brasiliensis* Mart., *Inga* spp., *Malpighia emarginata* Sessé & Moc ex DC, *Malus domestica* L., *Manilkara zapota* (Linnaeus) van Royen, *P. alata* Dryander, *Pouteria caimito* (Ruiz & Pav.) Radlk., *Prunus mume* Sieb. & Zucc., *P. persica*, *Pyrus communis* (Linnaeus) Batsch. *Spondias purpurea* L. and *Terminalia catappa.*

TABLE 2. TEPHRITOIDEA ADULTS RECOVERED FROM SAMPLES COLLECTED IN THE STATE OF SÃO PAULO, BRAZIL (MAR 1997 TO SEP 2003).

Plant species	Native (N) or Introduced (I)	Total number in samples	Total number of fruits	Mass Total (Kg)	Total (A+B+C)	*Ceratitis capitata* (A)		*Anastrepha* spp. (B)		Lonchaeidae (C)
						Female	Male	Female	Male	
Aleurites moluccana (L.) Willd.	I	1	12	0,93	0	—	—	—	—	—
Anacardium occidentale L.	N	2	42	2,14	0	—	—	—	—	—
Ananas sp.	N	2	29	3,05	0	—	—	—	—	—
Annona coriacea Mart.	N	1	12	3,86	0	—	—	—	—	—
Annona muricata L.	I	1	1	2,90	6	4	2	0	0	0
Annona reticulata L.	I	1	2	0,37	4	0	0	0	0	4
Annona squamosa L. x A. cherimola Mill.	I	1	1	0,61	3	0	0	0	0	3
Artocarpus heterophyllus Lam.	I	1	2	6,90	0	—	—	—	—	—
Averrhoa carambola L.	I	35	3473	165,40	2208	3	0	1040	1107	58
Bromelia antiacantha Bertol.	N	1	54	0,69	0	—	—	—	—	—
Capsicum sp.	I	2	142	0,62	24	0	0	0	0	24
Carica papaya L.	I	6	9	6,24	2	0	0	0	0	2
Cereus jamacaru DC.	N	1	3	0,32	0	—	—	—	—	—
Chrysophyllum cainito L.	I	1	31	1,83	0	—	—	—	—	—
Citharexylum myrianthum Cham.	N	23	15534	11,31	1587	0	1	651	751	184
Clausena lansium (Lour.) Skeels	I	1	244	0,87	0	—	—	—	—	—
Cryptocarya aschersoniana Mez	N	1	275	2,2	29	0	0	17	12	0
Cucurbita maxima (Dusc.)	N	2	3	4,46	28	0	0	9	19	0
Cucurbita moschata (Dusc.) Poir	I	11	64	214.00	815	0	0	303	318	194
Cucurbita moschata x *C. maxima*	I	1	1	4,39	0	—	—	—	—	—
Diospyros kaki L.f.	I	30	1718	205,34	26	13	9	0	2	2
Duguetia lanceolata A. St.—Hill.	N	1	1	0,18	0	—	—	—	—	—
Eriobotrya japonica (Thunb.) Lindl.	I	35	9434	116,34	9060	620	460	3308	4031	641
Fragaria ananassa (Wetson) Duchesne	I	6	551	4,78	179	0	0	69	109	1
Garcinia brasilensis Mart.	N	12	2338	19,73	80	35	31	2	4	8
Genipa americana L.	N	3	63	12,58	0	—	—	—	—	—
Gossypium hirsutum L.	I	13	1133	23,41	339	0	0	0	0	339
Inga spp.	N	23	6762	80,37	1202	17	7	501	270	407
Lycopersicon esculentum Mill.	I	3	273	202,00	0	—	—	—	—	—
Malpighia emarginata Sessé & Moc ex DC.	I	48	14874	63,51	908	95	87	155	153	418
Malus domestica L.	I	6	5108	23,07	76	1	5	7	4	59
Mangifera indica L.	I	51	1933	420,09	688	0	0	311	344	33
Manihot esculenta Crantz	N	2	421	1,68	0	—	—	—	—	—
Manilkara zapota (L.) P. Royen	I	10	254	9,91	138	84	40	1	0	13
Mimusops commersonii (G. Don) Engl.	I	3	135	3,17	45	0	0	14	18	13

TABLE 2. (CONTINUED) TEPHRITOIDEA ADULTS RECOVERED FROM SAMPLES COLLECTED IN THE STATE OF SÃO PAULO, BRAZIL (MAR 1997 TO SEP 2003).

Plant species	Native (N) or Introduced (I)	Total number in samples	Total number of fruits	Mass Total (Kg)	Total (A+B+C)	*Ceratitis capitata* (A)		*Anastrepha* spp. (B)		Lonchaeidae (C)
						Female	Male	Female	Male	
Murraya paniculata (L.) Jacq.	I	1	259	0.13	0	—	—	—	—	—
Musa paradisiaca L. (cv. Prata)	I	3	27	3.74	0	—	—	—	—	—
Passiflora alata Curtis	N	13	361	32.59	914	34	17	194	203	466
Passiflora edulis Sims	N	27	948	78.77	161	0	0	0	0	161
Persea americana Mill.	I	2	42	27,49	82	0	0	0	0	82
Picramnia sp.	N	1	117	0,13	4	0	0	3	1	0
Pouteria caimito (Ruiz & Pav.) Radlk.	N	8	682	31,12	375	1	0	142	162	70
Prunus domestica L.	I	6	349	13,30	73	0	0	28	44	1
Prunus mume Siebold & Zucc.	I	5	1938	25,30	910	251	176	223	238	22
Prunus persica (L.) Batsc.	I	26	1702	64,45	3854	1606	925	333	416	574
Prunus persica var. *nucipersica* Dippel	I	2	52	2,70	0	—	—	—	—	—
Punica granatum L.	I	1	11	1,65	1	0	0	1	0	0
Pyrus communis L.	I	2	260	24,44	35	0	1	16	17	1
Qualea grandiflora Mart.	N	1	58	1,74	0	—	—	—	—	—
Rollinia mucosa (Jacq.) Baill.	N	4	27	8,20	6	0	0	0	0	6
Rollinia sericea (R.E. Fries) R.E. Fries	N	2	43	1,22	197	0	0	63	79	55
Rubus ulmifolius Schott	I	3	959	1,48	1	0	0	1	0	0
Schinus terebinthifolius Raddi	N	1	16	0,15	35	0	0	0	0	35
Solanum gilo Radd.	I	3	228	8,03	97	2	0	0	0	95
Solanum lycocarpum St.Hil.	N	2	29	9,15	0	—	—	—	—	—
Solanum sp.	N	3	366	0,64	5	0	0	1	2	2
Spondias dulcis Parkinson	I	9	1113	70,40	147	0	0	83	61	3
Spondias mombin L.	N	1	119	2,13	0	—	—	—	—	—
Spondias purpurea L.	I	13	36288	34,99	491	2	0	202	283	4
Swartzia langsdorfii Raddi	N	3	230	19,00	25	0	0	0	0	25
Terminalia catappa L.	I	51	6060	157,26	1508	492	457	186	249	124
Theobroma cacao L.	N	1	12	5,68	0	—	—	—	—	—
Vitis vinifera L.	I	1	168	0,85	0	—	—	—	—	—

TABLE 3. *ANASTREPHA* FEMALE DIVERSITY OBTAINED FROM FRUIT SAMPLES COLLECTED IN THE STATE OF SÃO PAULO, BRAZIL (MAR 1997 TO SEP 2003).

Fruit fly species	Host plant	
	Family	Species
Anastrepha amita Zucchi	Verbenaceae	*Citharexylum myrianthum* Cham.
Anastrepha bahiensis Lima	Annonaceae	*Rollinia sericea (*R.E. Fries) R.E. Fries
Anastrepha distincta Greene	Fabaceae	*Inga* spp.
Anastrepha fraterculus (Wiedemann)	Anacardiaceae	*Spondias purpurea* L.; *Mangifera indica* L.
	Annonaceae	*Rollinia sericea* (R.E. Fries) R.E. Fries
	Clusiaceae	*Garcinia brasilensis* Mart.
	Combretaceae	*Terminalia catappa* L.
	Fabaceae	*Inga* spp.
	Lauraceae	*Cryptocarya aschersoniana* Mez
	Lytraceae	*Punica granatum* L.
	Malpighiaceae	*Malpighia emarginata* Sessé & Moc ex DC.
	Oxalidaceae	*Averrhoa carambola* L.
	Rosaceae	*Eriobotrya japonica* (Thunb.) Lindl.; *Fragaria ananassa* (Wetson) Duchesne; *Malus domestica* L.; *Prunus domestica* L.; *Prunus mume* Siebold & Zucc.; *Prunus persica* (L.) Batsc.*; Pyrus communis* L.*; Rubus ulmifolius* Schott
	Sapotaceae	*Pouteria caimito* (Ruiz & Pav.) Radlk.; *Manilkara zapota* (L.) P. Royen
	Picramniaceae	*Picramnia* sp.
	Solanaceae	*Solanum* sp.
Anastrepha grandis (Macquart)	Cucurbitaceae	*Cucurbita maxima* (Dusc.); *Cucurbita moschata* (Dusc.) Poir
Anastrepha leptozona Hendel	Sapotaceae	*Pouteria caimito* (Ruiz & Pav.) Radlk.
Anastrepha obliqua (Macquart)	Anacardiaceae	*Spondias dulcis* Parkinson; *Spondias purpurea* L.; *Mangifera indica* L.
	Malpighiaceae	*Malpighia emarginata* Sessé & Moc ex DC.
	Oxalidaceae	*Averrhoa carambola* L.
	Rosaceae	*Eriobotrya japonica* (Thunb.)
Anastrepha pseudoparallela (Loew)	Passifloraceae	*Passiflora alata* Curtis
Anastrepha serpentina (Wiedemann)	Sapotaceae	*Mimusops commersonii* (G. Don) Engl.
Anastrepha sororcula Zucchi	Anacardiaceae	*Mangifera indica* L.
	Malpighiaceae	*Malpighia emarginata* Sessé & Moc ex DC.
	Rosaceae	*Eriobotrya japonica* (Thunb.)

Medfly has become established in most areas of the country (Zucchi 2001). In the present work we reported for the first time medfly infestations on *C. myrianthum, P. mume*, and *S. gilo. Ceratitis capitata* is dominant in urban areas of São Paulo State (Raga et al. 2004) and it has shown a preference for coffee (Raga et al. 2002) and peach (Souza-Filho et al. 2009), although it can also infest native hosts (Table 2).

Our data indicated that Lonchaeidae is not exclusively an opportunistic group, although in the majority of fruits infested by them, previous infestation by tephritids can make them more suitable due to physical and chemical changes. Several Brazilian publications have shown an increasing number of reports of Lonchaeidae from fruit samples collected in different agro-ecosystems and biomes (Garcia & Corseuil 2004; Raga et al. 2004, 2005; Uchôa-Fernandes et al. 2002, 2003; Souza-Filho et al. 2009; Uchôa-Fernandes & Nicácio 2010). In the present work, lonchaeids were recovered from 23 introduced hosts (Table 2).

Ten *Anastrepha* species were recovered from the following fruit samples: *A. amita* Zucchi, *A. bahiensis* Lima, *A. distincta* Greene, *A. fratercu-*

lus (Wiedemann), *A. grandis* (Macquart), *A. leptozona* Hendel, *A. obliqua* (Macquart), *A. pseudoparallela* (Loew), *A. serpentina* (Wiedemann) and *A. sororcula* Zucchi. These *Anastrepha* species are associated with 16 botanical families (Table 3). Six species belong to the *fraterculus* Group: *A. amita, A. bahiensis, A. distincta, A. fraterculus, A. obliqua*, and *A. sororcula*. *Anastrepha pseudoparallela* is thought to infest *P. alata* exclusively although only lonchaeids emerged from fruit samples from *P. edulis*.

Although Barbados cherry (*M. emarginata*) showed low infestations, their samples presented the highest diversity of tephritids: *C. capitata*, *A. fraterculus*, *A. obliqua* and *A. sororcula*. Anacardiaceae, Rosaceae and Sapotaceae were infested by 4 tephritid species each.

Among the fruit fly species recovered from the fruit samples, the South-American fruit fly, *A. fraterculus,* was the most polyphagous species, infesting 22 hosts from 13 botanical families. *Anastrepha fraterculus* is the most economically important fruit fly in São Paulo State, where it infests 33 hosts, including introduced ones (Souza-Filho et al. 2000). We report for the first time the infestation of *A. fraterculus* on *C. aschersoniana* (Lauraceae), *Manilkara zapota* (L.) P. Royen (Sapotaceae), and *Picramnia* sp. (Picramniaceae) in Brazil. We report *A. fraterculus* infesting organic strawberry for the first time in São Paulo State (Table 3) at high infestation rates (up to 91.8 pupae kg^{-1}).

Our study showed new fruit fly-host associations in São Paulo State, probably due to the adaptation evolution of stenophagous/polyphagous species in highly disturbed ecosystems. Further studies should improve the knowledge of ecological aspects of Tephritoidea complex in different edapho-climatic conditions of São Paulo.

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References Cited

Aluja, M., and Mangan, R. L. 2008. Fruit fly (Diptera: Tephritidae) host status determination: critical conceptual, methodological, and regulatory considerations. Annu. Rev. Entomol. 53: 473-502.

Garcia, F. R. M. 2009. Fruit fly: biological and ecological aspects, pp. 1-35 *In* R. R. Bandeira [ed.], Current trends in fruit fly control on perennial crops and research prospects. Transworld Research Network, Kerala.

Garcia, F. R. M., and Corseuil, E. 2004. Native hymenopteran parasitoids associated with fruit flies (Diptera: Tephritoidea) in Santa Catarina State, Brazil. Florida Entomol. 87: 517-521.

Liquido, N. J., Shinoda, L. A., and Cunningham, R. T. 1991. Host plants of Mediterranean fruit fly: an annotated world review. Entomol. Soc. Am., Lanham, Maryland. Misc. Publ. 77, 52 pp.

McPheron, B. A. 2000. Population genetics and cryptic species, pp. 483-490 *In* K. H. Tan [ed.], Area-wide Control of Fruit Flies and Other Insect Pests. Penerbit Universiti Sains Malaysia, Penang.

Norrbom, A. L., Zucchi, R. A. and Hernández-Ortiz, V. 2000. Phylogeny of the genera *Anastrepha* and *Toxotrypana* (Trypetinae: Toxotrypanini) based on morphology, pp. 299-342 *In* M. Aluja and A. L. Norrbom [eds.], Fruit flies (Tephritidae): Phylogeny and Evolution of Behavior. CRC Press, Boca Raton.

Norrbom, A. L., and Korytkowski, C. A. 2009. A revision of the *Anastrepha robusta* species group (Diptera: Tephritidae). Zootaxa 2182: 1-91.

Raga, A., Prestes, D. A. O., Souza-Filho, M. F., Sato, M. E., Siloto, R. C., and Zucchi, R. A. 2002. Occurrence of fruit flies in coffee varieties in the State of São Paulo, Brazil. Bol. San. Veg. Plagas 28: 519-524.

Raga A., Prestes, D. A. O., Souza-Filho, M. F., Sato, M. E., Siloto, R. C., Guimarães, J. A., and Zucchi, R. A. 2004. Fruit fly (Diptera: Tephritoidea) infestation in citrus in the State of São Paulo, Brazil. Neotrop. Entomol. 33: 85-89.

Raga, A., Machado, R. A., Souza-Filho, M. F., Sato, M. E., and Siloto, R. C. 2005. Tephritoidea (Diptera) species infesting Myrtaceae fruits in the State of São Paulo, Brazil. Entomotropica 20:11-14.

Raga, A., Machado, R. A., Dinardo, W., and Strikis P. C. 2006. Eficácia de atrativos alimentares na captura de moscas-das-frutas em pomar de citros. Bragantia 65: 337-345.

Rengifo, J. A., Garcia, J. G., Rodriguez, J. F., and Wyckhuys, K. A. G. 2011. Host status of purple passion fruit for the Mediterranean fruit fly (Diptera: Tephritidae). Florida Entomol. 94: 91-96.

Souza-Filho, M. F., Raga, A., and Zucchi, R. A. 2000. Moscas-das-frutas nos estados brasileiros: São Paulo, pp. 277-283 *In* A. Malavasi and R. A. Zucchi [eds.], Moscas-das-frutas de Importância Econômica no Brasil. Holos, Ribeirão Preto.

Souza-Filho, M. F., Raga, A., Azevedo-Filho, J. A., Strikis, P. C., Guimarães, J. A., and Zucchi, R. A. 2009. Diversity and seasonality of fruit flies (Diptera: Tephritidae and Lonchaeidae) and their parasitoids (Hymenoptera: Braconidae and Figitidae) in orchards of guava, loquat and peach. Brazilian J. Biol. 69: 31-40.

Steyskal, G. 1977. Pictorial key to species of the genus *Anastrepha* (Diptera: Tephritidae). Entomol. Soc. Washington, Washington, DC, 35 pp.

Stone, A. 1942. The fruit flies of the genus *Anastrepha*. USDA, Washington, DC., USDA, Misc. Publ. 439, 112p.

Uchôa-Fernandes, M. A., Oliveira, I., Molina, R. M. S., and Zucchi, R. A. 2002: Species diversity of frugivorous flies (Diptera: Tephritoidea) from hosts in the Cerrado of the State of Mato Grosso do Sul, Brazil. Neotrop. Entomol. 31: 515-524.

Uchôa-Fernandes, M. A., Oliveira, I., Molina, R. M. S., and Zucchi, R. A. 2003. Biodiversity of frugivorous flies (Diptera: Tephritoidea) captured in citrus groves, Mato Grosso do Sul, Brazil. Neotrop. Entomol. 32: 239-246.

Uchôa-Fernandes, M. A., and Nicácio, J. 2010. New records of neotropical fruit flies (Tephritidae), lance

flies (Lonchaeidae) (Diptera: Tephritoidea), and their host plants in the south Pantanal and adjacent areas, Brazil. Ann. Entomol. Soc. Am. 103: 723-733.

ZUCCHI, R. A. 2000a. Espécies de *Anastrepha*, sinonímias, plantas hospedeiras e parasitóides, pp. 41-48. *In* A. Malavasi and R. A. Zucchi [eds.], Moscas-das-frutas de importância econômica no Brasil: conhecimento básico e aplicado. Holos, Ribeirão Preto.

ZUCCHI, R. A. 2000b. Taxonomia, pp. 13-24 *In* A. Malavasi and R.A. Zucchi [eds.], Moscas-das-frutas de importância econômica no Brasil: conhecimento básico e aplicado. Holos, Ribeirão Preto.

ZUCCHI, R. A. 2001. Mosca-do-mediterrâneo, *Ceratitis capitata* (Diptera: Tephritidae), pp. 15-22 *In* E. F. Vilela, R. A. Zucchi and F. Cantor [eds.], Pragas introduzidas no Brasil. Holos, Ribeirão Preto.