Host Ranges and Infestation Indices of Fruit Flies (Tephritidae) and Lance Flies (Lonchaeidae) in São Paulo State, Brazil

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Source: Florida Entomologist, 94(4) : 787-794
Published By: Florida Entomological Society
URL: https://doi.org/10.1653/024.094.0409
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 (Duss.) 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 baiensis Lima, Anastrepha distincta Greene, Anastrepha fraterculus (Wied.), Anastrepha grandis (Macquart), Anastrepha leptoza Zucchi, Anastrepha obliqua (Macquart), Anastrepha pseudoparallela (Loew), Anastrepha serpentina (Wied.), Anastrepha soroza 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 del 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 y Lonchaeidae) con huéspedes colectados en 67 municipios del estado de São Paulo, Brasil. Desde marzo de 1997 a septiembre de 2003, fueron 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 (Duss.) Poir, seguido por Mangifera indica L. y Passiflora alata Curtis, con 107.14, 59.00 y 38.50 pupas/fruto, respectivamente. En términos de pupario/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 baiensis Lima, Anastrepha distincta Greene, Anastrepha fraterculus (Wied.), Anastrepha grandis (Macquart), Anastrepha leptoza Zucchi, Anastrepha obliqua (Macquart), Anastrepha pseudoparallela (Loew), Anastrepha serpentina (Wied.), Anastrepha soroza Zucchi, Ceratitis capitata (Wied.) y Lonchaeidae. En todos los hospederos infestados por C. capitata o Anastrepha spp. también se registró la presencia de especímenes 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 (Tephritoidae) 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 Tephritoidae 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 Tephritioidea 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 (Tephritoidae).

Considering all collections, we obtained 43,104 pupae and 26,368 adults of Tephritoidae (Table 2). The following frequencies of Tephritoidae 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 langsdorffii* Raddi. Only 5 hosts showed infestation by *Anastrepha* spp.: *Cryptocarya aschersoniana* Mez, *Cucurbita maxima* (Duchesne), *Picramnia* sp., *Punica granatum* Linnaeus, and *Rubus ulmifolius* Schott.
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., *Gossypium hirsutum* L.f., *Passiflora alata* Curtis, *Passiflora edulis* Sims, *Punica granatum* L., *Pyrus communis* L., *Rubus ulmifolius* Schott, *Solanum gilo* Radd., *Solanum lycocarpum* St.Hil., *Solanum sp.* 6, *Spondias dulcis* Parkinson, *Spondias purpurea* L., *Swartzia langsdorffi* Raddi and *Terminalia catappa* L. 

### Table 1. Host plants of Tephritoidae 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 fruit¹ (minimum; maximum) | Pupae kg² (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                    | 2.09 (0.00;25.00)               | 0.16 (0.00;28.16)            |
| **Citharexylum myrianthum** Cham. | 3143                 | 0.2 (0.00;0.81)                 | 27.91 (0.00;1217.57)         |
| **Clausena lanisus** (Lour.) Skeels | 5                    | 0.02                            | 5.78                         |
| **Cryptocarya aschersoniana** Mez | 52                   | 0.19                            | 23.64                        |
| **Cucurbita moschata** Duch. ex Poir. | 1471                | 2.98 (0.00;107.14)              | 0.11 (0.00;28.16)            |
| **Diospyros kaki** L.f.        | 79                    | 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 annanassa** (Wetson) Duchesne | 275                  | 0.30 (0.00;0.76)                | 15.45 (0.00;36.54)           |
| **Garcinia brasiliensis** Mart. | 128                   | 0.05 (0.00;0.19)                | 6.49 (0.00;29.63)            |
| **Gossypium hirsutum** L.      | 5                     | 0.02                            | 5.78                         |
| **Guava**                      | 91                    | 0.02                            | 5.78                         |
| **Guava**                      | 912                   | 0.02                            | 5.78                         |
| **Malpighia emarginata** Sessé & Moc ex DC. | 58                    | 0.19                            | 23.64                        |
| **Malus domestica** L.         | 106                   | 0.02 (0.00;0.56)                | 40.59 (0.00;13.27)           |
| **Mangifera indica** L.        | 1161                  | 0.60 (0.00;69.00)               | 2.76 (0.00;283.33)           |
| **Manihot esculenta** Crantz    | 5                     | 0.02 (0.00;0.07)                | 0.01 (0.00;0.62)             |
| **Manilkara zapota** (L.) R. Royen | 232                  | 0.91 (0.00;3.08)                | 23.41 (0.00;84.38)           |
| **Minuosp commersonii** (G. Don) Engl. | 48                   | 0.36 (0.00;0.76)                | 15.14 (0.00;36.54)           |
| **Musa x paradisiaca** (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;9.96)             |
| **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 (0.00;256.00)          |
| **Swartzia langsdorffi** 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)          |
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) |
|---------------|-----------------------------|-------------------------|------------------------|----------------|---------------|----------------------|---------------------|-----------------|
| Aleurites moluccana (L.) Wild. | 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 |
| Annona reticulata L. | I | 1 | 2 | 0.37 | 4 | 0 | 0 | 0 |
| Annona squamosa L. x A. cherimola Mill. | I | 1 | 1 | 0.61 | 3 | 0 | 0 | 0 |
| Artocarpus heterophyllus Lam. | I | 1 | 2 | 6.90 | 0 | — | — | — |
| Averrhoa carambola L. | I | 35 | 3473 | 165.40 | 2208 | 3 | 0 | 1040 |
| Bromelia antianantha Bertol. | N | 1 | 54 | 0.69 | 0 | — | — | — |
| Capsicum sp. | I | 2 | 142 | 0.62 | 24 | 0 | 0 | 0 |
| Carica papaya L. | I | 6 | 9 | 6.24 | 2 | 0 | 0 | 0 |
| 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 | 1857 | 0 | 1 | 651 |
| Clausena lanisus (Lour.) Skeels | I | 1 | 244 | 0.87 | 0 | — | — | — |
| Cryptocarya eschersoniana Mez | N | 1 | 275 | 2.2 | 29 | 0 | 0 | 17 |
| Cucurbita maxima (Dusch.) | N | 2 | 3 | 4.46 | 28 | 0 | 0 | 9 |
| Cucurbita moschata (Dusch.) Poir | I | 11 | 64 | 214.00 | 815 | 0 | 0 | 303 |
| Cucurbita moschata x C. maxima | I | 1 | 1 | 4.39 | 0 | — | — | — |
| Diospyros kaki Lf. | I | 30 | 1718 | 205.34 | 26 | 13 | 9 | 0 |
| Duguetia lanceolata A. St.—Hill. | N | 1 | 1 | 0.18 | 0 | — | — | — |
| Eriobotrya japonica (Thunb.) Lindl. | I | 35 | 9434 | 116.34 | 9060 | 620 | 460 | 3308 |
| Fragaria ananassa (Wetsen) Duchesne | I | 6 | 551 | 4.78 | 179 | 0 | 0 | 69 |
| Garcinia brasiliensis Mart. | N | 12 | 2338 | 19.73 | 80 | 35 | 31 | 2 |
| Genipa americana L. | N | 3 | 63 | 12.58 | 0 | — | — | — |
| Gossypium hirsutum (Lour.) Skeels | I | 1 | 31 | 1.83 | 0 | — | — | — |
| Inga spp. | N | 23 | 6762 | 80.37 | 1202 | 17 | 7 | 501 |
| Lycopersicon esculentum Mill. | I | 3 | 273 | 202.00 | 0 | — | — | — |
| Malpighia emarginata Sessé & Moc ex DC. | I | 48 | 14874 | 63.51 | 908 | 95 | 87 | 155 |
| Malus domestica L. | I | 6 | 5108 | 23.07 | 76 | 1 | 5 | 7 |
| Mangifera indica L. | I | 51 | 1933 | 420.09 | 688 | 0 | 0 | 311 |
| Manihot esculenta Crantz | N | 2 | 421 | 1.68 | 0 | — | — | — |
| Manilkara zapota (L.) P. Royen | I | 10 | 254 | 9.91 | 138 | 84 | 40 | 1 |
| Mimusops commersonii (G. Don) Engl. | I | 3 | 135 | 3.17 | 45 | 0 | 0 | 14 |

Note: The table continues with similar entries for additional plant species.
| Plant species                  | Native (N) or Introduced (I) | Total number in samples | Total number of fruits | Mass Total (Kg) | Total (A+B+C) Female | Male | Ceratitis capitata (A) Female | Male | Anastrepha spp. (B) Female | Male | Lonchaeidae (C) Female | Male |
|-------------------------------|------------------------------|-------------------------|------------------------|-----------------|------------------------|------|-------------------------------|------|-----------------------------|------|------------------------|------|
| Murraya paniculata (L.) Jacq. | I                            | 1                       | 259                    | 0.13            | 0                      |      | 0                            |      | 194                         |      | 203                    |      |
| Musa paradisiaca L. (cv. Prata) | I                            | 3                       | 27                     | 3.74            | 0                      |      | 0                            |      | 0                           |      | 161                    |      |
| Passiflora alata Curtis      | N                            | 13                      | 361                    | 32.59           | 914                    | 34   | 17                           |      | 340                         |      | 250                    |      |
| Passiflora edulis Sims       | N                            | 27                      | 948                    | 78.77           | 161                    | 0    | 0                            |      | 0                           |      | 161                    |      |
| Persea americana Mill.       | I                            | 2                       | 42                     | 27.49           | 82                     | 0    | 0                            |      | 0                           |      | 0                      |      |
| Picramnia sp.                | N                            | 1                       | 117                    | 0.13            | 4                      |      | 3                            |      | 1                           |      | 0                      |      |
| Pouteria caimito (Ruiz & Pav.) Radlk. | N | 8                       | 682                    | 31.12           | 375                    | 1    | 0                            |      | 142                         |      | 162                    |      |
| Prunus domestica L.          | I                            | 6                       | 349                    | 13.30           | 73                     |      | 0                            |      | 0                           |      | 28                     | 44   |
| Prunus mume Siebold & Zucc.  | I                            | 5                       | 1938                   | 25.30           | 910                    | 251  | 176                          |      | 223                         |      | 238                    |      |
| Prunus persica (L.) Batsch.   | I                            | 26                      | 1702                   | 64.45           | 3854                   | 1606 | 925                          |      | 333                         |      | 416                    | 574  |
| Prunus persica var. nucipersica Dippel | I | 2                       | 52                     | 2.70            | 0                      |      | 1                            |      | 0                           |      | 0                      |      |
| Pyrus communis L.            | I                            | 2                       | 260                    | 24.44           | 35                     |      | 1                            |      | 16                          |      | 17                     |      |
| Qualea grandiflora Mart.     | N                            | 1                       | 58                     | 1.74            | 0                      |      | 0                            |      | 0                           |      | 0                      |      |
| Rollinia mucosa (Jacq.) Baill. | N                           | 4                       | 27                     | 8.20            | 6                      |      | 0                            |      | 0                           |      | 0                      |      |
| Rollinia sericea (R.E. Fries) R.E. Fries | N | 2                       | 43                     | 1.22           | 197                    |      | 0                            |      | 63                          |      | 79                     |      |
| Rubus ulmifolius Schott      | I                            | 3                       | 959                    | 1.48            | 1                      |      | 0                            |      | 1                           |      | 0                      |      |
| Schinus terebinthifolius Raddi | N                    | 1                       | 16                     | 0.15            | 35                     |      | 0                            |      | 0                           |      | 0                      |      |
| Solanum gilo Radd.           | I                            | 3                       | 228                    | 8.03            | 97                     | 2    | 0                            |      | 0                           |      | 0                      |      |
| Solanum lycocarpum St.Hil.   | N                            | 2                       | 29                     | 9.15            | 0                      |      | 0                            |      | 1                           |      | 2                      |      |
| Solanum sp.                  | N                            | 3                       | 366                    | 0.64            | 5                      |      | 0                            |      | 1                           |      | 2                      |      |
| Spondias dulcis Parkinson    | I                            | 9                       | 1113                   | 70.40           | 147                    |      | 0                            |      | 83                          |      | 61                     |      |
| Spondias mombin L.           | N                            | 1                       | 119                    | 2.13            | 0                      |      | 0                            |      | 0                           |      | 0                      |      |
| Spondias purpurea L.         | I                            | 13                      | 36288                  | 34.99           | 491                    | 2    | 0                            |      | 202                         |      | 283                    |      |
| Swartzia langsdorffii Raddi  | N                            | 3                       | 230                    | 19.00           | 25                     |      | 0                            |      | 0                           |      | 0                      |      |
| Terminalia catappa L.        | I                            | 51                      | 6060                   | 157.26          | 1508                   | 492  | 457                          |      | 186                         |      | 249                    | 124  |
| Theobroma cacao L.           | N                            | 1                       | 12                     | 5.68            | 0                      |      | 0                            |      | 0                           |      | 0                      |      |
| Vitis vinifera L.            | I                            | 1                       | 168                    | 0.85            | 0                      |      | 0                            |      | 0                           |      | 0                      |      |
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. fraterculus* (Wiedemann), *A. grandis* (Macquart), *A. leptozona* Hendel, *A. obliqua* (Macquart), *A. pseudoparallela* (Loew), *A. serpentina* (Wiedemann), *A. sororcula* Zucchi, *A. serpentina* (Wiedemann), *A. pseudoparallela* (Loew), and *A. serpentina* (Wiedemann).

### 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 | 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 brasiliensis* Mart. |
|                   | Combretaceae | *Terminalia catappa* L. |
|                   | Fabaceae | *Inga* spp. |
|                   | Lauraceae | *Cryptocarya aschersoniana* Mez |
|                   | Lytraceae | *Punica granatum* L. |
|                   | Malpighiaceae | *Malpighia emarginata* Sessé & Moc ex DC. |
|                   | Oxalidaceae | *Avrgrhoa carambola* L. |
|                   | Rosaceae | *Eriobotrya japonica* (Thunb.) Lindl.; *Fragaria ananassa* (Wetson) Duchesne; *Malus domestica* L.; *Prunus domestica* L.; *Prunus mume* Siebold & Zucc.; *Prunus persica* (L.) Batse.; *Pyrus communis* L.; *Rubus ulmifolius* Schott |
|                   | Sapotaceae | *Pouteria cainito* (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 cainito* (Ruiz & Pav.) Radlk. |
| *Anastrepha obliqua* (Macquart) | Anacardiaceae | *Spondias dulcis* Parkinson; *Spondias purpurea* L.; *Mangifera indica* L. |
|                   | Malpighiaceae | *Malpighia emarginata* Sessé & Moc ex DC. |
|                   | Oxalidaceae | *Avrgrhoa 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.) |
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 Tephritoidae complex in different edapho-climatic conditions of São Paulo.

ACKNOWLEDGMENTS

We are grateful to Mr. Gabriel Buratto da Silva for his technical assistance in laboratory activities.

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 [eds.], 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: Tephritoidae) 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: Tetranychidae) based 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: Tephritidae) 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. Tephritoida (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 pomicultura. Bразаntia 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.

UCHÓA-FERNANDES, M. A., OLIVEIRA, I., MOLINA, R. M. S., AND ZUCCHI, R. A. 2002: Species diversity of frugivorous flies (Diptera: Tephritidae) from hosts in the Cerrado of the State of Mato Grosso do Sul, Brazil. Neotrop. Entomol. 31: 515-524.

UCHÓA-FERNANDES, M. A., OLIVEIRA, I., MOLINA, R. M. S., AND ZUCCHI, R. A. 2003. Biodiversity of frugivorous flies (Diptera: Tephritidae) captured in citrus groves, Mato Grosso do Sul, Brazil. Neotrop. Entomol. 32: 239-246.

UCHÓA-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.