POPULATION FLUCTUATIONS OF ECONOMIC SPECIES OF *ANASTREPHA* (DIPTERA: TEPHRITIDAE) RELATED TO MANGO FRUITING PHENOLOGY IN COSTA RICA

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ABSTRACT

Fruit flies were systematically trapped in 4 localities in Costa Rica during 15 consecutive months using McPhail traps, with *Torula* yeast plus borax as attractant. Observations were made every two weeks and population fluctuations were evaluated with respect to the phenology of mango trees in the vicinity. A total of 10,446 fruit flies were collected: 97.6% *Anastrepha* spp. Schiner, 2.0% *Ceratitis capitata* (Wiedemann), and 0.4% *Toxotrypana curvicauda* Gerstaecker. *A. obliqua* (Macquart) was the species most closely associated with mango, *Mangifera indica* L.; *A. striata* Schiner with guava *Psidium guajava* L., and other Myrtaceae; *A. serpentina* (Wiedemann) with various species of Sapotaceae. Fruit fly species in which the biology is unknown were also collected. In general, the species of *Anastrepha* showed highest densities during periods of abundant mature fruit of their respective hosts.

RESUMEN

En cuatro localidades de Costa Rica y durante 15 meses consecutivos se realizó un muestreo sistematizado de moscas de las frutas, utilizando trampas de McPhail con levadura de *Torula* boratada como atrayente. Se hicieron observaciones semana de por medio y se evaluó la fluctuación de las poblaciones, relacionándola con la fenología de loa árboles hospederos localizados en las cercanías. Se recolectó un total de 10.446 indivíduos de *Anastrepha* spp. Schiner (97.6%), *Ceratitis capitata* (Wiedemann) (2.0%) y *Toxotrypana curvicauda* Gerstaecker (0.4%). *A. obliqua* (Macquart) resultó ser la especie más cercanamente relacionada con el mango, *Mangifera indica* L.; *A. striata* Schiner con la guayaba, *Psidium guajava* L. y otras mirtáceas; y *A. serpentina* (Wiedemann) con varias especies de sapotáceas. También se recolectaron especies cuya biología se desconoce. En general, las especies de *Anastrepha* observadas presentan mayor densidad durante el período de abundancia de frutas maduras de su respectivo hospedero.

Flies of the genus *Anastrepha* Schiner (Diptera, Tephritidae) are the most important fruit pests in tropical America. Of 185 described species (Norrbom 1985), 28 have been reported from Costa Rica (Jirón *et al.* 1988). Of these, three are economically important: *A. obliqua* (Macquart), *A. striata* Schiner and *A. serpentina* (Wiedemann) (Jirón and Hedström 1988). Some aspects of *Anastrepha* biology and control have been studied recently in Costa Rica, but there is no information on their population fluctuations and relations with host plant phenology. An earlier study (Jirón & Hedström 1988) showed that fruit flies tend to be associated with a given host plant family, and that their populations tend to increase during the fruiting season of the preferred hosts. This paper reports on these aspects for those *Anastrepha* species mentioned above, studied for 15 months in four regions of Costa Rica.

Materals and Methods

Systematic examples were taken every other week in four sites in Costa Rica: Lepanto and Buenos Aires, Puntarenas Province; Cañas, Guanacaste Province; and Orotina, Alajuela Province.

(A) LEPANTO: a 4-year-old, 4 ha. mango plantation, surrounded by adult. semi-wild members of the Ancardiaceae such as *Spondias purpurea* L., *S. mombin* L. and several species of Sapotaceae;

(B) OROTINA: a 12-year-old, 2 ha. orchard, located in a major area of mango production in Costa Rica.

(C) CAÑAS: a 10-year-old, 4.5 ha. mango plantation;

(D) BUENOS AIRES: an area of was composed of 1.0 ha, composed of mixed host tree species, planted 10-30 m apart: guava, avocado (*Persea americana* Mill.), inga (*Inga quadrangularis* L.), coffee (*Coffea arabica* L.), cassava (*Manihot esculenta* Crantz) and several varieties of *Citrus*. All of these are hosts of *Anastrepha* (Norrbom & Kim 1988).

Cañas and Lepanto are in areas of tropical dry forest. Buenos Aires and Orotina are in transitional zones to the tropical dry forest and non-seasonal tropical wet forest, respectively.

Standard McPhail traps, baited with a aqueous solution of *Torula* yeast (10 g/l) and borax (5 g/l) (Hedström & Jirón 1985) were set in groups of 15 in each orchard. The fruit fly trapping started in May 1985 through July 1986, and the traps were hung up 20-24 m apart, 2-4 m high. Every two weeks, mango tree phenology in each orchard was recorded, the traps were checked for *Anastrepha* spp., *Ceratitis capitata* (Wiedemann), and *Toxotrypana curvicauda* Gerstaceker and re-baited. The nomenclature of the adult flies follow Steyskal's key (1977).

Results and Discussion

A total of 10,446 adult fruit flies were captured. The flies captured were composed of 10,201 (97.6%) *Anastrepha* spp., 208 (2.0%) *C. capitata* and 38 (0.4%) *T. curvicauda*. During the trapping period, the last two species occurred in the study sites of Orotina, Cañas and Buenos Aires.

The bait used is a feeding attractant (Spishakoff & Hernández-Davila 1968). Nevertheless, the lowest level of trap catches in all plots coincided with the absence of mango fruits (Figs. 1-4). Such low trap catches persisted for some weeks after the fruit set was over. Previous studies demonstrated that the onset of infestations in mango fruits depended on the mango variety (Soto-Manitiu et al. 1987). It is clear that growing more than one mango variety in the same plot, favors the occurrence of adult fruit flies for a longer time. In Costa Rica it has been observed that a variety like "Yellow Haden" is infested by *A. obliqua* during the seventeenth week after fruit set; the one known as "Irwin" is infested after ten weeks; and finally the "Tommy Atkins" variety is infested by this fruit fly after the seventh week (Soto-Manitiu et al. 1987). Most Costa Rican mango orchards have more than one variety in the same orchard, and with the presence of some secondary host plants like Spanish plum used as live fences and some very old "criollo" mango trees in the vicinity maintains the *A. obliqua* adult population at high levels for a longer period (Figs. 1-4). Also, the local mango harvesters usually do not pick the small and unripe fruit during harvest. The fruit remaining on the tree all become infested with *A. obliqua*.

Of the 303 adult fruit flies captured in Lepanto, 94% were *A. obliqua*, 3% were *A. serpentina*, and 3% were *A. balloui* Stone (Fig. 1). A similar pattern was found in Cañas where a capture of 2,009 fruit flies consisted of 97, 1, 0.8 and 1.2% *A. obliqua*, *A.*

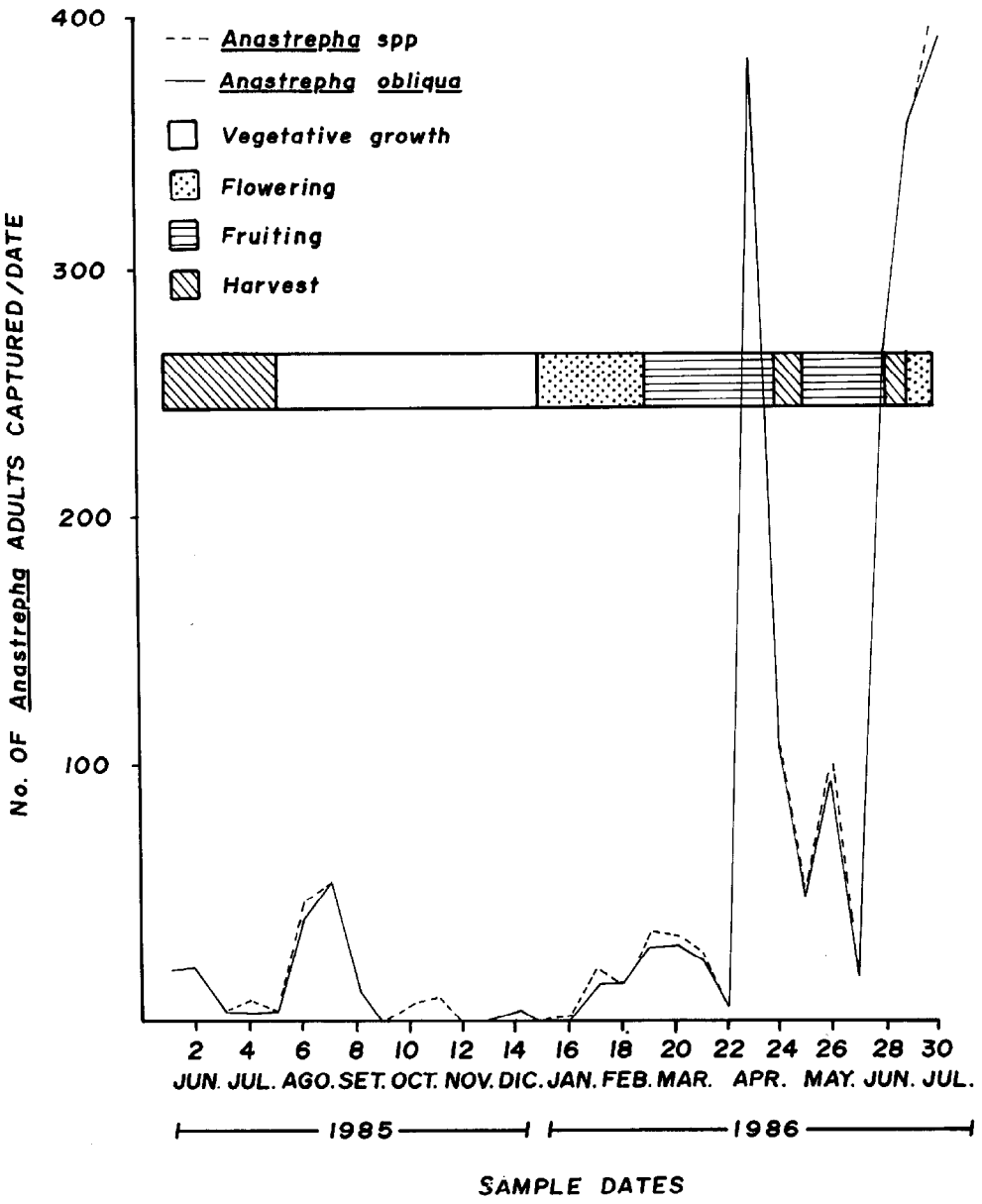

Fig. 1. Fruiting phenology of mango and weekly catches of *Anastrepha* spp. fruit flies in traps placed in mango trees in Lepanto, Puntarenas Province, Costa Rica.

striata, *A. serpentina* and other species of the same genus, such as *A. irretita* Stone, *A. distincta* Greene, *A. spatulata* Stone and *A. fraterculus* (Wiedemann), respectively (Fig. 2).

A. obliqua is most commonly found attacking mango (Jirón & Hedström 1988). It is probably attracted by the fruit for oviposition, whereas adults of other species may use the foliage for feeding or mating sites (Soto-Manitiu & Jirón 1989). This may explain the difference in the numbers of *A. obliqua* collected at Lepanto in 1985, when 8-10 fruits were produced by each tree, and in the numbers captured in 1988, when 30-35 fruits per tree were produced. The two-peak population increase at Cañas (Fig. 2) may

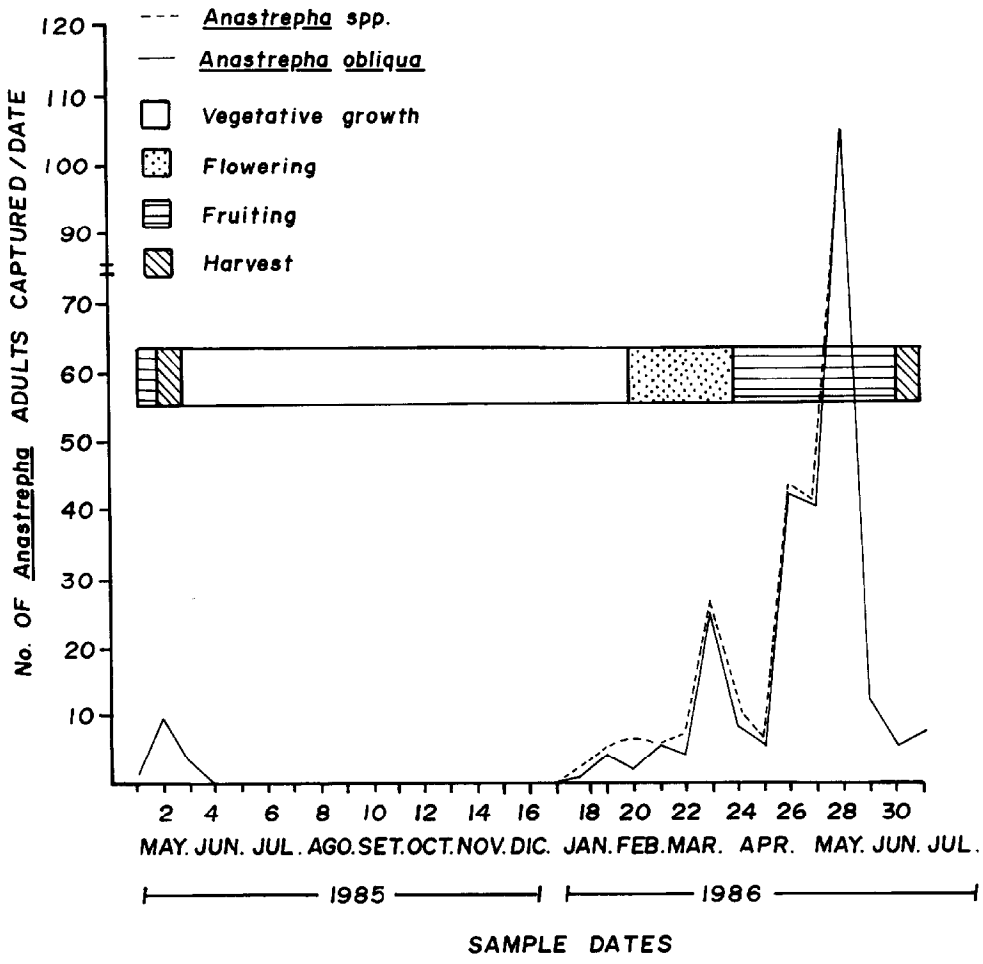

Fig. 2. Fruiting phenology of mango and weekly catches of *Anastrepha* spp. fruit flies in traps placed in mango trees in Cañas, Guanacaste Province, Costa Rica.

have been caused by the formation of early and late flowering caused when strong winds destroyed about half the flowers in December and January. This resulted in two distinct fruiting periods instead of one.

As shown in Table 1, the association of *A. obliqua* with mango is evident (97% of collected fruit flies in Cañas, 94% in Lepanto, 49.6% in Buenos Aires and 47.3% in Orotina). The same correlation was demonstrated in a previous study (Jirón & Hedström 1988). The high number of *A. obliqua* and *A. serpentina* collected in Orotina (Table 1) may be explained by the abundance of both mango and sapotaceous host trees in that area.

At the Orotina site, of 7,326 collected flies, 46, 6.5 and 0.2% were *A. serpentina*, *A. striata* and other species of *Anastrepha*. When mango fruits were overriped they were visited by a number of *Anastrepha*, such as *A. canalis* Stone, *A. balloui* and *A. panamensis* Greene. The host plants of immature *A. canalis* and *A. panamensis* are not well known (Soto-Manitiu et al. 1989, Jirón et al. 1988).

In Buenos Aires, host plants of *A. striata* (guava) and *A. obliqua* (mango) were available (Jirón & Hedström 1988), which may explain why both species occur in similar numbers. A total of 563 fruit flies collected at the latter site, 49.6, 47.8, and 2.7% were

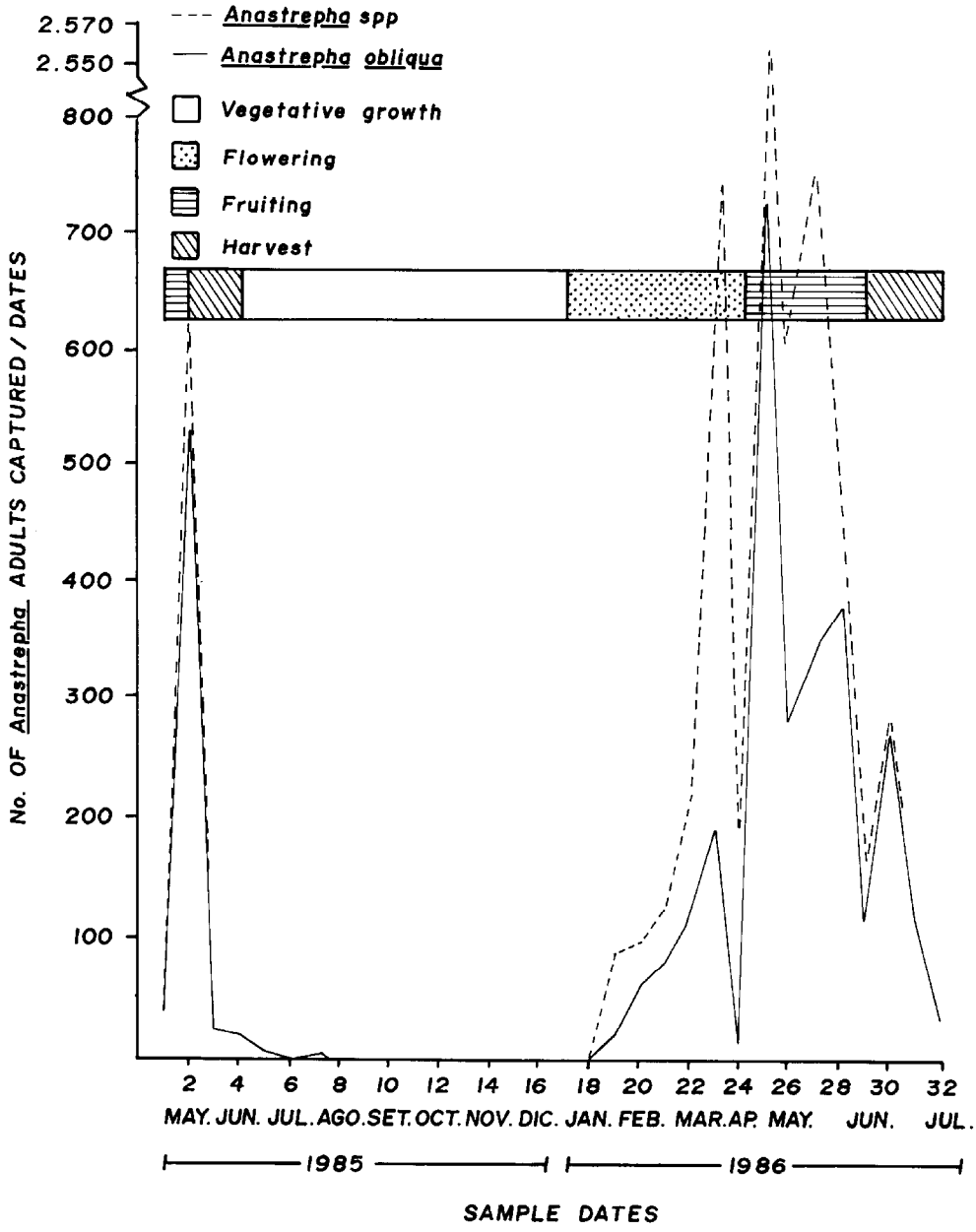

Fig. 3. Fruiting phenology of mango and weekly catches of *Anastrepha* spp. fruit flies in traps placed in mango trees in Orotina, Alajuela Province, Costa Rica.

A. obliqua, *A. striata* and other *Anastrepha* species (i.e. *A. fraterculus*, *A. distincta*, *A. manihoti* Lima and *A. chiclayae* Greene), respectively.

The high diversity of fruit fly species in Buenos Aires may result from a corresponding host plant diversity. Some of the host plants found in the surrounding were *Manihot esculenta* for *A. manihoti*, *Chrysophyllum cainito* L. for *A. serpentina*, *Inga quadrangularis* for *A. distincta*, *Psidium guajava* L. for *A. striata* and *A. fraterculus*. The latter species is strongly associated with Myrtaceae although it has been recorded as infesting some 68 plant species in the Neotropics (Norrbom & Kim 1988). We have found

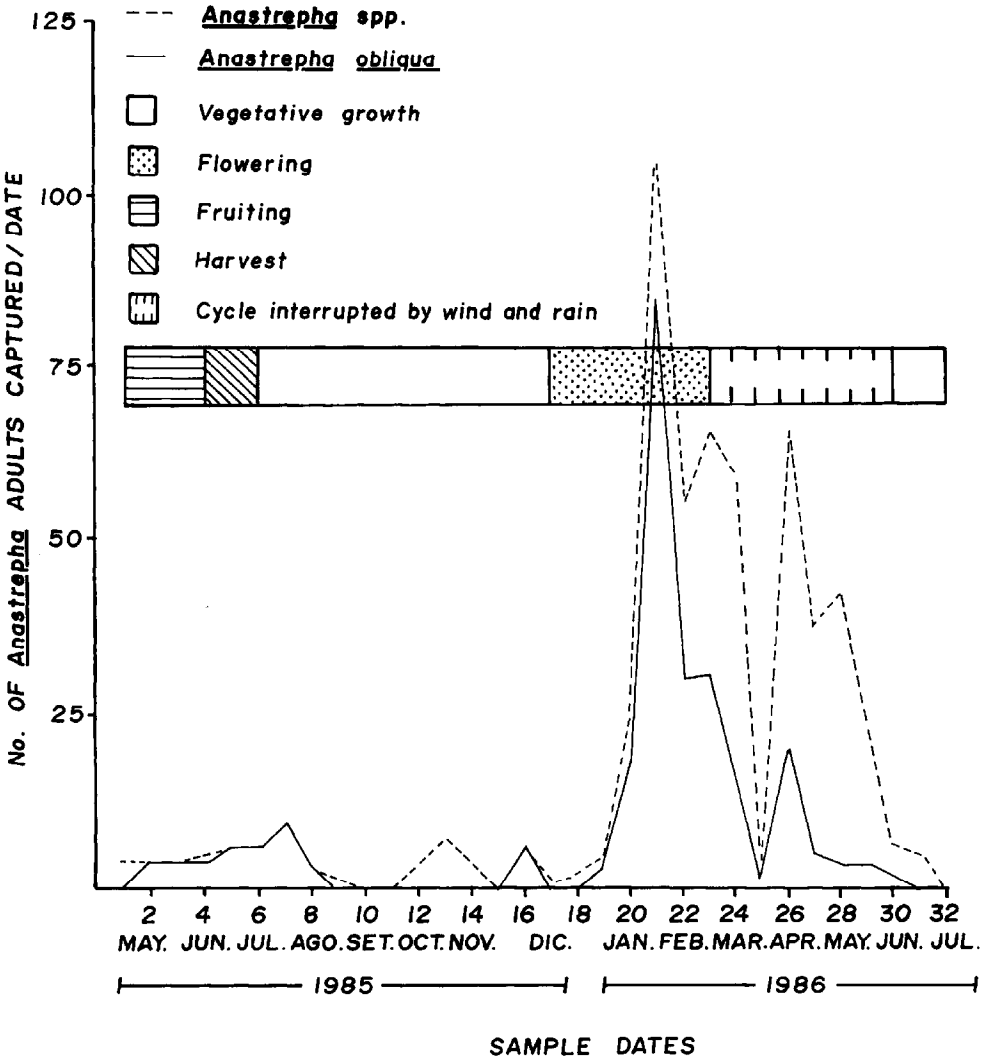

Fig. 4. Fruiting phenology of mango and weekly catches of *Anastrepha* spp. fruit flies in traps placed in mango trees in Buenos Aires, Puntarenas Province, Costa Rica.

it in association with *P. guajava*, although it does not seem to be of economic significance in Costa Rica (Jirón and Hedström 1988).

The highest number of *Anastrepha* caught, 2,560 individuals ($\bar{x} = 170$ per trap) in a single sample date was trapped on 15 April 1986, in Orotina. The trapped flies consisted of *A. obliqua* (49%), *A. serpentina* (38.8%), *A. striata* (5.5%) and others (7.5%, i.e. *A. fraterculus*, *A. panamensis*, *A. balloui* and *A. canalis*). This large capture of several species of *Anastrepha* is probably related to the diversity of different varieties of mango, other Anacardiaceae and three species of Sapotaceae in the plot. This peak coincided with the onset of the rainy season and the fruit production of *Chrysophyllum cainito* and *Manilkara achras*, two sapotaceous species exploited in the area which are important hosts of *A. serpentina* in Costa Rica (Jirón & Hedström 1988). Some guava trees also set fruit at the time, possibly favoring the occurrence of *A. striata*. The local population of *A. obliqua* adults increased with the first rains of the wet season. Producers pick the fruit at that time in order to market uninfested fruit.

TABLE 1. PROPORTION OF FRUIT FLY SPECIES (*ANASTEPHA OBLIQUA*, *A. SERPENTINA*, *A. STRIATA* AND *ANASTREPHA* SPP.) FOUND AT FOUR LOCALITIES IN COSTA RICA FROM MAY 1985 THROUGH JULY 1986.

Fly species	OROTINA	BUENOS AIRES	LEPANTO	CAÑAS
A. obliqua	3465 (47.3%)	279 (49.6%)	285 (94%)	1949 (97%)
A. serpentina	3370 (46%)	—	9 (3%)	16 (0.8%)
A. striata	476 (6.5%)	269 (47.8%)	—	20 (1%)
Anastrepha spp.	15 (0.2%)	15 (2.7%)	9 (3%)	24 (1.2%)
Total	7326	563	303	2009

The aberrant rain distribution in Buenos Aires cleary affected the phenology of some of these hosts including mango and guava which had "fragmented" periods of flowering, fruiting and vegetative growth. This may have affected the population dynamics of several species of *Anastrepha*. This does not occur in Cañas and Lepanto where there are well defined rainy and dry seasons. Orotina has defined seasonality with occasional rains during the dry period (December-May).

It was recently found that, like other *Anastrepha* species, *A. obliqua* has a tendency to migrate from its larval host tree to near by non-hosts (Soto-Manitiu & Jirón 1989). After emergence, adult fruit flies emigrate seeking nitrogen sources (bird drops, honey dew) and sugar juices from overripe fruits. The adult fly reaches sexual maturation several days later when it is far away from its original plot. This fruit fly behavior and the year round availability of ripe fruits may explain the high trap captures and species variety of *Anastrepha* sampled in Buenos Aires.

In Buenos Aires, from May to June (1985), there was a small population increase of *A. obliqua* when there were a few mango fruits available. During the same months of the following year, heavy rains and winds caused mango fruits to fall and there was a corresponding decrease in the population density of *A. obliqua*. In Buenos Aires, there were at least some trees of *P. guajava* with susceptible fruits at any time of the year, and *A. striata* occurred year round. The greatest number of captured individuals corresponded with the crops of its two chief hosts: *P. guajava* and *P. friedrichstalianum* (Berg) Ndzu. (Jirón & Hedström 1988).

The increase shown by other species of *Anastrepha* in 1986 (Fig. 4) is due to the relative abundance of host plants throughout the year (Jirón & Hedström 1988). *A. serpentina* was found more frequently at the time that its hosts, *C. cainito* and *M. achras*, produced fruits.

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A NEW SPECIES OF *PLOCETES* FROM THE FLORIDA KEYS WITH NOTES ON OTHER SPECIES OCCURRING IN THE UNITED STATES (*COLEOPTERA: CURCULIONIDAE; CURCULIONINAE; TYCHIINI)*

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Abstract

Plocetes clarki Anderson, new species is described (type locality; U.S.A., Florida, Monroe County, Sugarloaf Key, N.W., McKay Tract). Adults were collected on flowering *Guettarda scabra* Vent. (Rubiaceae) in open areas of a pinelands-palmetto-hardwood hammock transitional forest. This plant is the likely larval host. *Plocetes clarki* belongs