

bait appeared to be effective in controlling *G. juniperella*. The biologicals, Bactospeine®, Dipel®, and Thuricide® controlled *G. juniperella* larvae well and should be recommended for grower use.

END NOTE

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A SURVEY OF THE ECONOMICALLY IMPORTANT
FRUIT FLIES (DIPTERA: TEPHRITIDAE)
PRESENT IN CHIAPAS AND A FEW OTHER
FRUIT GROWING REGIONS IN MEXICO

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ABSTRACT

We report on the progress of a study that has as an objective the identification of the economically important fruit flies (Diptera: Tephritidae) of the State of Chiapas, Mexico. To date, the following genera and species have been identified: *Anastrepha acris*, *A. alveata*, *A. balloui*, *A. bicolor*, *A. chiclayae*, *A. distincta*, *A. fraterculus*, *A. leptozona*, *A. ludens*, *A. obliqua*, *A. montei*, *A. pallens*, *A. robusta*, *A. striata*, *A. serpentina* and *A. tripunctata* (*acris*, *alveata*, *balloui*, *leptozona* and *montei* are new records for Mexico); *Toxotrypana curvicauda*; *Zonosemata cocoyoc*; *Hexachaeta* sp.

(probably *obscura*); *Molynocoelia* sp. (near *lutea*) and *Blepharoneura* sp. We have also identified the genus *Richardia* (Diptera: Richardidae) and the genus *Xanthacrona* (Diptera: Otitidae). We provide information on how and where these specimens were collected and discuss the significance of these findings. Finally, we report on the identification of a few specimens collected outside of the State of Chiapas, which include among others *A. spatulata*, *A. robusta* and *A. pallens*.

RESUMEN

Se reportan los resultados de un estudio cuyo objetivo es la identificación de las moscas de la fruta de importancia económica (Diptera: Tephritidae) en el estado de Chiapas, México. Hasta la fecha se han identificado los siguientes géneros y especies: *Anastrepha acris*, *A. alveata*, *A. balloui*, *A. bicolor*, *A. chiclayae*, *A. fraterculus*, *A. distincta*, *A. leptozona*, *A. ludens*, *A. obliqua*, *A. montei*, *A. pallens*, *A. robusta*, *A. striata*, *A. serpentina* y *A. triangulata* (*acris*, *alveata*, *balloui*, *leptozona* y *montei* son nuevos reportes para México). *Toxotrypana curvicauda*; *Zonosemata cocoyoc*; *Hexachaeta* sp. (probablemente *obscura*); *Molynocoelia* sp. (cerca de *lutea*); *Blepharoneura* sp. También se han identificado los géneros *Richardia* (Diptera: Richardidae) y *Xanthacrona* (Diptera: Otitidae). Se provee información acerca de como y donde se colectaron los especímenes y se discute sobre la importancia de estos descubrimientos. Finalmente, se reporta sobre la identificación de algunos especímenes colectados fuera del estado de Chiapas, que incluyen entre otros a *A. pallens*, *A. robusta* y *A. spatulata*.

Even though fruit fly species (Diptera: Tephritidae) found in Mexico have been the focus of continuous attention by researchers, regulatory entomologists and fruit growers for most of the past 90 years, we still know relatively little about them. The early literature is filled with anecdotal accounts on the behavior and control of these insects (Herrera 1905, Crawford 1923) and more recent attempts to clear up some of the original confusion about their biology, ecology and behavior are rare (Baker et al. 1944, Baker 1945, Christenson and Foote 1960, McFadden 1964, Shaw et al. 1970, Morgante et al. 1983, Malavasi et al. 1983, Aluja et al. 1983, Robacker and Hart 1985, Aluja 1985). Taxonomy has been the field most intensely studied, resulting in extensive keys for adult identification (Dampf 1933, Greene 1934, Stone 1942, Shaw 1962, Ramos 1975, Steyskal 1977a, Foote 1980 and Norrbom 1985). Unfortunately, a challenge one still faces when attempting to identify field collected material is the lack of appropriate taxonomic keys for the immature stages since currently existing ones are out of date or incomplete (Greene 1929, Philips 1938, Bush 1962 and Berg 1979).

Three economically important genera of fruit flies are found in Mexico: *Anastrepha* Schiner, *Rhagoletis* Loew and *Toxotrypana* Gerstaecker. Stone (1942) reported 13 species of the genus *Anastrepha*: *aphelocentema* Stone, *chiclayae* Greene, *distincta* Greene, *fraterculus* Wiedeman, *lathana* Stone, *ludens* Loew, *mombinpraeoptans* Sein, *robusta* Greene, *serpentina* Wiedeman, *spatulata* Stone, *striata* Schiner, *tripunctata* Wulp (also in Foote 1965) and *zuelaniae* Stone. Foote (1967) added *A. triangulata* (described from Morelos by Shaw (1962)) to the list. Steyskal (1975) recognized *mombinpraeoptans* as a synonym of *obliqua* Macquart and also placed the genera *Lucumaphila* Stone, *Phobema* Aldrich and *Pseudodacus* Hendel in synonymy with *Anastrepha* (Steyskal 1977b). This adds 4 more species to the original list by Stone (1942): *dentata* Stone, *sagittata* Stone (formerly placed in *Lucumaphila*, Foote 1967), *bicolor* Stone, *pallens* Coquillett (formerly placed in *Pseudodacus*, Foote 1967).

There are 8 species of the genus *Rhagoletis* Loew reported in Mexico: *boycei* Cresson, *cingulata* Loew, *completa* Cresson, *juglandis* Cresson, *pomonella* Walch, *ramosae*

Hernandez-Ortiz, *striatella* Wulp, and *zoqui* Bush (Foote 1967, 1981, Hernandez-Ortiz 1985). Finally, Foote (1967) reports 1 species of the genus *Toxotrypana* : *curvicauda* Gerstaecker.

We consider that the number of *Anastrepha* species present in Mexico is much greater than the 18 previously reported. For example, a survey of tephritids conducted many years ago in Panama, a country with vegetational and geographical conditions that closely resemble certain regions of Mexico, yielded 54 species (Stone 1942). Only a few efforts of this nature have been carried out so far in Mexico. Baker et al. (1944) describe a series of intensive surveys throughout the country in which the partial distributions of *Anastrepha ludens*, *A. pallens*, *A. sagittata*, *A. serpentina*, *A. striata*, *A. distincta*, *A. obliqua*, *A. fraterculus*, *A. chiclayae*, *A. aphelocentema* and *Toxotrypana curvicauda* are reported. Gonzales-Hernandez and Tejada (1980) report *A. ludens*, *A. serpentina* and 2 unidentified species of *Anastrepha* in the State of Nuevo Leon. Duran-Pompa et al. (1981) report *A. ludens*, *A. serpentina* and *A. obliqua* in the Municipio of Texcoco, State of Mexico. Coronado (1964) and Vera-Graciano et al. (1979) report *Rhagoletis cingulata* and *R. pomonella* for the same region. Finally, Rios-Martinez (1961) identified 8 species of the genus *Anastrepha* in the State of Chiapas: *chiclayae*, *distincta*, *fraterculus*, *ludens*, *obliqua*, *serpentina*, *striata* and *tripunctata*.

This paper partially reports the results of a study primarily conducted in the State of Chiapas, in which the objectives were to study the taxonomy, biology, ecology and behavior of the local fruit flies and to develop adequate integrated management programs for those species causing economic damage to local orchards. In this particular case we report on the species identified so far in the Soconusco Region, the Mazapa de Madero Valley and the Chahuities Region in the neighbouring State of Oaxaca. We also include the results of identifications made on a few specimens received from the States of Nayarit, Sinaloa, Tabasco and Veracruz.

MATERIALS AND METHODS

Localities

The study area comprised the Soconusco region and Mazapa de Madero Valley in the State of Chiapas, Mexico. The agriculturally important Soconusco Region is located between 14°10' and 15°20' northern latitude and 92°10' and 93°10' western longitude. The region comprises 16 municipalities which cover an area of 5937 km². Mean annual temperature is 26° C (ranges between 19 and 32° C) and mean annual precipitation 3000 mm (ranges between 2000 and 5000 mm). Tapachula, the most important city in the region, is easily accessed by railroad, road and airplane. The major part of our survey was carried out in the municipalities of Tapachula, Suchiate and Mazatán with mean elevations of 137, 30 and 32 meters above the sea level.

The Mazapa de Madero Valley is located in the Sierra Madre de Chiapas approximately 105 km West from the city of Tapachula; it belongs to the municipality of Mazapa de Madero. Agriculture is the main source of income for local people but it is carried out on a much smaller scale than in the Soconusco Region. The valley has an area of approximately 116.8 km², a mean annual temperature of 20° C (ranges between 18 and 31° C) and a mean annual precipitation of 1500 mm (ranges between 1000 and 2000 mm). It is at an elevation of 1040 meters above sea level.

We also include the identifications of a few specimens sent to us from the Chahuities Region in the neighboring State of Oaxaca, the towns of Martinez de la Torre and Papanitla in the State of Veracruz, and the mango-growing regions in southern parts of the States of Nayarit and Sinaloa and in central portions of the State of Tabasco.

Survey Techniques

We established a series of trapping routes in which a total of 750 McPhail traps (McPhail 1937), designed for capturing adults, were distributed in the following fashion: 400 in the mango (*Mangifera indica*) orchards Buena Vista, San Francisco, El Pelon, Quinta Irenne and El Vergel (all within the Soconusco Region). 80 traps were placed in each orchard (50 in the main block of trees and 30 in the periphery, which in some occasions included non-host trees). It is important to note that the Quinta Irenne orchard had citrus (*Citrus* spp.), guava (*Psidium guajava*), chico zapote (*Manilkara ac-hras*), guanabana (*Anona muricata*) and chirimoya (*Anona cherimola*) trees in addition to mango. Another 100 traps were placed in citrus, guava and chico zapote orchards. These 500 traps were all distributed within the Soconusco Region.

Another 250 traps were distributed in the Mazapa de Madero Valley; most of them were hung on mango trees, but some were also hung in citrus, papaya, and mamey (*Calocarpum zapota*) trees.

Each trap was baited with Staley's hydrolized protein (PIB-7) and borax dissolved in 250 ml of water (20 ml of protein and 10 g of borax). Traps were hung in the upper 3/4 of the tree canopy and checked every 7 days. When serviced, the contents of each trap were sieved, the insects caught rinsed with clean water and then placed in a 25 ml vial filled with 70% alcohol; the traps were then also rinsed and re-baited. A strict record for each individual trap was kept to facilitate the processing of data.

The specimens received from outside of the State of Chiapas were also caught in McPhail traps and handled in the same way as described above.

Identification

All the flies caught in the traps were individually identified in the laboratory. Identifications were made by the following people: Juan Garcia, Eugenio Rios, Jorge Guillén (MoscaMed Program) and Amparo Ramos, Guadalupe Siller (DGSV-SARH, Mexico City) who identified *A. acris*, *A. balloui*, *A. distincta*, *A. fraterculus*, *A. ludens*, *A. obliqua*, *A. serpentina*, *A. spatulata*, *A. striata*, *A. robusta*, *T. curvicauda*, *Hexachaeta* sp. (probably *obscura*); Dr. Richard Foote (Systematic Entomology Laboratory, BBII, Agricultural Research Service, Washington, D.C.; retired) who identified *A. chichlayae*, *A. leptozona*, *A. montei*, *Molynocoelia* sp. (near *lutea*), *Blepharoneura* sp., *Richardia* sp. and *Xanthacrona* sp. and Dr. Allen Norrbom (Systematic Entomology Laboratory) who identified *A. alveata*, *A. pallens*, *A. bicolor*, *A. tripunctata*, *Zonosemata cocoyoc* and confirmed the identification of *A. balloui*.

RESULTS

Results are summarized in Table 1. The tephritid genera *Anastrepha*, *Toxotrypana*, *Molynocoelia*, *Hexachaeta* and *Blepharoneura* were identified in the Soconusco Region. A few specimens of *Richardia* (Diptera: Richardidae) and *Xanthacrona* (Diptera: Otitidae) were also collected in the same area. All specimens were collected in McPhail traps hung in mango, citrus, chico zapote and one unidentified wild tree. It is interesting to note that in 1 orchard (Quinta Irenne) eight species of *Anastrepha* were collected (unpublished data). Figure 2 indicates the proportion (%) of each species collected in the 5 commercial mango orchards studied.

In Mazapa de Madero only the genera *Anastrepha*, *Toxotrypana* and *Zonosemata* were identified. *Toxotrypana* specimens emerged from host fruits (*Carica papaya*) and *Anastrepha* specimens were collected in traps hung in mango trees. During 1 week in May 1985, 6 species of *Anastrepha* were collected in a single trap (*distincta*, *fraterculus*, *ludens*, *obliqua*, *serpentina* and an undetermined species).

TABLE 1. FRUIT FLY SPECIES IDENTIFIED IN THE STATE OF CHIAPAS AND A FEW OTHER FRUIT GROWING REGIONS IN MEXICO, INDICATING LOCALITY AND TREE TYPE WHERE TRAPS WERE HUNG.

Locality	Fruit Fly Species	Tree species on which trap was hung
Soconusco, Chiapas	<i>Anastrepha acris</i>	<i>Mangifera indica</i>
	<i>A. balloui</i>	"
	<i>A. distincta</i>	"
	<i>A. chiclayae</i>	"
	<i>A. fraterculus</i>	"
	<i>A. leptozona</i>	"
	<i>A. pallens</i>	"
	<i>A. robusta</i>	"
	<i>A. tripunctata</i>	"
	<i>A. obliqua</i>	<i>M. indica</i> , <i>Manilkara achras</i>
	<i>A. striata</i>	"
	<i>A. ludens</i>	<i>M. indica</i> , <i>Citrus</i> sp. <i>Manilkara achras</i>
	<i>A. serpentina</i>	"
	<i>A. alveata</i>	Unidentified wild tree
	<i>Toxotrypana curvicauda</i>	<i>M. indica</i>
	<i>Molynocoelia</i> sp. near <i>lutea</i>	"
	<i>Hexachaeta</i> sp. probably <i>obscura</i>	"
	<i>Blepharoneura</i> sp.	"
Mazapa de Madero, Chiapas	<i>A. bicolor</i>	<i>M. indica</i>
	<i>A. chiclayae</i>	"
	<i>A. distincta</i>	"
	<i>A. fraterculus</i>	"
	<i>A. ludens</i>	"
	<i>A. montei</i>	"
	<i>A. obliqua</i>	"
	<i>A. serpentina</i>	"
	<i>A. striata</i>	"
	<i>Zonosemata cocoyoc</i> <i>T. curvicauda</i>	Emerged from <i>Carica papaya</i>
Chahuities, Oaxaca	<i>A. chiclayae</i>	<i>M. indica</i>
	<i>A. distincta</i>	"
	<i>A. fraterculus</i>	"
	<i>A. ludens</i>	"
	<i>A. obliqua</i>	"
	<i>A. pallens</i>	"
	<i>A. robusta</i>	"
	<i>A. serpentina</i>	"
	<i>A. spatulata</i>	"
	<i>A. striata</i>	"
Nayarit	<i>A. chiclayae</i>	"
	<i>A. ludens</i>	"
	<i>A. obliqua</i>	"
	<i>A. serpentina</i>	"

TABLE 1. Con't

Locality	Fruit Fly Species	Tree Species on which trap was hung
Sinaloa	<i>A. striata</i>	"
	<i>A. chiclayae</i>	"
	<i>A. serpentina</i>	"
	<i>A. striata</i>	"
Tabasco	<i>A. ludens</i>	"
	<i>A. obliqua</i>	"
	<i>A. serpentina</i>	"
Martinez de la Torre		
Veracruz	<i>A. distincta</i>	<i>Citrus</i> sp.
	<i>A. fraterculus</i>	"
	<i>A. ludens</i>	"
	<i>A. obliqua</i>	"
	<i>A. serpentina</i>	"
	<i>A. striata</i>	"
	<i>T. curvicauda</i>	"
Papantla, Veracruz	<i>A. ludens</i>	"
	<i>A. striata</i>	"
	<i>A. serpentina</i>	"

Finally, all the specimens received from localities outside of the State of Chiapas belonged to the genera *Anastrepha* and *Toxotrypana* and were collected in traps hung in mango and citrus trees.

DISCUSSION AND CONCLUSIONS

Our initial assumption that there must be more *Anastrepha* and in general more tephritid species in Mexico than those previously reported in the literature, was confirmed. Five out of the 18 fruit fly species identified in this study are new records for Mexico: *Anastrepha acris*, *A. alveata*, *A. balloui*, *A. leptozona* and *A. montei*. Note

TABLE 2. RELATIVE ABUNDANCE OF THE *ANASTREPHA* SPECIES COLLECTED IN FIVE COMMERCIAL MANGO ORCHARDS IN THE SOCONUSCO REGION, CHIAPAS, MEXICO FROM 1982 TO 1985.

Species	Proportion (%)
<i>A. obliqua</i>	70.77
<i>A. ludens</i>	23.86
<i>A. serpentina</i>	1.65
<i>A. distincta</i>	1.51
<i>A. fraterculus</i>	0.47
<i>A. acris</i>	0.44
<i>A. striata</i>	0.25
<i>A. balloui</i>	0.03
<i>A. leptozona</i>	0.013
<i>A. chiclayae</i>	0.008
<i>A. sp.</i>	0.004

also that we confirmed the presence in the State of Chiapas of all the *Anastrepha* species reported in a previous study by Rios-Martinez (1961).

Trapping a particular fruit fly species in a trap placed in a certain tree species does not necessarily mean that it is a host. Being aware of this fact, we have conducted a study in which we identified most of the true hosts of the fruit fly species reported here (unpublished data). The fact that we identified up to 8 species of the genus *Anastrepha* in 1 mango orchard is not surprising since all the commercial orchards in the study areas are surrounded by native vegetation, including in many occasions, wild host plants. Besides, it is common practice to plant a wide array of varieties and fruit species in the same orchard (Aluja 1985, Aluja & Liedo 1986). The latter situation is bound to attract a large number of fruit flies of different species.

Capturing 5 species in one trap during the same week is a very interesting result which prompted us to conduct a series of behavioral studies to determine if there was competition for mating sites or interspecific mating attempts. It was shown that in the case of *A. ludens* and *A. obliqua*, the extremely different hours of the day when mating activities take place is a strong enough barrier to reduce interspecific sexual activities (Aluja et al. 1983).

We consider that the species which are new records for Mexico do not represent any economic hazard to the commercial fruit orchards of the region. Only *A. leptozona* was caught in large numbers (unpublished data) and when this was the case it was in areas of native vegetation, not even near commercial orchards. *A. acris* was caught only during a restricted part of the year (July–September) in 2 orchards (El Carmen and San Francisco). This is puzzling, especially since all our efforts to locate the host plants have been so far unsuccessful. Where these isolated populations spend the rest of the year merits further investigation. *A. montei* has only been caught on 2 occasions (3 specimens). This species is reported to attack yuca, *Manihot dulcis* and *esculenta* (Stone 1942). The trap in which it was caught was near some yuca plants and it is therefore possible that it was using orchard trees as resting or shelter sites. *A. alveata* and *A. balloui* are also extremely rare.

This study has also expanded our knowledge on the distribution of some *Anastrepha* species in Mexico. Information in this area is very limited. We are currently working on an updated distribution of the most common tephritids in Mexico.

Due to lack of more recent information we have followed Baker's terminology (Baker et al. 1944) and treated the specimens of *A. fraterculus* as the "Mexican form" of this species. The debate as to whether the South American populations are distinct species is an old one, but has not been resolved. Baker et al. (1944) and Baker (1945) pointed out some differences and suggested further careful biological work to define the latter. Mendes (1958) and Bush (1962) found some karyotypic differences between morphologically indistinguishable Mexican and Brazilian populations. Morgante et al. (1980) and Malavasi and Morgante (1982) in studies carried out in Brazil, uncovered considerable genetic heterogeneity among geographic populations and concluded that *fraterculus* includes many unrecognized species. Malavasi and Morgante (1983) later found that the level of genetic distance between populations stemming from different hosts within one orchard was very small. Aluja et al. (1983) speculated that a similar phenomenon could be acting in the case of *A. ludens*, *A. serpentina* and *A. obliqua*, species that also have wide geographic distributions. In the cases of *A. ludens* and *A. serpentina* geographic differences in the pattern of host exploitation were found and in the case of *A. obliqua* there are some unconfirmed reports of behavioral differences between Brazilian and Mexican populations (Aluja et al. 1983, Teles da Silva et al. 1985). It becomes clear then, that morphological characters for both immature and mature forms are not sufficient to unravel all the questions posed in relation to the taxonomic and phylogenetic classification of neotropical tephritids. Genetic, ecological and behavioral studies are

also necessary. The efforts by Morgante et al. (1980), Malavasi and Morgante (1982, 1983) and the recent comprehensive work by Norrbom (1985) are certainly steps in the right direction.

In conclusion we have provided evidence that the number of species of the genus *Anastrepha* reported in Mexico should be increased by 5 and that the distribution of some of these species is more widespread than the limited literature in this field indicates. Our results, added to the literature reports, indicate that the species of the genus *Anastrepha* present in Mexico are: *acris*, *alveata*, *aphelocentema*, *balloui*, *bicolor*, *chiclayae*, *dentata*, *distincta*, *fraterculus*, *lathana*, *leptozona*, *ludens*, *montei*, *obliqua*, *pal-lens*, *robusta*, *serpentina*, *sagittata*, *spatulata*, *striata*, *triangulata*, *tripunctata* and *zuelaniae*.

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NATURAL HOST PLANT SURVEY OF THE
ECONOMICALLY IMPORTANT FRUIT FLIES
(DIPTERA: TEPHRITIDAE) OF CHIAPAS, MEXICO

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ABSTRACT

We provide a natural host-plant list of some of the fruit flies (Diptera: Tephritidae) reported for the State of Chiapas. Out of 92 plant species sampled, 39 species representing 12 plant families were identified as natural host of *Anastrepha distincta*, *A. fraterculus*, *A. leptozona*, *A. ludens*, *A. obliqua*, *A. serpentina*, *A. striata* and *Toxotrypana curvicauda*.