Anastrepha ludens

Introduction

The Mexican fruit fly, *Anastrepha ludens*, (Loew) is of quarantine importance to the Caribbean. This pest occurs throughout Central America including Belize. Primary hosts include – mango and citrus.

Identity

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Authority : Loew
Classification
Kingdon : Animalia
Phylum : Arthropoda
Class : Insecta
Order : Diptera
Family : Tephritidae
Genus : *Anastrepha*
Species : *ludens*
Synonyms : (*Trypeta*) *Acrotoxa ludens* (Loew), *Trypeta ludens* (Loew), *Anastrepha ludens* (Loew), *A. lathana* (Stone 1942).
Common names: Mexican fruit fly, mosca mexicana de la fruta.
Role : Pest

Signs & symptoms

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Newly hatched larvae eat and burrow into the pulp of the fruit, taking on the color of their food so that when small they are easily overlooked. Many maggots may be found in a single fruit.
A. ludens can even infest seeds of yellow sapote (Christensen and Foote, 1960).

Morphology

Steck *et al* (1990)

Steck *et al.* (1990) provide a key to identify the third instar larvae of 13 *Anastrepha* species based on posterior and anterior spiracles, dorsal spinules, tubules, oral ridges, anal lobes and their respective size and number.
Adult: (Fig 1) Medium sized, yellow-brown. Mesonotum 2.75-3.6 mm long, yellow-brown, a slender median stripe widening posteriorly, humerus, a lateral stripe from transverse suture to scutellum, and scutellum pale yellow; frequently a diffuse brownish spot in middle of

Fig 1. Adult Female: *Anastrepha ludens* (Gilbert *et al*., 1984)

scutoscutellar suture; pleura yellow-brown, a stripe from humerus to wing base below notopleuron, and metapleuron, pale yellow; metanotum yellow-brown, the sides of the postscutellum darkened, and this color frequently extending down along sides of metanotum. Macrochaetea brownish-black; pile pale yellow-brown. Sternopleural bristle present, sometimes very slender.

Wing (Fig 2) 6.6-9.0 mm long, the bands rather pale yellowish-brown; costal and S bands touching on vein R4+5, or narrowly separated; V band separated from S band or very narrowly connected, usually rather pale anteriorly.

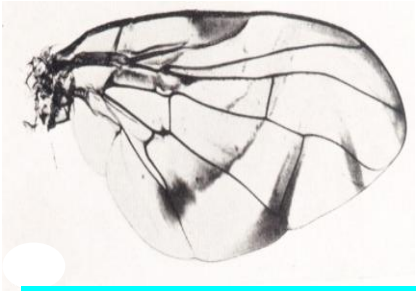

Fig 2. Wing *Anastrepha ludens* (Stone, 1942)

Female Terminalia: Ovipositor sheath 3.4 - 4.7 mm long, tapering to apical third, which is somewhat expanded and depressed; spiracles 0.85 - 1.35 mm from base. Rasper of moderate-sized hooks in five to seven rows. Ovipositor 3.2-4.7 mm long (for synonym *A. lathana* (Stone) 3.0 mm minimum), moderately stout, the tip elongated, tapering, with rather few, rounded serrations on apical half or less; shaft at extreme base abruptly widened (Fig 3).

Male terminalia: Tergal ratio about 1.12; clasper about 0.37 mm long, stout basally, flattened apically; outer margin somewhat convex to the subtruncate apex; inner margin nearly straight; teeth slightly proximal of middle (Stone, 1942, Steyskal, 1977).

Fig 3. Ovipositor *Anastrepha ludens* (Stone, 1942)

Biology & Ecology	Alies van Sauers-Muller MOA/CFF

This species is the only important member of the genus *Anastrepha* that is subtropical rather than tropical, occupying the northern portion of the range of the genus and extending southward only at the higher altitudes. *Anastrepha ludens* can withstand freezing rather well, whereas in hot areas it may be killed by the heat of the sun (Weems, 1963). The species is also more dominant in orchards at higher elevations (Aluja, 1994). The adults are reported to be long-lived, up to 9 months in laboratory studies (Fletcher, 1989).

Egg development requires approximately three days, larval development 9-11 days and pupation 14-16 days (Celedonio-Hurtado *et al.*, 1988).

The host fruit may have a pronounced influence on the length of larval development. The minimum time for *A. ludens* from egg deposition to appearance of the first adult in figs was 32 days; in mandarin and apple it was (at the same temperature, 25ºC), 52.8 days (Christenson and Foote, 1960). *A. ludens* is reported to oviposit only one egg per fruit and they mark the fruit with epideictic pheromones. Even so, multiple ovipositions by different females can result in a number of larvae occurring in the same fruit (Fletcher, 1989).

Females were found to have a net fecundity rate (F1 generation wild flies) of approximately 46.8 eggs per female (approx. 4.24 eggs per day, with a life expectation of

17.3 days). This is much lower than that of med fly, Oriental fruit fly (OFF) or Melon fly. Also the developmental time is longer than that of aforementioned species. From laboratory colonies of the Mexican fruit fly, up to 400 eggs per female were recorded, even numbers as high as 1700 eggs for laboratory studies (Christenson and Foote, 1960). Over 95 % of the adults emerge between 0600 and 1000 hrs (Aluja, 1994). Calling activities have been observed in the late afternoon. The underside of the leaves is the site for male display and pheromone release, and for mating. Males establish single leaf territories. Male display includes puffing of abdominal and anal pouches and intermittent wing fanning. Wing waving by males also occurs (Nation, 1989). In the field, mating occurred in the late afternoon and early evening. Leks usually form in host trees, but away from the host fruit (Females approach territory holding males and pre-copulatory orientation), approach and wing waving behavior on the part of both sexes has been observed. Males mount females in a face-to-face orientation by flying over them and turning around to mount. Males produce courtship songs after mating (Sivinski and Burk, 1989)

Anastrepha ludens is known to move long distances from their breeding sites in Mexico to invade citrus groves in southern Texas (Enkerlin *et al.*, 1986). Distances of up to 150 km have been postulated (Christenson *et al*, 1960).

Dispersal/vectors

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Artificial spread of the pest is caused by the movement of any article that may harbor the fly (as eggs, larvae, pupae, adults) from infested to uninfested areas. These articles include all *Anastrepha ludens* host fruits and vegetables. *A. ludens* enters uninfested areas when persons bring in prohibited fruits infested with maggots, or when infested fruits and vegetables are shipped or mailed from areas where *A. ludens* is established.

Management

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The **Sterile Insect Technique** is used in maintaining a fly-free zone in Mexico, Texas and California. Technology for the eradication programs used to maintain these zones is supported by research by the Sanidad Végétal laboratories in Mexico and the USDA ARS laboratory in Weslaco, Texas. Both research groups cooperate with APHIS Plant Protection and Quarantine and International Services Departments in establishing protocols and executing sterile insect release programs.
The Mexican fruit fly rearing facility at Mission, TX, is capable of producing 80 million sterile flies per week.
In Mexico, production of sterile *A. ludens* has reached 8 million flies in 1994 as part of a large-scale fruit fly eradication programme (Reyes *et al.*, 2000).

Trapping: McPhail traps baited with Torula yeast are so far the best attractant for Mexican fruit flies. However, different formulations are being tested, such as ammonium

carbonates, methylamine HCl and putrescine (AMPu)(Robacker, 1995). Recent tests with ammonium acetate and putrescine (Thomas, 1999) and an improved McPhail (IMP) trap further improved trap catches. Trapping is not a good method to estimate populations of this fruit fly. Cutting fruit after harvest or late in the season is a good method of estimating populations.

Combining pest management practices (picking fruit from trees, not fallen fruit) growing conditions might result in such a low infestation rate of the product, which is to be shipped, that further quarantine treatments are no longer required.
Sterile fly release and/or bait sprays, and removal of alternate native hosts in the immediate surroundings can be part of this system approach.

Mangan *et al*. (1999) mention the use of treatments of citrus with high-temperature forced air as a quarantine treatment against Mexican fruit fly (*A. ludens*).

Biological Control

The following Braconids were recorded for *Anastrepha ludens* in Mexico (Aluja, 2000):

- *Diachasmimorpha longicaudata* (Ashmead) (in Mexico)(introduced)
- *Doryctobracon areolatus* (Szépligeti, 1911) (in Mexico)
- *Doryctobracon crawfordi* (in Mexico)

From the Eucoilinae (Figitidae), the following species was recorded in the Neotropical region (Malavasi and Zucchi, 2000):

- *Aganaspis pelleranoi* (Brèthes, 1924) (referring to Aluja, 1990)

From the family Eulophidae the following parasitoid was recorded (Aluja, 2000):

- *Aceratoneuromyia indica* (in Mexico)

Host notes

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Host records are cited according to Norrbom and Kim (1988), Eskafi *et al*. (1987) and Hernandez et al., (1993). Host preference (if available) is indicated as follows: primary, secondary, and occasional host. These authors mentioned more hosts, but all were recorded as lab-infested or questionable hosts.
Hosts included:

Anacardium occidentale L. (cashew apple); *Mangifera indica* L. (mango); *Spondias purpurea* L. (wild plum, purple mombin); *Annona squamosa* L. (anona); *Carica papaya* L. (papaya); *Mammea americana* (mamey); *Persea americana* (avocado); *Psidium guajava* L. (guava); *Passiflora edulis* (Sims) (passion fruit); *Coffea arabica* L. (coffee); *Citrus aurantifolia* (Christm.) (Swingle) (lime); *Citrus aurantium* L. (sour orange); *Citrus spp.*

According to Jiron *et al.* (1988), the Mexican fruit fly does not attack citrus and mango in Costa Rica, as it does in Mexico and Guatemala.

Inspection Procedures

Regulation of fruit shipments from quarantined areas and sterilization of fruit before shipment from quarantined areas is required.
Checking fruit at ports of entry, road stations.
Treating fruit imports.

Distribution

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North America: Texas, USA.
Central America: Mexico, Guatemala, El Salvador, Costa Rica (not of economic importance, Jiron *et al.* 1988), Nicaragua (Berg, 1979), Honduras (Hernandéz-Ortiz, 1993), Belize (Pollard, 1985).

Fig 4. Distribution: *A. ludens* (Malavasi and Zucchi, 2000)

Bibliography

Aluja, M. (1994) Bionomics and management of *Anastrepha. Ann. Rev. Entomol.* 1994**. 39,** 155-178.

Berg, G.H. (1979) Pictorial key to fruit fly larvae of the family Tephritidae. *OIRSA, El Salvador.* 36 pp.

Celedonio-Hurtado, H., Liedo, P., Aluja, M., & Guillen, J., (1988) Demography of *Anastrepha ludens*, *A. obliqua* and *A. serpentina* (Diptera: Tephritidae) in Mexico. *Florida Entomologist* **71 (2)** 110-119.

Christenson, L.D., & Foote, F.H., (1960) Biology of fruit flies. *Annual Review of Entomology* (5); 171-192.

Enkerlin, D., Enkerlin, W. R., (1986) Movement of native and sterile *Anastrepha ludens* (Loew) adults and of the tropical species *A. serpentina* in an area with native and cultivated hosts, Allende, N.L. Mexico. *II Intern. Symp. Fruit flies, Crete*, p. 407.

Eskafi, F.M., Enkerlin, R.T., (1987) Host plants of fruit flies (Diptera:

Tephritidae) of economic importance in Guatemala. *Florida Entomologist* **70 (1);** 116-123.

Fletcher, B.S. (1989) Ecology, life history strategies of tephritid fruit flies. In: *A.S. Robinson and G. Hooper. World Crop Pests 3B. Fruit flies, their biology, natural enemies and control.* pp 195-206.

Foote, R.H. (1980) Fruit fly genera south of the United States. *U.S. Department of Agriculture, Technical Bulletin 1600,* 79 pp.

Gilbert, A.J., Bingham, R.R., Nicolas, M.A., & Clark, R.A., (1984). Insect trapping guide. Pest Detection/Emergency Projects. CDFA.

Hernandez-Ortiz, V. (1990) Lista preliminar de especies mexicanas del genero *Anastrepha* (Diptera: Tephritidae) con descripción de nuevas especies, registros y sinonimas. *Folia Entomológica Mexicana* **80;** 227-244.

Hernandéz-Ortiz, V. (1993). Taxonomy, Distribution, and natural host plants of *Anastrepha* fruit flies in Mexico. In: Fruit flies: Biology and Management. M. Aluja and P. Liedo Eds). Springer Verlag.

Hernandez-Ortiz, V., & Aluja, M., (1993) Listado de especies del genero neotropical *Anastrepha* (Diptera: Tephritidae) con notas sobre su distribucion y plantas hospederas. Folia Entomol. Mex. **88;** 89-105.

Jiron, L.F., Soto-Manitiu, J., & Norrbom, A.L., (1988) A preliminary list of the fruit flies of the genus *Anastrepha* (Diptera: Tephritidae) in Costa Rica. *Florida Entomologist* **71(2),** 130-137.

Malavasi, A., & Zucchi, R.A., (Eds). (2000). Moscas-das-frutas de importancia economica Brasil, conhecimento basico e aplicado. 327 pp.

Nagakawa. S., Cunningham, R.T., Farias, G.J. (1969) Differentiation of parasitized and unparasitized pupae of the melon fly and oriental and mediterannean fruit fly. *Journal of Economic Entomology.* **Vol 62.** 970-971.

Nation, J.L. (1989) The role of pheromones in the mating system of *Anastrepha* fruit flies. In: *A.S. Robinson and G. Hooper. World crop pests 3A. Fruit flies. Their biology, Natural enemies and control.* pp. 189-205.

Norrbom, A.L., & Kim, K. C., (1988) A list of the reported host plants of the species of *Anastrepha* (Diptera: Tephritidae). *USDA/APHIS/PPQ. APHIS 81-52, September 1988,* 114 pp..

Pollard, G.V., & Alleyne, H., (1985) Insect pests as constraints to the production of fruits in the Caribbean. *Seminar on pests and diseases as constraints in the production and marketing of fruits in the Caribbean.* **Barbados.**

Reyes, J., Santiago, G., & Hernández, P., (2000) The Mexican fruit fly eradication programme. In*: Area-wide control of fruit flies and other pests. Penerbit Universiti Sians Malaysia, Penang.* K-H. Tan (ed.). pp. 377-380.

Robacker, D.C. (1995) Attractiveness of a mixture of ammonia, methylamine and putrescine to Mexican fruit flies (Diptera: Tephritidae) in a citrus orchard. *Florida Entomologist* **78(4)** 571-578.

Sivinski, J., & Burk T., (1989) Reproductive and mating behaviour. In: *A.S. Robinson and G. Hooper. World crop pests 3A. Fruit flies. Their biology, natural enemies and control.* pp. 343 - 351.

Steck, G.J., Carrol, L.E., Celedonio-Hurtado, H., Guillen-Aguilar,, (1990) Methods for identification of *Anastrepha* larvae (Diptera: Tephritidae), and key to 13 species. *Proc. Entomol. Soc. Wash.* **92 (2),** pp. 333-346.

Steyskal, G.C. (1977) Pictorial key to species of the genus *Anastrepha* (Diptera: Tephritidae). *Entomological Society of Washington*. pp. 1-34.

Stone, A. (1942) The fruit flies of the genus *Anastrepha*. *United States Department of Agriculture, Miscellaneous publication* **no 439**. pp. 1-112.

Thomas, D.B. (1999) Testing of synthetic lures and trap devices for surveillance of the Mexican fruit fly, *Anastrepha ludens* (Loew) (Diptera: Tephritidae). *USDA/ARS, Subt. Agr.Res. Lab. Texas.*

Weems, H.V. Jr. (1963) Mexican fruit fly (*Anastrepha ludens* (Loew) (Diptera:Tephritidae*). Florida Dept. Of Agriculture, Div. Of Plant Industry. Entomology Circular* No. 16, 2p.

WEB RESOURCE:

http://creatures.ifas.ufl.edu/fruit/tropical/mexican_fruit_fly