# *Ceratitis capitata*

## Introduction

*Ceratitis capitata* (Wiedemann), the Mediterranean fly is native to Sub Saharan Africa and is known to attack more than 50 plant species belonging to 67 families. It is global in its spread and has not been recorded as occurring in the Caribbean sub region.However it is found in South and Central America.
This pest is of major phytosanitary significance to the Caribbean.

## Identity

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Authority : Wiedemann
Classification
- Kingdom : Animalia
- Phylum : Arthropoda
- Class : Insecta
- Order : Diptera
- Family : Tephritidae
- Genus : *Ceratitis*
- Species : *capitata*
- Synonyms : *Ceratitis citriperda* (MacLeay), *C. hispanica* (De Breme), *Pardalaspis asparagi* Bezzi, *Tephritis capitata* Wiedemann
- Common names : Medfly; Mediterranean fruit fly, moscamed, doubabat al fakiha, la ceratite, Mittelmeerfruchtvliege, mosca mediterranea della frutta, mosca da fruta, mouche méditerranéenne des fruits
- Role : Pest

## Signs & symptoms

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Infested fruits have oviposition punctures, which rot forming dark stains around the punctures. Fruits suffer deformities and premature fruit drop due to heavy mining by large numbers of small white maggots (Hill and Waller, 1988). Medfly is proved to be not only a plant primary pest but also a plant pathogen vector (Cayol *et al.,* 1994).

## Morphology

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**Fig. 1: The adult medfly**

The adult medfly is slightly smaller than a common housefly and is very colorful (Fig. 1). It has red and blue iridescent eyes, a brown head (5 - 6 mm long) (Hill and Waller, 1988), a shiny, black thorax (back), and a yellowish abdomen with silvery cross bands. Its wings, normally drooping, display a blotchy pattern with yellow, brown, and black spots and bands. The male has triangular expansions (spatulate) at the end of the anterior pair of orbital setae (White and Elson–Harris, 1992).

## Biology & Ecology

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*C. capitata* is a multivoltine (i.e. more than one generation per year) and polyphagous (many hosts) fruit fly species.

### Life History

The entire life cycle takes 30 - 40 days and there may be 8 - 10 generations a year (Hill and Waller, 1988). The length of time required for the medfly to complete its life cycle under tropical summer weather conditions is 21-30 days (Weems, 1981). A female medfly will lay 1-10 eggs in an egg cavity 1 mm deep, may lay as many as 22 eggs per day, and may lay as many as 800 eggs during her lifetime (usually around 200-500). Females usually die soon after they cease to oviposit. Eggs are deposited under the skin of fruit, which is just beginning to ripen, often in an area where some break in the skin already has occurred. Several females may use the same deposition hole with 75 or more eggs clustered in one spot.

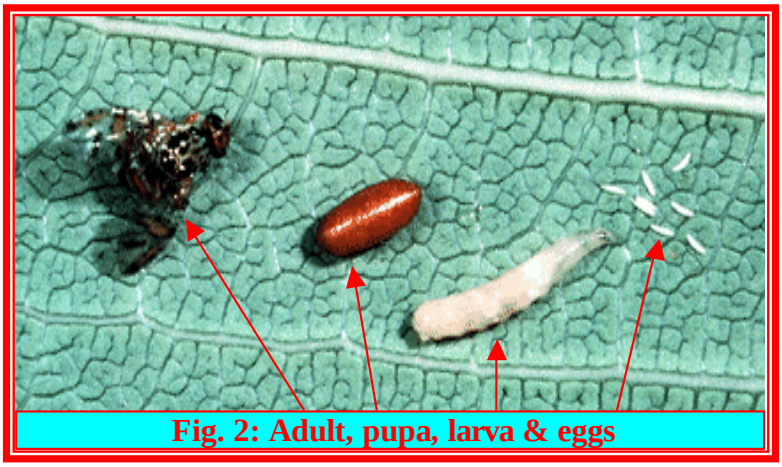

**Fig. 2: Adult, pupa, larva & eggs**

**Eggs** undergo an incubation period of 2 - 3 days. When the eggs hatch, the larvae promptly begin eating, and at first tunnels are formed. The larvae may keep close together in feeding until nearly full grown. Fruit in a hard or semi-ripe condition is better for oviposition than fully ripened fruit. During warm weather eggs hatch in 1.5 - 3 days. Lower temperatures considerably increase the duration of the egg stage.

The **Larvae** pass through 3 instars. Larval life may be as short as 6-10 days when the mean temperature averages 77-79°F (25 - 26.1ºC). The kind and condition of the fruit often influence the length of the larval stage. In citrus fruits, especially limes and lemons, it appears to be longer. Thus larvae require 14 - 26 days to reach maturity in a ripe lemon, as compared with 10 - 15 days in a green peach. Larvae leave the fruit in largest numbers at or just after daybreak and pupate in the soil or whatever is available (Fig. 2).
If larvae of the third instar are confronted with an unfavorable microclimate, they are able to jump and move to more suitable conditions.
Minimum duration of the **pupal** stage is 6 - 13 days when the mean temperature ranges from about 76 - 79F (24.4 - 26.1ºC). Back and Pemberton (1915) noted that this period may be increased to at least 19 days when the daily temperature means drop to about 69 - 71F (20.6 - 21.7ºC).
**Adults** emerge in largest numbers early in the morning during warm weather and emerge more sporadically during cool weather. They can fly short distances, but winds may carry them a mile or more away. Copulation may occur at any time throughout the day. Mating occurs on fruits early morning and late afternoon, and between leaves from midmorning to early afternoon. Mating is inhibited by light intensities below 200 foot candles. Newly emerged adults are not sexually mature. Males often show sexual activity 4 days after emergence, and copulation has been observed 5 days after emergence. Some adults may survive up to a year or more under favorable conditions of food (fruit, honeydew, or plant sap), water and cool temperatures. When host fruit is continuously available, and weather conditions favorable for many months, successive generations will be large and continuous. Lack of fruit for 3 - 4 months reduces the population to a minimum.
**http://www.cdfa.ca.gov/pests/medfly/lifecycle.html** a USDA-CDFA site provides another drawing of the medfly lifecycle

## 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 medfly-host fruits and vegetables. Medfly enters uninfested areas when persons bring in prohibited exotic fruits infested with maggots, or when infested fruits and vegetables are shipped or mailed from areas where the medfly is established.
Visit website http://www.cdfa.ca.gov/pests/medfly/invades_calif.html

## Management

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### Chemical Control

Bazzoni *et al.*, (1987), report that sugar solutions containing anethol, an aromatic ether present in high concentrations in the essential oil of fennel (*Foeniculum vulgare*), produced high levels of mortality (85 % after 24 hrs) clear sign of systemic toxicity, when ingested by *C. capitata*.
Aerial and ground application of bait spray, which contains minimal amounts of the insecticide Malathion and protein bait that attracts the flies, is used.

A good review of control methods of fruit flies and alternative methods is found in USDA-MRP-APHIS Draft Environment Impact Statement (Anonymous, 1999) "Fruit Fly Cooperative Program"

### Aerial Suredye bait or ground Suredye bait

Suredye bait spray is a formulation of xanthene dye and bait that is still being tested and developed for use against various fruit fly species.

### Soil treatment:

Diazinon, Chlorpyrifos and Fenthion are soil drench chemicals that are approved in USA for fruit fly control programmes (See Environmental Consequences for more information). Typically, one treatment (but up to three) may be made, applied directly to the soil within the drip line of host plants within the immediate vicinity of fruit fly larval detection. Because of the nature of the chemicals and /or the method of delivery, there is no potential for drift, runoff, or leaching.

Used in combination with fruit stripping, soil treatment establishes freedom from the pests and provides the capability to certify the nursery stock for movement. Applications are limited to the soils of regulated nursery stock grown within the quarantined area. Generally, no more than three applications are made.

### Mass Trapping

Mass trapping reduces fruit fly populations by attracting fruit flies to traps where they become stuck or are exposed to a minute amount of pesticide, and die before they have the opportunity to mate. The fruit flies are attracted to bait at the traps (conventional fruit fly traps sticky panels, fiberboard squares, wicks, or bait spots on telephone poles roadside trees), where they become stuck with a sticky substance or are killed with a minute amount pesticide (naled or malathion). Mass trapping has potential for many species of fruit flies but is not effective for all species.

The sticky panels employed for fruit fly control uses synthetic lures (trimedlure, capilure, ceralure, methyl eugenol or cuelure) applied directly to the panels or wicks attached to the panels. For the medfly, the bait widely used is trimedlure and it attracts the male medflies hence the method has also been called Male Annihilation.

### Sterile Insect Technique

Sterile insect technique involves medflies reared in large quantities, sterilized with a small amount of irradiation, and released into areas where they mate with wild medflies producing no offspring. Eventually the wild population is eliminated through attrition. According to Hendrichs *et al.*, (1995), one of the main obstacles for a wider use of the Sterile Insect Technique (SIT) against the Mediterranean fruit fly (medfly) is the damage commercial fruit suffers due to sterile female stings. For further information refer to Website!

Successful eradication campaigns have been held in Chile, California and Mexico.

## Biological control

According to Vargas *et al.*, (1999), classical biological control successes with fruit flies have been limited with the exception of the introduction of the Braconid wasp, *Fopius arisanus* (Sonan), for the control of the Oriental fruit fly, *Bactrocera dorsalis* (Hendel) in Hawaii. In the last 50 years, this parasitoid has shifted to *Ceratitis capitata* and now provides successful biological control in Hawaii. Another parasitoid, *Diachasmimorpha longicaudata* (Ashmead) is already mass-reared for biocontrol of medflies. These parasitoids could be an ideal tool for the suppression of Mediterranean fruit fly population.
Fungi, bacteria and viruses all infect Tephritidae (Bashiruddin, 1988). Their usefulness as applied pathogens has attracted relatively little attention (Debouzie, 1989). Tests are done using entomopathogenic fungi in bait stations with food lure (as compared to bait stations with food lure and malathion). Results are promising (Dimbi *et al.*, 2002).
Nematodes (*Steinernema* spp.) have been used to kill *C. capitata* in the field (Lindegren, 1990, Lindegren *et al.*, 1990).

The following Braconids were recorded for medfly (Malavasi and Zucchi, 2000)(Nakagawa *et al.*, 1969)(Stark *et al.*, 1992)(Messing *et al.*, 2000):

- *Doryctobracon areolatus* (Szépligeti, 1911) (in Brazil)
- *Opius bellus* (Gahan, 1930) (in Brazil)
- *Opius tryoni* (Cameron) (Hawaii)(introduced)
- *Fopius arisanus* (Sonan) egg parasite (Hawaii)(introduced)
- *Diachasmimorpha longicaudata* (Ashmead) (Hawaii, Costa Rica) (introduced)
- *Diachasmimorpha tryoni* (Cameron) (Hawaii)(introduced)
- *Diachasmimorpha kraussii* Fullaway (Hawaii)(introduced from Australia)
- *Biosteres vandenboschi* (Fullaway) (Hawaii)(introduced)
- *Psytallia incisi* (Silvestri) (Hawaii)(introduced)

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

- *Aganaspis nordlanderi*
- *Aganaspis pelleranoi* (Brèthes, 1924)
- *Lopheucoila anastrephae*
- *Odontosema anastrephae* (Borgmeier, 1935)

## Host notes

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Alies van Sauers-Muller MOA/CFF

More that 350 species belonging to 67 families have been listed (Liquido *et al.*, 1991; Liquido *et al.*, 1995). 40 % of these host plants belong only to five families: Myrtaceae (6 %), Rosaceae (10 %), Rutaceae (9 %), Sapotaceae (9 %), and Solanaceae (6 %). Medfly is an opportunistic insect infesting, for example, in the laboratory, other plants which are not normally hosts. However, only about 75 species of hosts that provide for reproduction of the medfly should be regulated,( See hosts that follow):

*Mangifera indica* L. **(**mango); *Annona cherimola* Mill., (cherimoya); *Annona reticulata* L., (anona, custard apple);
*Carissa grandiflora* (E.H.Mey.) A.DC., (Natal plum, carissa); *Carica papaya* L., (papaya); *Carica quercifolia* Solms, (papaya); *Garcinia xanthochymus* Hook.f. ex T. Anderson, (gourka); *Terminalia catappa* L., (tropical almond); *Diospyros decandra* Lour., (persimmon); *Diospyros kaki* L.f., (oriental persimmon); *Dovyalis caffra* (Hook.f.&Harv.) Warb, (kei apple); *Dovyalis hebecarpa* (G. Gardn.)Warb., (Ceylon gooseberry); *Juglans* sp., (walnut); *Persea americana* Mill., (avocado); *Malpighia glabra* L., (Barbados cherry); *Ficus carica* L., (common fig); *Musa acuminata* Colla, (Chinese dwarf banana); *Eugenia uniflora* L**.**, (Surinam cherry); *Feijoa sellowiana* O.Berg, (feijoa guavasteen, pineapple guava); *Psidium cattleianum* Sab., (strawberry guava, waiawi); *Psidium guajava* L. (guava); *Syzygium jambos* (L.), (iambo, rose apple); *Syzygium malaccense* (L.) Merrill & L.M. Perry, (mountain apple); *Arenga pinnata* (Wurmb.) Merrill, (sugar palm); *Phoenix dactylifera* L., (date palm**);** *Passiflora edulis* Sims (passion fruit); *Punica granatum* L., (pomegranate); *Cydonia oblonga* Mill., (quince, mannela); *Malus* pumila Mill., (common apple); *Prunus americana* Marsh., (native plum); *Prunus armeniaca* L., (apricot); *Prunus domestica* L., (garden plum); *Prunus persica* (L.) Batsch., (peach); *Prunus persica* (L.) Batsch., var. *nectarina* ((Ait.f.) Maxim., nectarine); *Pyrus communis* L. (common pear); *Rubus idaeus; Coffea canephora* Pierre ex Froehn., (robusta coffee); *Coffea arabica* L., (Arabian coffee); *Coffea liberica* Bull ex Hiern, (Liberian coffee); x *Citrofortunella mitis* (Blanco) J.Ingram and H.E.Moore (calamondin); *Citrus aurantifolia* (Christm.)Swingle (lime); *Citrus aurantium* L. (sour orange); *Citrus* x *limonia* Osbeck (lemon); *Citrus* x *nobilis* Lour. (king orange); *Citrus* x *paradisi* Macfady (grapefruit, pomelo); *Citrus reticulata* Blanco (mandarin, clementine); *Citrus sinensis* (L.) Osbeck (Valencia, sweet orange); *Fortunella japonica* (Thunb.) Swingle (kumquat); *Murraya paniculata* (L.) Jacq. (mock orange, jaminorange); *Blighia sapida* GK. Konig, (akee); *Litchi chinensis* Sonn., (litchi, lychee); *Argania spinosa* (L.) Skeels, (argan, Morocco ironwood); *Chrysophyllum cainito* L., (caimito, star apple); *Capsicum annuum* L., (pepper); *Lycopersicon esculentum* Mill., (tomato); *Opuntia sp*., (prickly pear); *Opuntia ficus-indica* (L.) Mill., (Indian fig); *Euphorbia longan* (Lour.) Steud., (longan, dragon's eye, rubber tree, caoutchoue, gooseberry); *Ficus benghalensis* **L**., (india fig); *Eugenia brasiliensis* Lam., (Brazilian plum, Spanish cherry); *Psidium guineense* Swartz, (Brazilian guava); *Psidium littorale* Raddi, (yellow cattley guava); *Olea europaea* L., (common olive); *Prunus dulcis* (Mill.) D.A. Webb, (almond).

## Distribution

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Unless otherwise indicated according to Weems (1981): native of sub-Sahara etc. from Sub-Saharan Africa (White & Elson-Harris, 1992)(fig.3).
**Africa:** Algeria, Angola, Botswana, Burundi, Cameroon, Canary Islands, Cape Verde Islands, Dahomey, Egypt, Ethiopia, Ghana, Guinea, Ivory Coast, Kenya, Liberia, Libya, Madagascar, Malagasy Republic, Malawi, Mali, Mauritius, Morocco, Mozambique, Niger, Nigeria, Reunion, Rwanda, Saint Helena, Seychelles, Senegal, Sierra Leone, South Africa,

Sudan, Tanzania, Togo, Tunisia, Uganda, Upper Volta, Zaire, Zambia, Zimbabwe, Australia, New Zealand, Tasmania.
**Caribbean:** Bermuda.
**Central America:** Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama,
**Europe:** Albania, Azores, Balearic Islands, Crete, Cyprus, France, Greece, Italy, Malta, Portugal (and Madeira Islands), Sardinia, Sicily, Spain, and Yugoslavia.
**Middle East:** Israel, Jordan, Lebanon, Saudi Arabia, Syria, and Turkey.
**North America:** Hawaii.
**South-America:** Argentina, Bolivia, Brazil (south and southeastern regions; Bahia, Maranhão Belem, Pará Rondônia (Silva)), Colombia, Ecuador, Paraguay, Peru, Tasmania, Uruguay, Venezuela.

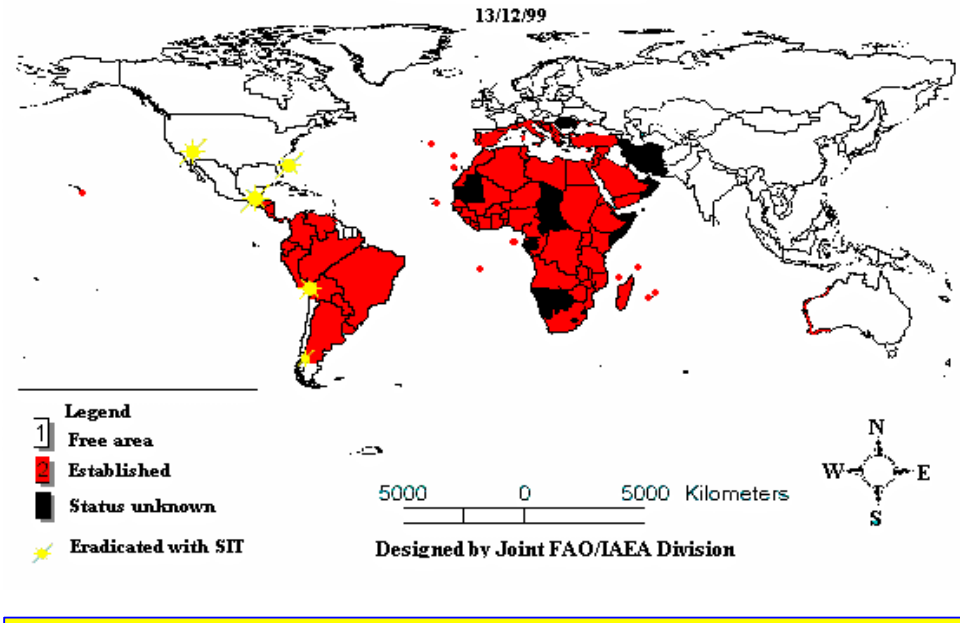


Fig. 3

## Bibliography

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Anonymous, (1999) Fruit Fly Cooperative Control Program. *Draft Environmental Impact Statement.* USDA, Marketing and Regulatory Programs APHIS.

Back, E.A., Pemberton C.E., (1915) Life history of the Mediterranean fruit fly from the standpoint of parasite introduction. *J. Agric. Res*. **3(5),** 363-374, United States Dept. Agric., Washington, D.C.

Bashiruddin, J.B. (1988) Queensland fruit fly virus, a probable member of the Picornaviridae. *Archives of Virology.* **v. 100 (1/2),** pp. 61-74.

Bazzoni, E. G. Sanna Passino, Moretti, M.D.L. Prota, R. (1987) Toxicity of anethole and its effects on egg production of *Ceratitis capitata* (Wied) *Annals of Applied Biology,* **131 (3),** 369-374.

Cayol, J.P., Causse R., Louis C., Barthes, J., (1994) Medfly *Ceratitis capitata* (Wiedemann) (Dipt.,) as a rot vector in laboratory conditions. *Journal of Applied Entomology,* 1994**, vol 117 (4),** 338-343.

Debouzie, D. (1989) Biotic mortality factors in Tephritid populations. In*: World Crop Pests, Vol. 3B: Fruit flies, their biology, natural enemies and control.* (Eds). by Robinson & Hooper.

Dimbi, S., Ekesi, S., Maniania, N.K., Lux, S.A, Zenz, N., (2002) Development of entomopathogenic fungi for the management of African fruit flies: *Ceratitis cosyra, C. rosa* var *fasciventris* and *C. capitata*. In: *Abstracts, 6th International symposium on fruit flies of economic importance.* May 2002, Stellenbosch. p. 47.
Hendrichs, J., Frantz, G., Rendon, P., (1995) Increased effectiveness and applicability of sterile insect technique through male-only releases for control of Mediterranean fruit Flies during fruiting seasons. *Journal of Applied Entomology, 1995,* **Vol. 119, no 5,** pp. 371 - 377.

Hill, D.S., & Waller, J.M., (1988) Pests and Diseases of Tropical Crops. *Longman Scientific and Technical Intermediate Tropical Agricultural Series.*

Lindegren, J.E. (1990) Field suppression of three fruit fly species (Diptera: Tephritidae) with *Steinernema carpocapsae*. Proceedings and Abstracts, Vth International Colloquim on Invertebrate Pathology and Microbial Control, Adelaide, Australia, 20-24 August 1990. 223 p.

Lindegren, J.E., Wong T.T., McInnis D.O., (1989) Response of Mediterranean fruit fly (Diptera:Tephritidae) to the entomogenous nematode *Steinernema feltiae* in field tests in Hawaii. Environmental Entomology 19: 2, 383-386.

Liquido, N.J., Shinoda, L.A. Cunningham, R.T., (1991) Host plants of the Mediterranean fruit fly (Diptera, Tephritidae) an annotated. Mis. Pubbl. Entomol. Soc. Am 77(0), **Vol. 52.**

Liquido, N.J., P.G.Barr and R.T. Cunningham. (1995). Anencyclopedic bibliography of the host plants of the Mediterranean fruit flly, *Ceratitis capitata* (Wiedemann). Software.

Malavasi, A. Zucchi, R.A., (Eds). (2000) Moscas-das-frutas de importancia economica no Brasil, conhecimento basico e aplicado. 327 pp.

Messing, R.H. Ramadan, M.M., (2000) Host range and reproductive output of *Diachasmimorpha kraussii* (Hymenoptera: Braconidae), a parasitoid of tephritid fruit flies newly imported to Hawaii. In: K.H. Tan (ed.). *Area-wide control of fruit flies and other pests.* Penerbit Universiti Sians Malaysia, Penang. pp. 713-718.

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

Papadopoulos, N.T. Katsoyannos, B.I., (2002). Parasitization of the Mediterranean fruit Fly by Aganaspis daci (Hymenoptera: Eucoilidae) in Greece. In: *Abstracts, 6th International symposium on fruit flies of economic importance*. May 2002, Stellenbosch. p. 69.

Pemberton, C.E. and H.F. Willard. (1918). Interrelation of fruit–fly parasites in Hawaii. *Journal of Agricultural Research*, **12,** 285-295.

Stark, J.D., Vargas, R.I., Messing R.H., Purcell M., (1992) Effects of cyromazine and diazinon on three economically important Hawaiian Tephritid fruit flies (Diptera: Tephritidae) and their endoparasites (Hymenoptera: Braconidae). *Journal of Economic Entomology*, **vol 85 (5),** 1687-1694.

Vargas, R.I., Harris, E.J., Liedo, P., Rendon P., Jeronimo, P., (1999) An effective natural enemy for the suppression of Mediterranean fruit fly in Coffee. *3rd working group on fruit flies of the Western Hemisphere, Guatemala*, July 4-9, 1999.

Weems, H.V. Jr. (1981) Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae*) Entomology Circular no 230. Fla. Dept. Agric. and Consumer Services. Division of Plant Industry.* 8 pp.

White, I.M., Elson-Harris, M., (1992) Fruit flies of economic importance: their identification and bionomics. *CAB INTERNATIONAL*, Wallingford, U.K. 601 pp.

## WEB RESOURCES -

**http://www.cdfa.ca.gov/pests/prp/**
**http://www.moscamed.org.mx/**
**http://www.extento.hawaii.edu/kbase/crop/Type/ceratiti.htm**
**http://www.cdfa.ca.gov/pests/medfly/background.html**
**http://www.sel.barc.usda.gov/Diptera/tephriti**