PEST FACT SHEET

False codling moth

Thaumatotibia leucotreta

Common names: FCM, valskodlingmot
Higher taxon: Lepidoptera: Tortricidae
Synonyms: *Cryptophlebia leucotreta* (Meyr.)
EPPO code: ARGPLE

False codling moth (FCM) is a native pest to South Africa. It is a polyphagous pest of many important South African export crops. The most important cultivated hosts of FCM are citrus, stone fruit, avocadoes, pomegranates, persimmons, macadamias and hot peppers. Grapes, litchies, cotton and maize are of secondary importance.

Female moths lay their eggs on the surface of fruit. When the eggs hatch, the new larvae bore into the fruit. All five larval instars develop within the fruit. Once the final instar larva is ready to pupate, it drops to the ground, spins a cocoon and pupates in the top layer of soil. Adults usually emerge within a couple of weeks.

FCM can be effectively controlled using integrated means which include orchard sanitation, augmentation of natural enemies, monitoring of population levels and timing of control actions using pheromone lures, mating disruption, attract and kill, and sterile insect technique. Insecticides have limited efficacy because larvae are present inside fruit and pupae are in soil.

FCM is a quarantine pest in many areas of the world. The main reason for its high pest status is not because of the damage it causes, but because it is endemic to sub-Saharan Africa.

False codling moth, *Thaumatotibia leucotreta,* adult female.

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BIOLOGY

Number of generations per year: 5-6 overlapping generations; no winter diapause
Length of generation: 5 weeks to 3 months
Threshold for development: 11.6º C (lower)

Adult female FCM emit a pheromone which serves to attract male mates. Males can sense this pheromone from as far as 1225 m away using a specialized gland on the hind wing. Attracted males approach the source of the pheromone before conducting the following courtship behaviour: rapid vibrations of the anal tufts, extension of the genital valves, orienting towards the source of the pheromone, followed by movement towards and contact with the female. Finally mating is attempted, sometimes several times before it is successful.

Mated females begin to lay eggs two days after adult emergence. If the female has not mated, she lays unfertilized eggs. Eggs are laid singly on the surface of fruit or leaves. Preferential laying sites are higher in the tree and damaged, ripened or rotting fruit are selected preferentially.

When eggs hatch, first instar larvae bore immediately into the fruit. Larvae undergo five development stages within the fruit, and the larval stage is the most damaging of the FCM life cycle. Initial penetration holes are miniscule and may be hard to detect. Upon completing the five larval instars, the final instar emerges from a characteristic hole, pushing out frass as it goes. This hole is much larger than the initial penetration hole, but by the time it is detected, the larva has already emerged. The larva then drops to the ground where it pupates in a strong silk cocoon in the top layer of the soil.

Depending on the fruit, damage may be different. For example, in citrus, FCM rarely bore deep below the surface of the fruit and stay mostly in the albedo. In stone fruit, larvae bore into the centre of the fruit and feed around the stone. In citrus, fruit typically drops 3-5 weeks after penetration of the larva. If a larva is found within a fruit, degree day models can be used to calculate when the initial penetration occurred in order to determine when and why control measures may have failed.

The length of the life cycle and the damage caused differs from fruit type to fruit type in South Africa and also from region to region. The polyphagous habits of this pest and its ability to adapt to a variety of hosts and environmental conditions make it of significant quarantine concern in other areas of the world.

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IDENTIFICATION

Egg

Size: 0.9 mm long
Duration: 9-12 days winter; 6-8 days in summer
Eggs are flattish and oval.

FCM eggs.

Larva

Final instar size: 15 mm long
Duration: 35-67 days in winter, 25-35 days in summer
Early instars are pale and spotted. Later instars are bright pink and can be distinguished from other species under the microscope by using several larval morphological features on the head, thorax, and abdomen.

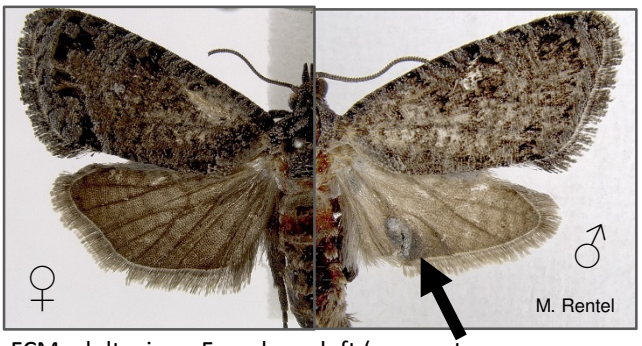
Pupa

Size: 11 mm long
Duration: 29-40 days in winter, 21-24 days in summer
Pupae are contained within a tough cocoon in the soil. The prepupal stage is light beige.

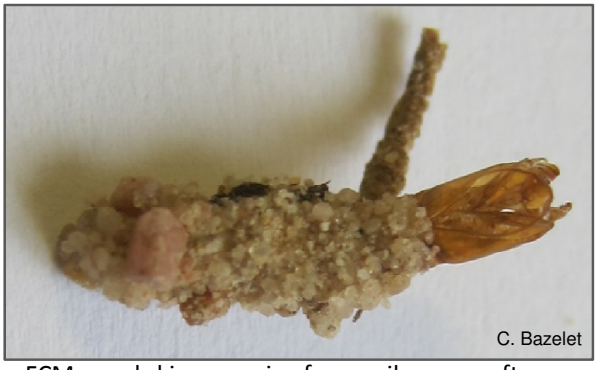
FCM larvae.

Adult

Size: male: 15-16 mm, female: 19-20 mm wingspan
Duration: 2-3 weeks
Number of eggs laid by single female: 100-400 eggs
Adults are easily recognizable by a triangular marking on the other edge of the wing, with a c-shaped black marking above it. Adult males have a tuft of fine hairs on the hind wing for sensing as well as a tuft of elongated scales on the hind tibia and abdominal terminus.



FCM adult wings. Female on left (no scent organ on hind wing); male on right (scent organ on hind wing - androchonia).



FCM pupal skin emerging from soil cocoon after adult emergence.

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ECONOMIC IMPORTANCE

FCM is of significant economic importance because many of the plants it occurs on are valuable crop commodities. In South Africa, citrus crop losses of 10-20% were common in the early 1990s due to FCM damage. In 1989, losses of 28% were reported on a late peach crop due to FCM.

In South Africa, the most damage is on citrus, stone fruit, avocado, pomegranates, persimmon, macadamias and hot peppers. Grapes, cotton, maize and litchi are of lesser importance.

HOST PLANTS

FCM is extremely polyphagous with over 70 plant hosts recorded worldwide in 40 plant families. In South Africa, 24 cultivated plants have been observed as potential hosts for FCM, but many of these were in the laboratory so it is unknown whether the same can occur in the wild.

Common name	Scientific name	Family
Navel orange	*Citrus sinensis*	Rutaceae
Olive	*Oleae europaea*	Oleaceae
Avocado	*Persea americana*	Lauraceae
Grape	*Vitis vinifera*	Vitaceae
Peach	*Prunus persica*	Roseaceae
Pomegranate	*Punica granatum*	Punicaceae
Litchi	*Litchi chinensis*	Sapindaceae
Mango	*Mangifera indica*	Anacardiaceae
Macadamia	*Macadamia integrifolia*	Proteaceae
Coffee	*Coffea arabica*	Rubiaceae
Pineapple	*Ananas comosus*	Bromeliaceae

FCM feeding in citrus.

FCM feeding in grape.

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MANAGEMENT

Monitoring

The most important monitoring technique for FCM in citrus is fruit-drop inspection. Fruit which has fallen from the tree is investigated for presence of FCM. A pheromone lure and dispenser are also available.

Prevention

Orchard sanitation and biological control play critical roles in the prevention of FCM outbreaks in South African citrus. All infested and damaged fruit should be collected from orchard floors and destroyed. Naturally-occurring egg parasitoids, *Trichogramma cryptophlebiae* should also be augmented or occasionally released to help prevent FCM outbreaks.

Control measures

In addittion to controlled releases of egg parasitoids, the CrleGV virus is commercially available as an IPM-compatible means of combatting FCM. Mating disruption, sterile insect technique and attract and kill techniques which utilize the pheromone together with an insecticide, are also IPM appropriate control measures. A large variety of chemicals are registered for use against FCM but should be used sparingly in order to preserve natural enemy populations.

FCM feeding damage to grape bunches.

FCM damage to pomegranate.

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MANAGEMENT

Natural enemies (biological control)

The FCM egg parasitoid, *Trichogramma cryptophlebiae*, is naturally abundant in citrus orchards, but can also be purchased commercially to combat FCM infestations. Under optimal conditions, it can parasitize up to 80% of FCM eggs in a given citrus orchard.

A few species of wasp and fly larval parasitoids also occur naturally in South African citrus orchards. The wasp *Agathis bishopi* (Braconidae) has been shown to parasitize up to 40% of FCM larvae in an Eastern Cape orchard.

Ants (Formicidae), *Orius* bugs (Anthocoridae) and assassin bugs (Reduviidae) prey on pupae, eggs and larvae of FCM, respectively. Two species of entomopathogenic fungi and two virus species have also been isolated from FCM. One of these viruses, CrleGV, has been shown to be effective in the field and is available commercially.

Attractants and trapping (pheromonal control)

Studies from the late 1960s until the early1990s attempted to identify the pheromone compound emitted by females to attract male FCM. A two-component mixture was identified in 1993 as the best performing pheromone. This consists of (E)-8-Dodecenyl acetate and (Z)-8-Dodecenyl acetate in a ratio of 9:1 and is commercially available as a lure in South Africa. A pheromone dispenser was designed two years later for dispensing of this lure.

Pheromone based trapping systems can be used to monitor population levels or for mating disruption. Dispensers are loaded with the female pheromone and males are attracted to the trap where they are captured. In citrus, because of the quarantine significance of this pest, trapping is currently used in order to time control measures rather than to identify economic thresholds since interception rates of zero are targeted.

QUARANTINE REGULATIONS

FCM is a quarantine pest in several countries including Israel, Jordan, New Zealand, several South American countries, and the USA. It poses a risk of establishment in many areas of the world, but probably not in Northern Europe as it is cold-intolerant. While it has been intercepted repeatedly at many ports worldwide, its potential for establishment remains to be determined.

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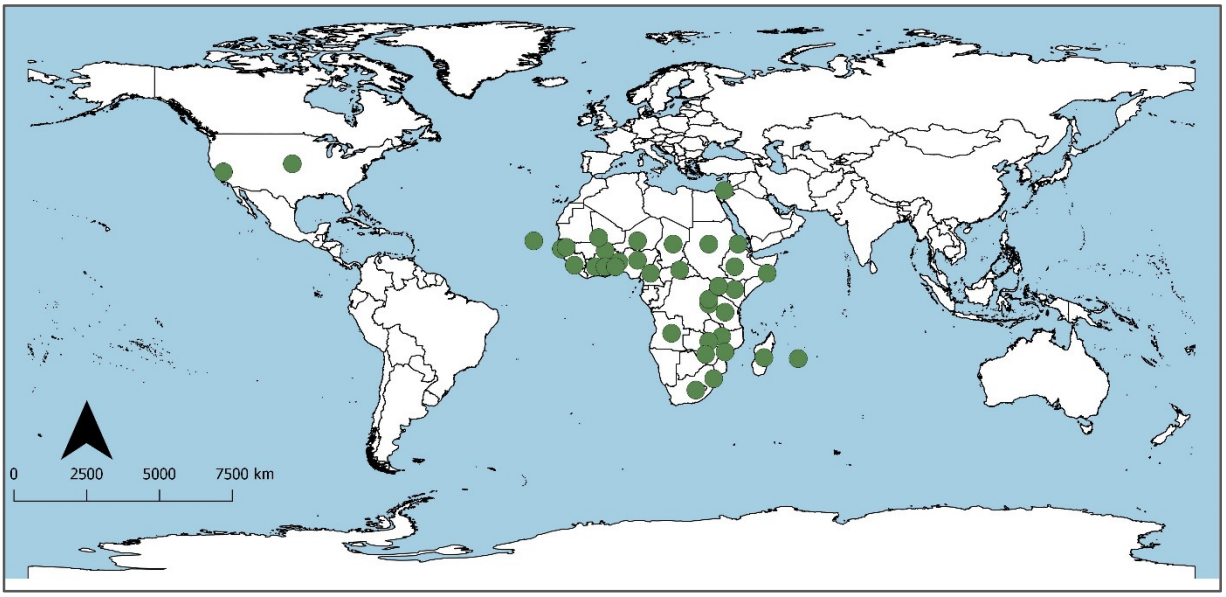
DISTRIBUTION

FCM is native and widespread throughout sub-Saharan Africa. It also occurs on some Indian and Atlantic Ocean islands such as Mauritius and Madagascar. Since the 1980's FCM has been established in Israel. It was intercepted once in a consignment in the USA in 2008, but extensive surveys did not find established populations of FCM in the USA at that time.

It has occasionally been detected in the Netherlands, UK and Sweden, but these are thought tot be incidental collections and not to originate from established populations as temperatures in these regions are too cold to support permanent populations of FCM.



False codling moth, *Thaumatotibia leucotreta*, distribution. Data from CABI (2017). Map drawn by C.S. Bazelet.

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