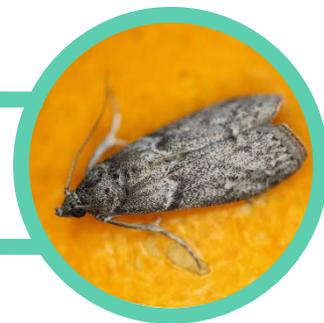


# Carob moth



## *Ectomyelois ceratoniae*

**Common names:** Date moth, pomegranate fruit moth, locust bean moth, knot-horn, blunt-winged, karobmot

**Higher taxon:** Lepidoptera: Pyralidae: Phycitinae

**Synonyms:** *Apomyelois ceratoniae* (Zeller)

**EPPO code:** MYELCE

Carob moth is an extremely polyphagous and versatile pest which easily adapts its life history and morphology to fit a large variety of hosts. In South Africa it is a known pest of citrus, especially grapefruit, pomegranates, macadamia and pecans. The pest probably originates from the Middle East but is widespread throughout southern Africa.

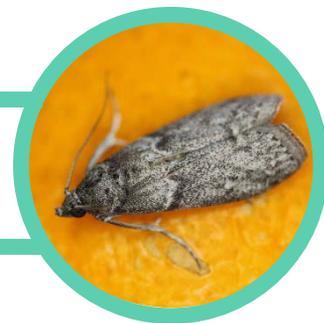
Larvae (caterpillars) of the carob moth cause significant damage by boring into fruit. Carob moth larvae look very similar to false codling moth (FCM) larvae and should be inspected under a microscope. The holes are normally a bit bigger than those made by FCM but do not go as deep into the fruit. Frass is extruded from the hole, like FCM.

The pest is thought to have 4 or 5 generations per year under good conditions. Larvae overwinter inside available citrus or other fruit. Orchard sanitation (removal of rotting or fallen fruit) seems to be important for maintaining low carob moth populations. Their numbers are elevated in orchards with severe mealybug or other honeydew-producing insect infestation, sooty mould or fungal growth. Two commercial lures are available in South Africa and chemical controls for FCM should be effective against carob moth as well.



Carob moth, *Ectomyelois ceratoniae*, adult.

# Carob moth



## *Ectomyelois ceratoniae*

### BIOLOGY

**Number of generations per year:** 4-5

**Length of generation:** variable depending on host and moisture

**Threshold for development:** 12.5° C (lower), 38° C (upper).

Two recent MSc theses have shed light on biology of carob moth in South Africa.

Eggs are oviposited during twilight and dark with peak oviposition occurring 3-5 days after female adult emergence. Females choose oviposition spots using olfactory cues, with preference shown towards plants infested with certain fungi, or those which are damaged and have holes already, such as damaged carob pods.

Once eggs hatch, larvae undergo 3-6 instars with variation in instar duration caused by variation in light, temperature and host plant nutritional quality and moisture content. Moisture content of the host appears to be the single largest determinant which can lead to doubling in generation time. A recent study found that a degree day model was difficult to develop because development rates vary with sex, host plant and moisture content. These factors can themselves vary depending on agricultural practices and local conditions.

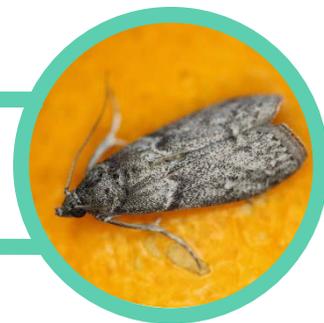
Carob moth larvae are often confused with false codling moth (FCM) larvae as they co-occur in a number of hosts including citrus and pomegranate and are superficially similar looking, although keys have been developed to easily tell them apart under the microscope. Both pests bore into fruit, creating a penetration hole out of which frass exudes. Carob moth holes tend to be slightly larger than FCM holes as the larvae are larger when they bore into fruit. Furthermore, carob moth rarely penetrate deeply into fruit but stay just beneath the rind. Finally, carob moth pupates within the fruit while FCM drops to the ground in order to pupate in the soil.

In South African citrus, carob moth are most abundant in orchards with severe mealybug or other honeydew-producing insect infestation. Larvae overwinter in fruit. When a larva is ready to pupate, it spins a web over its feeding area within which pupae can be found. Pupal longevity, unlike larvae, is not affected by host properties.

Adult males emerge two days before females and courtship communication is based on pheromones. Adults are inactive during the daytime and begin activity around sunset. Females emit sex pheromone over a broad time range at dusk. As they age, they emit the pheromone earlier in the evening and for longer durations.



# Carob moth



## *Ectomyelois ceratoniae*

### IDENTIFICATION

#### Egg

**Size:** 0.7 mm long, 0.5 mm thick

**Duration:** 1-8 days; 1-3 days at 30° C

Eggs of the carob moth are usually ovoid in shape and deposited singly or in clusters of up to 3 eggs. Eggs are first whitish/yellowish but turn pink 12-24 hours after being fertilized. Below 20° C, eggs do not hatch.



Carob moth, *Ectomyelois ceratoniae*, egg.

#### Larva

**Final instar size:** >0.15 mm head capsule width

**Duration:** 23.7 days at 30° C

Larvae are slender, elongate, cream white to light pink in colour. Their head capsules are yellow to brown and superficially they look similar to FCM larvae.



Carob moth, *Ectomyelois ceratoniae* larva.

#### Pupa

**Size:** 11 mm long

**Duration:** 7 days at 30° C

Pupae are yellow to brown with dark ventral abdominal markings. Male and female pupae can be differentiated.

#### Adult

**Size:** 19-26 mm wingspan

**Duration:** 5-15 days

**Number of eggs laid by single female:** 200 eggs

Adults are small, inconspicuous grayish moths which vary in terms of their size, wing markings and genital structures. The rear wing is light gray and fringed with long hairs.

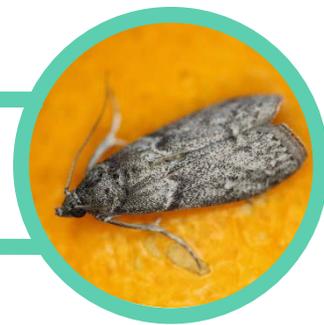


Carob moth, *Ectomyelois ceratoniae*, male adult.



Carob moth, *Ectomyelois ceratoniae*, pupa.

# Carob moth



## *Ectomyelois ceratoniae*

### ECONOMIC IMPORTANCE

In different areas of the world, carob moth is of varying economic importance on different hosts of both field crops and stored products.

It is a major pest of carob, pomegranate and citrus throughout many areas of the Middle East. It is also a pest of live and stored almonds, pistachios and dates in Australia, Iran, Tunisia, USA and Israel.

In South Africa, over 50 hosts have been identified, many of which are exotic species. Carob moth is a minor pest on citrus, especially grapefruit, as well as on pomegranates, pecan and macadamia nuts.



Carob moth, *Ectomyelois ceratoniae*, feeding damage.

### HOST PLANTS

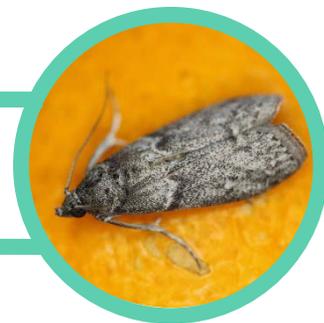
Common name	Scientific name	Family
*Citrus	<i>Citrus</i> sp.	Rutaceae
Carob tree	<i>Ceratonia siliqua</i>	Fabaceae
Almond	<i>Prunus dulcis</i>	Rosaceae
Pistachio	<i>Pistacio vera</i>	Anacardiaceae
Dates	<i>Phoenix dactylifera</i>	Arecaceae
*Pomegranate	<i>Punica malus</i>	Punicaceae
Walnuts	<i>Juglans</i> sp.	Juglandaceae
*Pecans	<i>Carya illinoensis</i>	Juglandaceae
*Macadamia	<i>Macadamia integrifolia</i>	Proteaceae
Pigeon pea	<i>Cajanus cajan</i>	Fabaceae
Tamarind	<i>Tamarindus indica</i>	Fabaceae



Carob moth, *Ectomyelois ceratoniae*, feeding damage.

\* Indicates known hosts in South Africa.

# Carob moth



## *Ectomyelois ceratoniae*

### MANAGEMENT

#### Monitoring

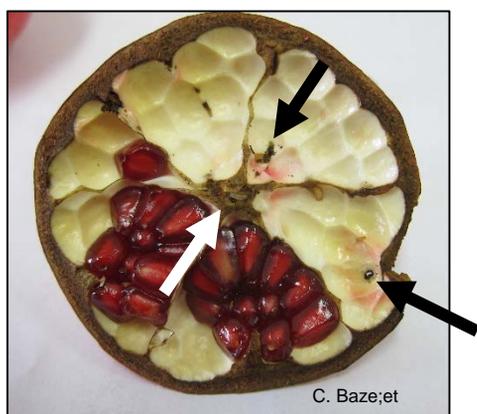
Two male lures are commercially available in South Africa for attracting carob moth. These can be used throughout the season to adult moth activity levels. No thresholds are currently available to signal initiation of action measures. It is also recommended to use trained personnel to detect larvae in fruit on trees. Five trees per orchard can be inspected weekly for fruit showing any damage signs associated with larvae. In the absence of trained personnel, dropped fruit should be investigated for larvae weekly under five trees per orchard. Larvae should be identified as carob moth or FCM.

#### Prevention

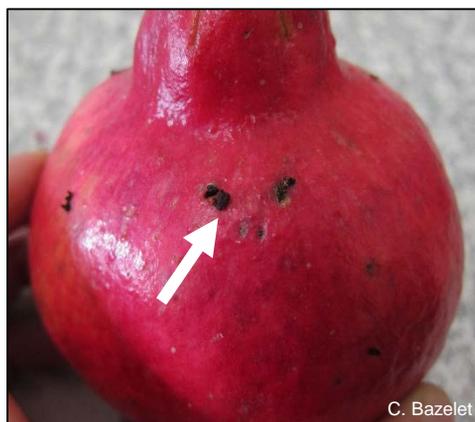
In citrus orchards, controlling mealybug may assist in the prevention of carob moth infestations. Orchard sanitation – collecting dropped and rotting fruit from orchard floors – is the most effective way to deter carob moth in citrus, date and pomegranate orchards in South Africa. In Turkey, this action alone led to an 80% decrease in infestation rates.

#### Control measures

Many commercially available sprays are effective against carob moth. Experiments showed that FCM and carob moth are affected similarly by many products so can be controlled simultaneously. A mating disruption product from the USA is currently under evaluation and shows promise for mating disruption of South African carob moth. *Bacillus thuringiensis* has been used effectively against carob moth in the Middle East in pomegranate and date orchards.

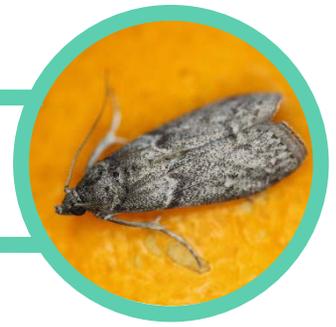


Carob moth, *Ectomyelois ceratoniae*, feeding damage to pomegranate. Arrow indicates frass, penetration hole, and size of larva.



Carob moth, *Ectomyelois ceratoniae*, feeding damage to pomegranate. Arrow indicates frass exuded from penetration hole.

# Carob moth



## *Ectomyelois ceratoniae*

### MANAGEMENT

#### *Natural enemies (biological control)*

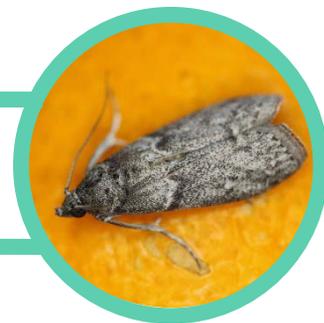
Two species of parasitoid have been identified from carob moth in South Africa: *Phanerotoma carobivora* and *Phanerotoma ornatulopsis*. In other regions of the world at least 12 species of parasitoid have been identified including species from the genera *Trichogramma*, *Bracon* and *Brachymeria*. These include larval, pupal and egg parasitoids. There are also known mite and beetle predators on carob moth larvae. Two strains of *Bacillus thuringiensis* have been found to be effective as control measures of carob moth.

#### *Attractants and trapping (pheromonal control)*

The female carob moth emits a sex pheromone to attract males. This was isolated and identified in 1991 and consists of 3 chemical compounds at a ratio of 8:1:1. When either of the minor components is added to the major component, male flight response is triggered. Two male lures are commercially available in South Africa which utilize parapheromones synthesized to mimic the naturally occurring pheromones. However, these lures seem to have differing attraction capabilities from region to region so their efficacy must still be investigated.

A mating disruption product from the USA, SPLAT® EC, is the only registered mating disruption product for carob moth in the world. It was evaluated in South Africa and found to be effective against South African carob moth populations.

# Carob moth



## *Ectomyelois ceratoniae*

### QUARANTINE REGULATIONS

Carob moth has been listed as a quarantine pest in Brazil since 1995, and, as of 2016, is a phytosanitary pest in China, so its detection can lead to container rejection.

### DISTRIBUTION

Carob moth is thought to originate from the Mediterranean region but is found all over the world. In South Africa it was first discovered in the Western Cape in 1974 but has since been found throughout South Africa.



Carob moth, *Ectomyelois ceratoniae*, distribution. Red stars indicate published presence records of pest. Base map from <http://geology.com/world/world-map.shtml>. Reprinted from Morland (2015).

### REFERENCES

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