Controlling the Greater Wax Moth

...a pest of honeycombs

United States Department of Agriculture

PREPARED BY Science and Education Administration

Farmers' Bulletin Number 2217

Contents

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Washington, D.C.

Revised January 1981

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The greater wax moth is also known as the bee moth, the bee miller, the wax miller, and the webworm. In its larval stages, it damages combs and honey and is responsible for large losses to beekeepers in the United States. This insect is found almost everywhere that bees are raised. Its greatest damage is done in the Southern States, where its season of activity is longest.

Nature of Damage

The greater wax moth is most destructive to combs in storage, especially to combs stored in dark, warm, poorly ventilated places. The larvae of the moth tunnel into the combs, leaving them a mass of webs and debris (fig. 1).

Greater wax moths sometimes attack combs within the active hive, though such attacks are less common than those on stored combs. If the colony is strong, the bees defend themselves well against attack, and chance of infestation is slight. However, weak, diseased, starved, or otherwise abnormal colonies are a prey of the greater wax moth, and in these colonies the combs are often destroyed. Thus, though greater wax moths may not destroy a healthy colony, they may con-

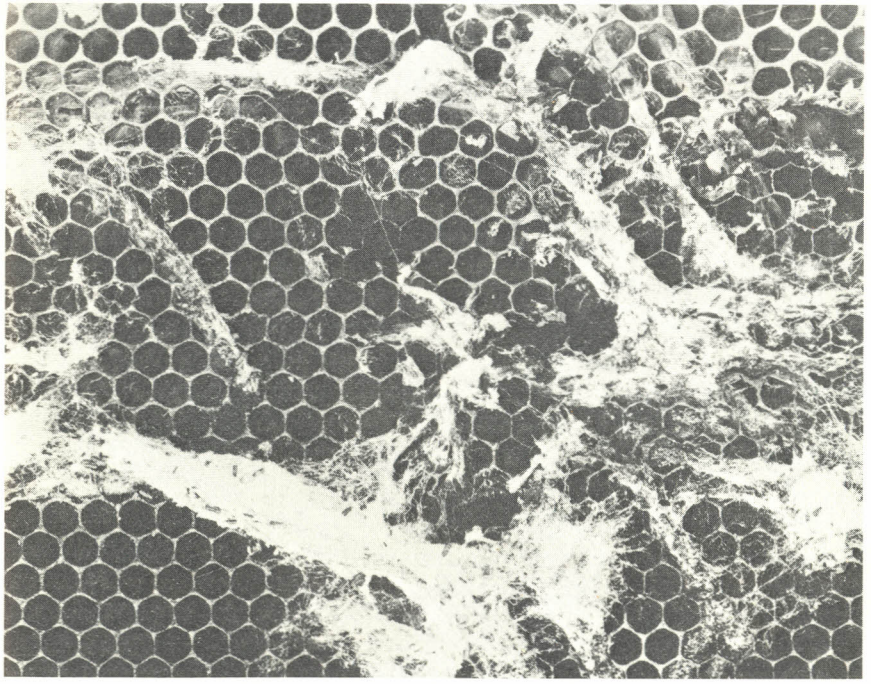

Figure 1.—Part of a comb damaged by the webs and tunnels of greater wax moth. BN-25449

tribute to the destruction of an already weakened colony.

The larvae of the greater wax moth also do considerable damage to comb honey. The eggs are probably laid on the comb or section boxes before the comb-honey supers are removed from the hives, but the damage does not become evident until some time after the honey has been placed in storage. The damage consists of small, rather inconspicuous tunnels and borings made by the larvae through the thin wax caps of the honey cells. The honey leaks out through these holes, making the affected section unmarketable.

Description and Development

The greater wax moth passes through three stages of development before becoming an adult—egg, larva, and pupa. In the Southern States these stages are not confined to particular times of the year. All stages may be present at any time during the year, and development is continuous except during periods of low temperature.

The Egg

The egg of the greater wax moth is small, white, and slightly oblong; its greatest diameter is less than one-fiftieth of an inch (0.05 cm). Normally, the female lays eggs in masses rather than singly, but even the masses are usually very difficult to see (fig. 2).

The eggs are laid most frequently in the cracks between hive parts—that is, between supers, between hive body and bottom board, or between top super and cover (see fig. 3). The egg masses may be deposited in these cracks from outside the hive or, if the colony is weak, from inside the hive. Egg laying within the hive almost always occurs in places farthest from the light.

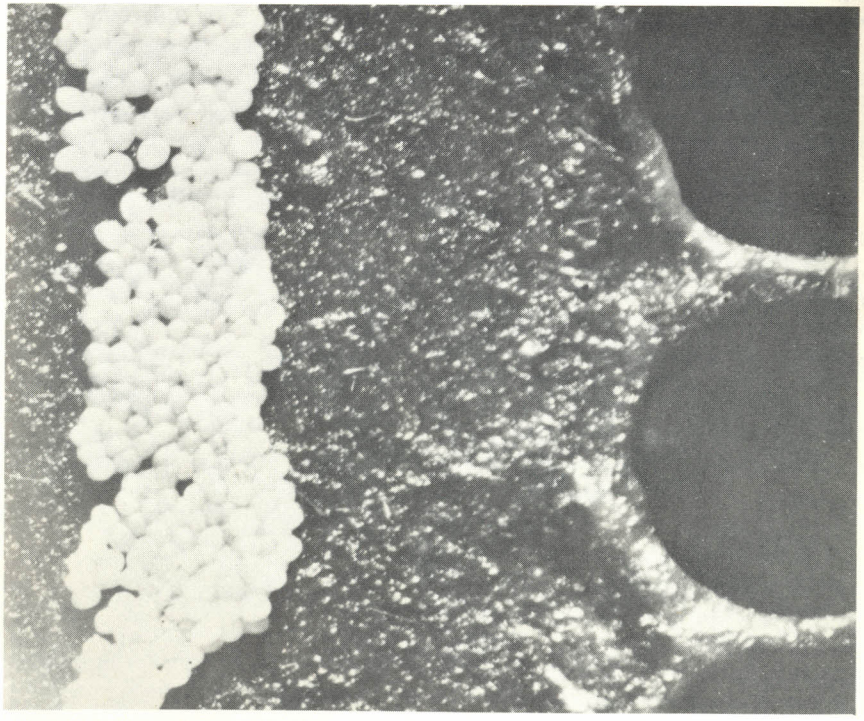

Figure 2.—Eggs of the greater wax moth, laid on a comb. Greatly enlarged. BN-25446

At 75° to 80°F (24° to 27°C), the eggs hatch in 5 to 8 days, but at lower temperatures (50-60°F or 10-16°C), the incubation period may extend to 35 days.

The Larva

The newly hatched larvae are often seen on the inner covers of hives and in cracks between supers and hive parts. They are white, extremely small, and very active. Almost immediately after hatching they attempt to burrow into the wax. The first attempts often do little more than roughen the surface of the wax; but after the first day, the larvae tunnel into the cell wall and make their way toward the midrib of the comb.

The length of the larval period ranges from 28 days to nearly 5 months. During this period the larvae grow from about one-twenty-fifth of an inch (0.1 cm) to as much as seven-eighths of an inch (2.22 cm) in length. The rate of growth and final size of the larvae depend chiefly on the food supply and temperature.

The larvae receive most of their nourishment from impurities in the wax, and in obtaining these impurities they ingest the wax itself. Foundation, which contains less of the impurities then the darker brood combs, is seldom attacked. Small larvae can develop on foundation, but many of them die, and those that survive develop at a relatively slow rate.

It is almost certain that some of the damage attributed to the lesser wax moth (*Achroia grisella*) is the work of these poorly fed greater wax moth larvae (*Galleria mellonella*).

Temperatures most favorable for development of the larvae are between 85° and 95°F (29° and 35°C)—about those normally found in a beehive during the active season. At lower temperatures, growth is retarded; at 40° to 45°F (5° to 7°C), no feeding or growth takes place, and the larvae seem to become dormant.

The Cocoon

When fully grown, the larva spins a dense, rough silken cocoon. Some cocoons are found amid the tunnels and webbing in the combs, or in the refuse on the bottom of the hive; but usually the cocoon is firmly attached to some solid support, such as the frame, the side of the hive, or the inner cover (fig. 4). Frequently, the larva cements its cocoon inside a cavity that it has chewed in the wood. These cavities sometimes extend completely through the end or top bars of the frame.

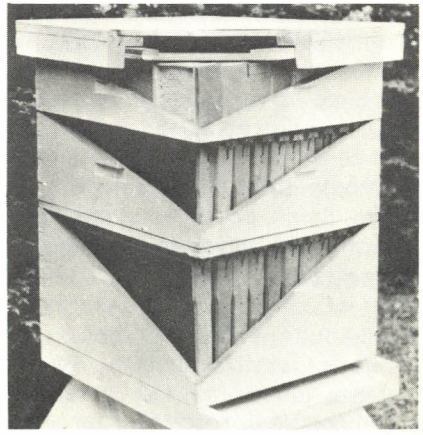

Figure 3.—A modern hive cut away to show the interior. The honey supers are the middle and top boxes. A full-depth hive body is at bottom; shallow hive bodies are in the middle and at top. BN-25450

The Pupa

Within the cocoon the larva changes to the pupa. The duration of the pupal stage within the cocoon ranges from 8 to 62 days; the higher the temperature, the shorter the duration. As with many other insects, the pupal period allows the greater wax moth to pass through the fall and winter protected against harmful weather conditions. In the South, especially in warm winters, the adults may emerge at any time.

The Adult

The normal adult of the greater wax moth is about three-fourths of an inch long (1.9 cm) and has a wingspread of 1 to 1¼ inches (2.5 to 3.1 cm) (fig. 5). The males are slightly smaller than the females and may be distinguished from them by the shape of the outer margin of the fore wing, which is scalloped in the male but smooth in the female. Adults are commonly seen in the resting position, with their grayish-brown wings folded in rooflike fashion. The moths are not easily disturbed, but when molested they run rapidly before they take wing.

The moths vary widely in size and color, according to the type of food consumed by the larvae and the length of the developmental period. Small, poorly nourished larvae, or those whose development is slowed by low temperatures or other influences, transform into small adults; sometimes these adults are less than half the normal size. Larvae that feed on dark brood combs transform into moths that may be dark gray to almost black; those that feed on foundation become silvery-white moths that are smaller than those that feed on brood combs.

Figure 4.—Cocoons of the greater wax moth. BN-25444

The female starts depositing eggs from 4 to 10 days after she emerges from the cocoon; she continues depositing as long as her vitality lasts. Egg laying may be rapid at times; females have been known to deposit more than 100 eggs in 1 minute. The total number of eggs laid by a female varies considerably, but it is usually fewer than 300. The adults may live as long as 3 weeks.

Other Comb-Damaging Moths

The lesser wax moth (*Achroia grisella*) also does some damage to stored combs. Its larvae inflict damage similar to that of the greater wax moth larvae, but the tunnels are smaller, the webs finer, and feeding and webbing are more confined to the outer surface of the combs.

The larvae of the Mediterranean flour moth (*Ephestia kuehniella*) feed on pollen in the hive, and do some damage to combs by boring tunnels through the midrib. The flour moth larvae also tunnel into brood cells and consume the food intended for the developing bee larvae. These two moths may be controlled by the methods used for control of the greater wax moth.

Control Measures in the Apiary

The most effective natural enemies of greater wax moths are the bees themselves. When the colony is strong, the bees will carry the moths out of the hive and prevent any damage by the larvae. It is only when the colony has been weakened by disease, starvation, or other means—that the wax moth succeeds in seriously damaging inhabited combs. Accidental loss of queens late in the fall may mean the loss of colonies from greater wax moth damage before the first spring inspection.

Therefore, any beekeeping practices or manipulations that help maintain strong colonies will also decrease the chances of greater wax moth infestation. There is no better insurance against the ravages of the pest than to have strong, queenright colonies.

There is one beekeeping practice that is especially important in preventing greater wax moth infestation—keeping the hive clean. Propolis, burrcombs, and refuse should be removed from the bottom board, since they provide protection for larvae of the greater wax moth, even in strong colonies.

Control Measures for Stored Combs

When combs are removed from the hive and placed in storage, there is increased danger of damage by the greater wax moth. Steps must be taken to kill any existing stages of the greater wax moth and guard against later infestation. The most satisfactory method of controlling the insect in stored combs is the use of fumigants and the proper storing of the combs after fumigation.

Fumigation of Stored Combs

Fumigants are liquid or solid chemicals that form gases when exposed to the air. These gases kill the adult moths, larvae, pupae, and sometimes the eggs. If the combs are thoroughly aired after fumigation, fumigants do not leave residues that would be harmful to bees.

Paradichlorobenzene and ethylene dibromide, used as directed, effectively protect stored combs from the greater wax moth. They are not recommended for use on combs containing honey intended for human consumption. (See "Precautions" p.11.)

Fumigation with paradichloroben zene. Paradichlorobenzene (PDB) is a white crystalline substance that evaporates slowly in the air. It is most effective at temperatures above 70°F (21°C), and volatilizes more rapidly as the temperature rises. The gas is heavier than air, nonflammable, and nonexplosive.

PDB can be used to protect all combs in storage except those containing honey intended for human consumption. The odor of PDB is readily absorbed by honey, and though the bees do not object to this odor, such honey is unfit for market purposes. Stored honey combs protected with PDB can be used for spring feeding as long as the combs are aired for a few hours before being placed on colonies.

Treatment with PDB requires no special storage facilities. The supers should be stacked as tightly as possible, and special precautions should be taken to see that the gas, which is heavier than air, cannot escape at the bottom of the stack. For long periods of storage, as over winter, the cracks between supers should be covered with strips of gummed paper. No more than 5 full-depth supers or 10 half-depth supers should be used in a stack. Taller supers may not allow for complete diffusion of the heavy gas, especially during periods of low temperature.

In a stack of five 10-frame supers, 3 ounces (89 g) of the crystals (6 tablespoons) should be sprinkled on the frames of the top super. The crystals may be placed directly on the top bars of the frames, or, preferably, separated from the frames by a piece of paper or cardboard. The cover should then be put tightly in place.

At intervals of 2 or 3 weeks the covers of the stacks should be raised and the top supers examined; if crystals are no longer present, more should be added. PDB kills adults and immature stages but not eggs. The continuous presence of crystals within the stack not only repels moths, but also kills any young larvae that hatch after the combs are placed in storage.

Fumigation with ethylene dibromide. Ethylene dibromide is sold as a heavy, clear liquid. It is nonexplosive, nonflammable, and easily stored. On exposure to air it forms a colorless gas that is heavier than air and has a slight, not unpleasant odor. This compound volatilizes and diffuses rather slowly, killing all stages of the greater wax moth, including the egg.

Fumigation with ethylene dibromide should take place in a gas-tight room or under gas-tight covers such as polyethylene sheeting or plastic-coated tarpaulin. Fumigation with ethylene dibromide should continue for at least 24 hours, since the gas diffuses slowly, especially at temperatures below 60°F (16°C). Do not enter the fumigation room until it is completely aired following fumigation.

The label for use of ethylene dibromide to control wax moths is in the process of being reviewed by the Environmental Protection Agency for re-registration. For this reason, users are referred to the current label accompanying the product. Read the entire label for dosage rates and precautions before attempting to use this material. Ethylene dibromide has been shown to be carcinogenic and must be used with caution. Consult your State apiary inspector before using the chemical.

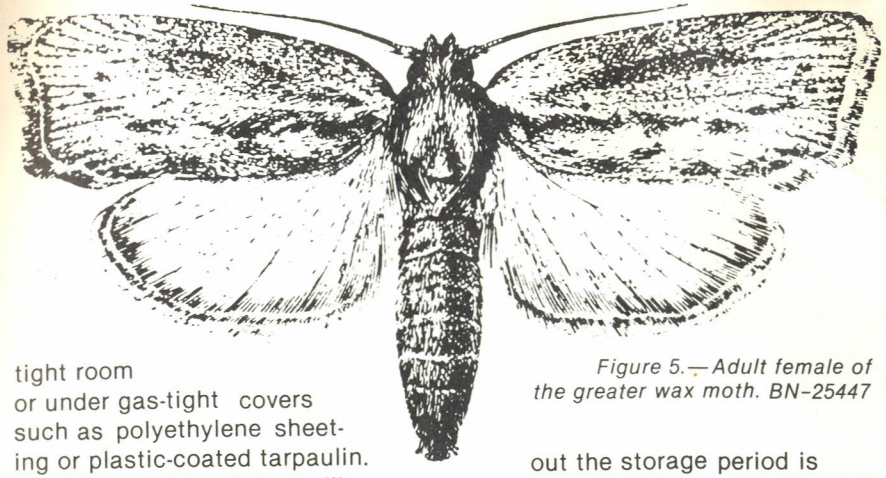

Figure 5.—Adult female of the greater wax moth. BN-25447

Fumigation with carbon dioxide. Carbon dioxide can be used as a fumigant to destroy all stages of the moth on comb honey or stored combs. Since a high concentration of carbon dioxide is required for fumigation, a relatively airtight room is necessary.

A fumigation period of 4 hours is required with a concentration of carbon dioxide of 98 percent by volume, at a temperature of 100°F (38°C), and a relative humidity of 50 percent. *Do not enter the fumigation chamber while fumigating.* Bee equipment fumigated with carbon dioxide does not require aeration to dissipate residues.

Storage

The threat of damage by the greater wax moth to stored combs is continuous, except when temperatures in the storage area drop below 40°F (5°C). The presence of PDB in the stacked supers throughout the storage period is a constant check on the greater wax moth; but ethylene dibromide provides better temporary control. Fumigants may effectively destroy all existing stages of the moth, but they may not prevent a later reinfestation.

Therefore, fumigation with these chemicals should be followed by storing the frames in a moth-free room that is clean, well lighted, and ventilated. The supers should be placed on end and spaced to allow air circulation. This will help repel greater wax moths, which like to lay their eggs in dark, poorly ventilated places. The common method of storing combs in tightly closed, crowded hive bodies is highly favorable for wax moth infestation and development.

Nonchemical Control

Temperature extremes can be used to control this pest, because the growth and development of the greater wax moth depends on temperature. Use of high or low temperatures avoids the hazard of honey contamination.

Heat. All stages of the greater wax moth are killed at a temperature of 115°F (46°C), for 80 minutes. At a

higher temperature, 120°F (49°C), the time of exposure can be reduced to 40 minutes. Make sure you allow combs to reach the required temperature before measuring the exposure time. *Warning.*—Be careful not to expose honey combs to temperatures in excess of 120°F (49°C).

If heat is used to control the greater wax moth, follow these precautions:

- Heat treat only those combs having little or no honey (wax softened at high temperatures may sag and become distorted).
- Heat treat supers of the combs when in an upright position—not on the ends or sides.
- Provide adequate air circulation so that the heat will be uniformly distributed throughout the comb. (Ventilating fans are useful for this purpose.)
- Turn the heater off and allow combs to cool before moving the supers.

Cold. Low temperatures can also be used to destroy all stages of the greater wax moth. Use of low temperatures avoids the sagging problem which sometimes occurs when combs are treated with heat. Thus, combs with honey and pollen can be treated by use of low temperatures without much danger to the combs. The minimum temperature and exposure time to destroy all stages of the greater wax moth follow:

Temperature (°F)	(°C)	Time in hours
20	– 7	4.5
10	– 13	3.0
5	– 5	2.0

The use of heat or low temperatures avoids the hazard of residues, and bee equipment can be reused without endangering the honey bees.

In most cases, honey houses can be converted into a heating chamber by adding a thermostat and a circulating fan. Home freezers can be used for the cold treatment—the only limitation being the size of the freezer.

Once the combs are treated, they should be stored in a chamber which prohibits the entry of adult greater wax moths. Combs should be inspected monthly for signs of infestation, especially if temperatures rise above 60°F (16°C).

Precautions

The fumigants ethylene dibromide and PDB, used improperly, can be injurious to man and animals. Follow the directions and heed all precautions on the container label. Keep the fumigants well labeled, in a dry place where they will not contaminate food or feed, and where children and pets cannot reach them.

Ethylene dibromide requires special care in handling. If the liquid is spilled on the skin, it causes blisters or burns if not washed off immediately. The gas is irritating to the lungs and nasal passages. PDB fumes in high concentrations may be irritating to the eyes and nasal passages.

Fumigate out-of-doors, under an open shed, or in a well-ventilated room away from workrooms or workers.

Where large quantities of combs or equipment must be fumigated, wear a gas mask, have someone work with you or watch you, expose yourself as little as possible, and post warning signs to prevent accidental exposure of others.

Do not use ethylene dibromide or PDB on stored combs containing honey intended for human consumption.

Summary of Control Methods of the Greater Wax Moth

Treatment	Empty comb	Full comb[1] (food use)	Full comb[2] (non-food use)	Temperature or dosage level	Length of exposure
Paradichlorobenzene	Yes	No	Yes	3 ounces (84 g) or 6 tablespoons per stack of 5 supers.	Keep constant supply while in storage.[3]
Ethylene dibromide	Yes	No	Yes	Consult current label.	Consult current label.
Carbon dioxide	Yes	Yes	Yes	98 percent by volume at 100°F (38°C).	4 hours.
Heat	Yes	No[4]	No[4]	115°F (46°C)	2 hours.
Cold	Yes	Yes	Yes	20°F (– 7°C) 10°F (– 13°C) 5°F (– 15°C)	4.5 hours. 3 hours. 2 hours.

[1]Honey to be used for human consumption.
[2]Honey to be used for bee food. (Not for human consumption.)
[3]Paradichlorobenzene is most effective at temperatures above 70°F (21°C). Eggs of the greater wax moth are not destroyed by PDB.
[4]Not recommended because the temperatures required may cause sagging of combs.