LIGHT BROWN APPLE MOTH, A THREAT TO CALIFORNIA GRAPE VINEYARDS?

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The light brown apple moth (LBAM), *Epiphyas postvittana*, was confirmed in California by the USDA APHIS in March, 2007, the first time this pest has been detected in the continental United States. It has since been found in Alameda, Contra Costa, Los Angeles, Marin, Monterey, Napa, San Francisco, Santa Clara, Santa Cruz, San Mateo and Solano counties. LBAM is considered to have high potential to cause economic damage to agricultural commodities. APHIS issued a Federal Domestic Quarantine order on May 2, 2007, with restrictions on interstate shipment of plant material and the CDFA issued a State Interior Quarantine order restricting intrastate shipment of plant material from counties where LBAM is known to occur. A Technical Working Group has been established to advise APHIS and CDFA on response to the LBAM infestation. The Technical Working Group has recommended that the agencies adopt a long-term goal of eradicating LBAM, and a workplan and feasibility assessment is being developed. Should APHIS decide LBAM can no longer be eradicated, then management of the pest will move to a traditional IPM program, which would probably include monitoring, use of a degree-day model to target young larvae with insecticides, pheromone mating disruption, and conservation of biological control agents, with the intensity of inputs depending on crop and location.

LBAM is a native of Australia that has also become established in New Zealand, New Caledonia, Great Britain, and Hawaii.. It has a broad plant host range of over 250 known species that includes landscape trees, ornamental shrubs, fruit crops and certain vegetable crops. Examples of plants on which it is a reported pest include apple, pear, peach, apricot, citrus, persimmon, avocado, grape, kiwifruit, strawberry, caneberries, cole crops, oak, willow, walnut, poplar, cottonwood, alder, pine, eucalyptus, rose, camellia, jasmine, chrysanthemum, clover, and plantain. Its presence in California is of concern because of its broad host range and the fact that much of California has a climate which is favorable for its survival.

Although LBAM is found throughout Australia, it does not survive well at high temperatures. It is a more serious pest in cooler areas with mild summers, moderate rainfall (~ 29 inches) and moderate to high relative humidity (approximately 70%). Hot, dry conditions may substantially reduce populations. The adult moth typically only flies short distances, about 300 feet, to find suitable hosts. Therefore its dispersal is most likely by movement of infested nursery plants or green waste, and on equipment and containers. It is difficult to say how quickly it may spread, if at all, in California, and how well it would succeed in warmer and drier areas of the state.

Identification. LBAM is in the Lepidoptera family Tortricidae, which includes a number of other notable pest species. Because an effective sex pheromone for LBAM to detect male moths is available commercially and used with delta traps, adult males are the easiest stage to find. Adults are also more easily identified than the other life stages, including the larval. An extensive surveillance program has been established throughout California by regulatory agencies to establish the area of LBAM infestation. The adult male (Figure 1) is about 0.3 to 0.4 inch (8 to 10mm) long and the adult female (Figure 2) slightly larger. Their wingspread is about twice their length. The overall color of both sexes is yellowish brown, but the forewings of the male are slightly to much darker towards the distal edges.

The eggs are are similar to those of other leafrollers in California, pale white to light green and laid slightly overlapping each other as an egg mass on the upper surface of foliage, however they occasionally deposit egg masses on fruit. The eggs become dark before hatching. A typical egg mass has 20 to 50 eggs, but may be larger. Newly hatched larvae are pale yellow, and there are 5 or 6 larval instars. Mature larvae are light green with a light brown head (Figure 3), and the setae (hairs) on the body are white. Larvae have a greenish anal comb. The larvae are active, and may grow to 0.75 inch (18 mm) in length at maturity. After emerging, the larva builds a silken shelter by rolling a leaf lengthways and webbing its edges together. These webbed leafrolls are rather easy to see when they are present, and are characteristic of all leafrollers including a number of endemic species to California (Figure 4). Leaves may also be webbed together or joined to fruit. The larvae feed within these shelters. Larvae may also build

webbed shelters within grape bunches, and feed on the berries. LBAM does not have a diapause, and will most likely overwinter as a larva in leaf litter and other plant material.

Monitoring. An effective sex pheromone for attracting male LBAM is commercially available, and is used to detect the presence of the moth. In Australia, it is recommended that pheromone traps to detect and monitor the male moths be placed at one per 5 acres, with at least one in every vineyard no matter how small. There is a degree-day model for predicting LBAM development. The lower and upper developmental thresholds for LBAM are 45º and 88ºF, respectively. This model predicts that there will most likely be 2 generations a year on the central and north coast regions of California, but that there may be 3 to 4 generations a year in the central valley and southern California. In Australia, generations do not overlap, but they do in Great Britain and New Zealand. This likely reflects different weather conditions during the winter since there is no diapause.

Within their range, LBAM larvae are present for most of the year on host plants. Larvae are best detected by looking for the characteristic webbing of leaves. When fruit is present, larvae and webbing may be found within grape bunches and this is when they are most damaging. Larvae can persist in bunches remaining on vines after harvest, and they may survive for up to 2 months in the winter without feeding.

Damage. A number of other leafroller species are common in California, and they can easily be confused with LBAM. Like LBAM, adults of all California leafrollers hold their wings over their abdomen in a bell shape when at rest, and all have protruding mouthparts that resemble a snout. Most of these species are about 0.4 to 0.5 inch (10-12mm) long, however color patterns on their wings differ, and gentalia are used to make positive identification. Eggs of all species as well as those of LBAM are laid more or less in flat, tightly packed masses. Like these other leafrollers, LBAM feeds from within the webbed shelter it constructs. Foliar feeding by leafrollers is generally considered minor in fruit crops, and the primary concern is fruit damage. Grapes can be severely damaged by leafroller larvae feeding among the berries, increasing the incidence of Botrytis bunch rot, as well as by feeding along the bunch stem and directly on the berries. They may also feed on grape buds, and the injured buds may fail to develop shoots or clusters. Damage to grapes by LBAM is similar to that of two leafroller species endemic in California vineyards: the orange tortrix, *Argyrotaenia citrana*, and the omnivorous leafroller, *Platynota sultana*. Orange tortrix (Figures 5 and 6) is common in coastal vineyards and the omnivorous leafroller (Figure 7) is more common in hot inland valleys, but may also be present in warmer coastal areas.

Control. Although it is impossible to determine how severe LBAM will be should it become established in California vineyards, it might be expected that their management would be similar to that of orange tortrix and omnivorous leafroller. *The UCIPM Pest Management Guidelines for Grapes* (http://www.ipm.ucdavis.edu/PMG/selectnewpest.grapes.html) reveal a number of management strategies which might be applicable for LBAM management as well. These include vineyard sanitation practices such as removing broadleaf weeds during the winter and removing cluster mummies when pruning, then placing them in row middles where discing can bury them, are important for reducing overwintering populations. If monitoring suggests that insecticide treatment is necessary, there are several reduced-risk insecticides available for control of leafrollers in grapevines including *Bacillus thuringiensi*s, spinosad (Entrust and Success), and methoxyfenozide (Intrepid), as well as cryolite and a number of organophosphates and carbamates, although none of these products currently list LBAM as a target pest on their California labels.

Figure 1. A male light brown apple moth showing distinct dark coloration on the distal half of the forewing. Wing coloration can vary considerably. *Photo used with permission from Dr. David Williams, Principal Scientist, Perennial Horticulture, Department of Primary Industries, Victoria, Australia.*

Figure 2. A female light brown apple moth. *Photo used with permission from Dr. David Williams, Principal Scientist, Perennial Horticulture, Department of Primary Industries, Victoria, Australia.*

Figure 3. A mature light brown apple moth larvae. *Photo used with permission from Dr. David Williams, Principal Scientist, Perennial Horticulture, Department of Primary Industries, Victoria, Australia.*

Figure 4. A leafroller larva and webbing in a curled leaf. Leaf webbing is characteristic of a number of California leafroller species. *Photo provided by the UC Statewide IPM Program, Jack Kelly Clark, photographer, and are copyrighted by the Regents, University of California*.

Figure 5. Orange tortrix adults and an egg mass. Orange tortrix moths have light brown to orange-brown forewings with a v-shaped marking at the center of each wing. The orange tortrix egg mass is similar to that of other leafrollers including the light brown apple moth. *Photo provided by the UC Statewide IPM Program, Jack Kelly Clark, photographer, and are copyrighted by the Regents, University of California*.

Figure 6. An orange tortrix larva. Orange tortrix larvae generally have straw-colored to greenish-gray bodies with a yellowish-brown head capsule and prothoracic shield which is adjacent to the head. *Photo provided by the UC Statewide IPM Program, Jack Kelly Clark, photographer, and are copyrighted by the Regents, University of California*.

Figure 7. An omnivorous leafroller adult. The forewings of omnivorous leafroller moths are dark, rusty brown on the upper half, and tan on the lower half. A darker colored band extends outward on the resting moth from the middle of the wings in a V-shaped pattern that separates dark and light areas. *Photo provided by the UC Statewide IPM Program, Jack Kelly Clark, photographer, and are copyrighted by the Regents, University of California*.