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Light Brown Apple Moth: A Potential Invasive Pest in Arkansas

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The light brown apple moth (LBAM), *Epiphyas postvittana* (Tortricidae), is a native pest of Australia and is now widely distributed in New Zealand, the United Kingdom, the Netherlands and Sweden. Although it was reported in Hawaii in the late 1800s, a detection of the LBAM in California during 2007 was the first on the United States mainland (USDA, APHIS 2008). As of July 2007, LBAM has been found in eight San Francisco Bay area counties and in Monterey, Santa Cruz and Los Angeles counties. Following the confirmed detection of LBAM in California, officials initiated an emergency control program, including a quarantine order restricting intrastate and interstate shipment of plant material from LBAM-infested counties. Arkansas, having similar host and ecological conditions to parts of the world where the LBAM is a major pest, initiated a monitoring program in 2008 and continued monitoring in 2009 and 2014. As of October 31, 2014, no LBAM specimens have been found.

Pest Potential

Caterpillars of the LBAM feed on leaves, buds, shoots and fruit of plants. Young larvae construct and feed under silken shelters, whereas older larvae roll together leaves and buds. Larval feeding on the surface of fruit results in irregular brown areas, and larvae sometimes enter fruit to feed.

This invasive pest has a very wide host range and has been recorded feeding on over 500 different plant species. It attacks nearly all types of fruit crops, ornamentals, vegetables and greenhouse crops and is an occasional pest of young pine seedlings (Venette et al. 2003). Some potential woody plant hosts in Arkansas include apple, peach, cherry, rose, grape, strawberry, oak, willow, walnut, poplar and cottonwood. Among the herbaceous hosts are chrysanthemum, corn, pepper, tomato, pumpkin, beans, cabbage, alfalfa and clover.

Although LBAM larvae feed on leaves and buds, feeding damage to fruit causes the greatest economic losses. In Australia, LBAM causes AU$21.1 million annually in lost production and control costs, or about 1.3% of gross fruit value, for apples, pears, oranges and grapes (Camper and Cranshaw 2008).

Because of the pest potential of LBAM, many countries have specific regulations to prevent its introduction. As a regulated pest, many plant products grown in LBAM-infested areas are restricted or prohibited in certain commerce. If the LBAM became established in Arkansas, other states would likely impose restrictions on the movement of potentially infested fruits, vegetables and nursery stock. These restrictions could seriously impact the marketing of agricultural products from Arkansas. A primary purpose of LBAM surveillance is to determine if the moth is – or is not – present in the state. If populations are detected, then targeted efforts to eradicate it may be implemented.

Monitoring in Arkansas

The primary method used to detect LBAM in Arkansas involves a sticky trap with a pheromone-lure attractant. The specific lure used for LBAM is

a 20:1 mixture of (E)-11-tetradecenyl acetate: (E,E)-(9, 11)-tetradecadienyl acetate in a 3 mg dose per rubber septum. This pheromone lure mimics the sex pheromone produced by the female. Males, but not females, are strongly attracted to this lure.

The Arkansas 2008 trapping program was concentrated at larger retail and wholesale nurseries. Sites were also selected at commercial orchards and in commercial pine timber stands. Survey activities began on July 1 and continued into December (335 sites). Jackson traps were monitored every two weeks and pheromone was changed every six weeks. Most sites were visited 11 times. Counties where trapping occurred included Pulaski, Faulkner, Lonoke, Conway, Saline, Garland, Washington, Sevier, Benton, Madison, Carroll, White, Boone, Johnson, Pope, Ouachita, Grant, Jefferson, Franklin, Crawford, Ashley, Clay, Craighead, Baxter, Sharp, Columbia and Polk.

The 2009 trapping program was identical to the 2008 program, with 40 additional traps (375 sites) being established at locations that included "big box" retail stores, retail and wholesale nurseries, tomato farms and marketing facilities, orchards and vineyards and others. The 2014 trapping program had a total of 20 Jackson traps placed in nine vineyards and 11 tree fruit orchards in 11 Arkansas fruit-growing counties including Benton, Boone, Carroll, Faulkner, Franklin, Hempstead, Howard, Johnson, Madison, Pope and Washington.

Description and Biology

The adult male LBAM has a forewing length of 6-10 mm with a light brown area at the base distinguishable from a much darker, red-brown area at the tip. The darker, red-brown area is absent in some males giving the moth a uniformly light brown appearance. Adult females also have a uniform light brown appearance with only slightly darker oblique markings distinguishing the area at the tip of the wing. Female moths often have a dark spot on the hind margin of the forewing. Coloration in the LBAM is highly variable. Adult females are larger than males and have a forewing length of 7-13 mm. At rest with wings folded, the LBAM has a characteristic bell shape and the moth's length is about half that of its wingspan. Males have a "fan" of large scales at the tail end of the abdomen, whereas the brown ovipositor can be seen when viewing the tip of the female abdomen from below.

Females can lay eggs between 6 and 10 days after moth emergence, depending on the temperature. LBAM eggs are laid in clusters of 3-150, usually on the upper surface of host plant leaves or fruit, as is the case with most leafroller species. Eggs appear flat with a pebbled surface. They overlap each other within the raft to form a smooth mass, making it difficult to distinguish the eggs from the surrounding leaf surface.

Figure 1. Light brown apple moth color variation. *(Natasha Wright, Florida Department of Agriculture and Consumer Services, Bugwood.org)*

Figure 2. Light brown apple moth at rest with wings folded. *(Department of Primary Industries and Water, Tasmania Archive, Bugwood.org)*

Eggs of the LBAM are approximately 0.7 mm by 1.0 mm. Coloration is initially white to pale green, changing to a paler yellow green as they develop. Eggs take from 5 to more than 30 days to hatch, depending on the temperature. As caterpillars develop within the egg, their darkening head capsule is visible through the egg wall, giving egg clusters a blotchy or speckled appearance just prior to hatching.

Figure 3. Light brown apple moth egg mass.
(Department of Primary Industries and Water, Tasmania Archive, Bugwood.org)

Eggs parasitized by tiny wasps (e.g. *Trichogramma* spp.) are black just prior to wasp emergence.

LBAM larvae are difficult to distinguish from the larvae of native leafroller species occurring in the same habitat. Most leafroller species have five or six larval instars (stages). The first instar of the LBAM is about 1.5-2.0 mm long and has a dark brown head; all other instars have a light grayish-brown head and prothoracic plate. The final instar larvae range from 10 to 18 mm in length. Mature larvae are medium green and have a darker green central stripe and two side stripes running down the body. This green longitudinal striping can be helpful for distinguishing LBAM caterpillars from other native leafrollers. The LBAM overwinters in the larval stage, and overwintering larvae are darker in color.

Larvae of the LBAM and native leafrollers cause similar damage to foliage and fruits. There is no way of distinguishing the damage of different species. Early instars actively crawl about over plant surfaces and may suspend themselves from a fine silken thread until they find a suitable feeding site. These early instars often settle on the under surface of leaves close to the main veins, where they construct silken shelters and feed on the leaf tissue; this feeding typically creates small windows in the leaves. Other young larvae may settle on the shoot tips or areas of new growth, where they web the leaves together with silk. A third settlement site is the calyx of fruits where their presence is detected only from observing the fine silken webbing among the sepals.

Larger larvae disperse from these settlement positions to construct feeding niches between adjacent leaves, between a leaf and a fruit, in a developing bud or on a single leaf, where the leaf roll develops. Older larvae feed on all leaf tissue except main veins. Buds of deciduous host plants are especially vulnerable to attack in the winter and early spring, when the interior of the buds may be eaten.

Surface fruit damage may appear as small, circular 'stings,' caused by young larvae biting through the skin. The maturing fruit produces a layer of corky tissue over the larval damage, and this helps prevent secondary infection by pathogens. Internal damage to fruit is much less common than surface damage, but a young larva may enter the interior of some fruit through the calyx.

Pupae of the LBAM are initially green, but turn brown after rapidly hardening. Pupae continue to darken during development. LBAM pupae are typically found within a thin-walled, silken cocoon

Figure 4. Light brown apple moth larvae.

Figure 5. Light brown apple moth damage.

Figure 6. Light brown apple moth pupa.
(Department of Primary Industries and Water, Tasmania Archive, Bugwood.org)

between two leaves webbed together and are usually 10-15 mm long; the female pupae are larger than those of the male. At the end of the abdomen, two prominent broad-based, laterally-projecting spines and a number of hooks support the pupa in its cocoon. Each abdominal segment also has a series of short, backward-projecting spines that are used by the pupa to move partially out of its cocoon prior to moth emergence (Horticulture and Food Research Institute of New Zealand, Limited 1998).

Identification

There are many native tortricids that can be confused with the LBAM, some of which include the obliquebanded leafroller, redbanded leafroller, fruit-tree leafroller, uglynest caterpillar, oak leafroller and *Xenotemna pallorana* (no common name) (Camper and Cranshaw 2008). Adult moths must be identified by a qualified entomologist. Larval stages cannot be reliably identified using morphological characters. Molecular diagnostics based on PCR amplification of ribosomal DNA have been developed and are especially useful for the identification of immature specimens (Armstrong et al. 1997). If you suspect the presence of LBAM, please notify The Arkansas State Plant Board (501-225-1598), http://plantboard.arkansas.gov/Pages/default.aspx, or the State Plant Health Director's Office of USDA, APHIS, PPQ, (501) 324-5258.

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