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TREE LOCATION AND WINTER TEMPERATURE INFLUENCE ON MIMOSA WEBWORM POPULATIONS IN A NORTHERN URBAN ENVIRONMENT[1]

by E. R. Hart, Fredric D. Miller, Jr.[2], and Rex A. Bastian

Abstract. Mimosa webworm, *Homadaula anisocentra* Meyrick (Lepidoptera: Plutellidae) exhibits dramatic fluctuations in population levels on ornamental honeylocust, *Gleditsia triacanthos* L., in northern urban settings. Winter temperatures and tree location were evaluated for their effects on overwintering pupal survivorship and defoliation. Extremely cold winters caused high pupal mortality and were followed by low first-generation defoliation; an extremely mild winter caused low pupal mortality and was followed by very high first-generation defoliation. Pupal overwintering sites on heated structures were 5 to 9°C (3 to 5°C) above the ambient low temperatures, decreasing the probability of pupal exposure to lethal temperatures. Second-generation larvae moved 50 to 80 ft. (ca. 25 m) from infested trees to overwintering sites.

The urban forest is recognized as different from the surrounding, more natural forests of an area (Rowntree, 1984). Features that distinguish the urban forest from a natural setting include, not only the trees themselves, but also the urban microenvironment in which the trees and their associated organisms interact. Examples of this interaction have been observed with the gypsy moth in the northeastern states (Wargo, 1978; McManus et al., 1979; Houston, 1981) and with the bronze birch borer in the north-central states (Ball and Simmons, 1980; Kennedy and Ball, 1981). An additional example of the influence of the urban environment on a tree-insect interaction was observed in our studies of the mimosa webworm, *Homadaula anisocentra* (Lepidoptera: Plutellidae), on ornamental honeylocust, *Gleditsia triacanthos*, in central Iowa.

The mimosa webworm is a common pest of ornamental honeylocust throughout much of the urban planting range of the tree in the United States, especially in the east-central and north-central states. The larvae live within webbed foliage, tying the leaflets together with fine silk and feeding on the surface of the leaflets. Extensive feeding results in dead, brown foliage that reduces the tree's aesthetic value. Perhaps even more important, however, is the severe loss of photosynthetic area that may lead to reduction in growth and vitality. The mimosa webworm is not known to cause direct mortality of honeylocust but, as with other tree species, heavy defoliation would be expected to lower tree defenses, predisposing them to attack by secondary organisms.

In the northern part of the insect's range, there are two generations per year, the second generation overwintering in the pupal stage. First-generation larvae pupate in the webbed leaves in midsummer. Second-generation larvae cease feeding in mid- to late September, descend to the ground on silk strands and move toward vertical objects. If these objects have cracks, crevices, or corners, they will serve as overwintering sites. In the urban environment, our observations indicate

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[2]Present address: Office of Agricultural Entomology, 172 Natural Resources Building, 607 East Peabody Drive, Champaign, Illinois 61820.

that only a small percentage of the larvae pupate and overwinter on the trunk of the host tree. The majority of the population overwinters on nearby trees, shrubs, and structures.

During the past 10-12 years, rather dramatic fluctuations in mimosa webworm populations have been observed in central Iowa and at similar latitudes in surrounding states. These fluctuations have been confined to the urban environment, while native honeylocust stands have no detectable infestations. South of this region, however, native trees often are defoliated. Several hypotheses have been advanced to explain the differences in infestation levels between urban and native trees in the northern part of the insect's range: 1) native trees in northern latitudes have a degree of resistance to the insect, 2) natural control agents such as predators and parasites are able to suppress the webworm populations in natural stands but not in the urban environment, and 3) the urban environment offers protection from physical extremes, such as high and low temperatures or high winds and rainfall, that may cause larval or pupal mortality. Although any of these hypotheses may contain part or all of the answer, our research group, already with interests and involvement in investigating the effects of meteorological phenomena on urban forest pests, elected to examine the effect of low winter temperatures on pupal mortality.

We noted that low webworm population levels seemed to follow severe winters and that high population levels seemed to follow mild winters in central Iowa. However, some trees suffered significant defoliation almost every year, whereas others of the same clone in other locations had little or no defoliation, regardless of preceding winter conditions. A study was initiated in the summer of 1981 to assess the possible influence of winter conditions and tree location on these phenomena.

The objectives of our study were to: 1) determine the overwintering sites utilized by the mimosa webworm in the urban environment; 2) determine the relationship between tree location and overwintering site utilization, 3) evaluate the influence of these overwintering sites on pupal survival and consequent defoliation levels, and 4) determine the correlation between winter temperatures and mimosa webworm populations the following season.

Materials and Methods

In the fall of 1981, at a time corresponding to peak defoliation by second-generation mimosa webworm, 50 honeylocust trees were selected in the city of Ames, Iowa. These trees were typical urban plantings, located in front, back, and side yards of residences. They ranged in size from 6.7 to 22.4 in (17.1 to 57.0 cm) dbh. The canopy of each tree was divided into four quadrants corresponding to the four cardinal compass directions (N, S, E, W). Percentage defoliation for each quadrant was calculated as the mean of the estimates (to the nearest 5%) of the project personnel. Total defoliation for each tree was calculated as the mean of the defoliation of the four quadrants. Defoliation estimates were made for the second generations of 1981 and for the first and second generations of 1982 through 1984. Peak defoliation levels were considered to be directly related to the preceding adult population level, which, for the first generation, were considered to be dependent upon the survival rate of overwintering pupae.

After defoliation levels were estimated, the surrounding area was examined thoroughly for the presence of mimosa webworm cocoons. At locations where cocoons were found, the following data were recorded: 1) the object to which they were attached, 2) the surface texture of the object, 3) the linear distance from the trunk and dripline of the host tree, and 4) the cardinal direction from the host tree. The trunk of the host tree also was examined for the presence of mimosa webworm cocoons. If the overwintering site were a woody plant, the common name, dbh, and type of bark texture were recorded.

A similar study also was conducted at the Iowa State Fairgrounds in Des Moines in June 1983. The same evaluation of pupation sites and distances from host trees was performed. Defoliation estimates were not conducted because many of the trees were treated with insecticides for the control of mimosa webworm larvae.

During the winters of 1981-82, 1982-83, and 1983-84, studies were conducted to determine the survival of overwintering pupae (Miller and

Hart, 1986). In these tests, second-generation pupae were collected from infested urban trees in central Iowa and placed in locations in Ames, Iowa, that were typical of pupal overwintering sites in the urban environment including sites on heated structures such as behind shutters and under eaves. Air temperatures in the immediate vicinity of the pupae were monitored throughout the winter. Samples of pupae were removed from the overwintering sites periodically during the winter and checked for mortality. To determine the level of cold acclimation of these pupae, some were tested from each sampling period to determine the supercooling point (SCP), which may be defined as the lowest temperature that pupae reach before they die from the formation of ice crystals.

Pupae collected in Iowa also were stationed in similar locations in Kansas City, Missouri, and Fayetteville, Arkansas, in the winter of 1982-83 to determine the effects of warmer winter conditions on the survivorship of mimosa webworm pupae. Samples from these localities also were tested periodically throughout the winter for mortality and for their ability to resist freezing.

Results and Discussion

During the 3 years of this study, central Iowa had extremes in winter weather. In the winters of 1981-82 and 1983-84, record low temperatures occurred in January and December, respectively, whereas the winter of 1982-83 was one of the mildest on record.

During this study, mimosa webworm pupae were found on more than 100 different sites, including vertical surfaces on practically all structures common to the urban environment, and on woody plants with rough or scaly bark.

The mean percentage defoliation by the first-generation larvae showed a positive correlation with the severity of the preceding winter (Table 1). The first-generation defoliation following the severe winters of 1981-82 and 1983-84 was less than 20%. Defoliation following the mild winter of 1982-83 was more than 55%, a higher level than occurred during the second generation in either of the other years.

The relationship among temperature, winter survival, and defoliation is supported by the results of the pupal mortality study (Miller and Hart, 1986). In central Iowa during the winters of 1981-82 and 1983-84, the coldest air temperatures approached or were lower than the lowest SCP, −22 to −24°F (−30 to −31°C) of the overwintering pupae in January and December, respectively. Nearly 100% mortality occurred in the test pupae in both years during the coldest weather regardless of the location of the overwintering site. In 1982-83, the coldest air temperature was more than 9°F (5°C) above the SCP of the pupae, and a majority of the test pupae (greater than 60%) survived the winter.

Throughout the winters in central Iowa, temperatures behind shutters and under eaves of heated structures were 5 to 9°F (3 to 5°C) warmer than the lowest ambient air temperatures in central Iowa. During the 1982-83 winter, mean percent emergence for pupae located behind shutters and under eaves was 72% and 65%, respectively. It is logical to infer that any pupae in such highly protected areas would be more likely to remain above the lethal SCP and thus have a greater chance of surviving the winter.

Regardless of the minimum air temperatures reached, the MWW pupae reached a SCP of −22 to −24°F (−30 to −31°C) each winter at all Ames, Iowa study sites. The pupal samples from Missouri and Arkansas, both locations where the temperatures did not approach the lows of central Iowa, also reached a SCP of at least −11°F (−24°C) by early November and maintained a SCP between −11°F (−24°C) and −24°F

Table 1. Percent defoliation (to the nearest 5%) of ornamental honeylocust by mimosa webworm, *Homadaula anisocentra* Meyrick, in Ames, Iowa, second generation 1981 through second generation 1984.

	Generation 1 (Summer)		*Generation 2 (Fall)*	
Year	*Percent defoliation*	*Number of trees*	*Percent defoliation*	*Number of trees*
1981	—	—	40	50
1982[a]	15	49	50	49
1983[b]	55	44	80	45
1984[a]	15	49	20	49

[a]Growing season following extremely cold winter.
[b]Growing season following extremely warm winter.

(−31 °C) for the rest of the winter.

Thus, in the northern parts of its present range, the mimosa webworm can maintain populations in the urban forest, although it cannot survive the low temperatures of most winters in the natural forest. Farther north, even in the protected areas associated with heated structures, temperatures are likely to drop below the SCP, limiting the northern range of the insect. Moving southward from the central Iowa study area, there is a progressively lower probability that the air temperature will drop below the SCP of the overwintering pupae, which may explain the occurrence of mimosa webworm in stands of native honeylocust in warmer climates.

Generally, the more severe the winter temperatures, the lower is the first-generation infestation the following spring. The exact relationships of first-generation defoliation to second-generation defoliation are not entirely clear, but second-generation infestations usually are greater than first-generation infestations.

The mobility of mature larvae is certainly sufficient to allow at least a small percentage of the population on most host trees in the urban forest to reach favorable overwintering sites. It was not uncommon to find overwintering pupae on structures 50-80 ft (ca. 15-25 m) from the trunk of the host tree. It is highly probable that the distance of honeylocust from a heated structure is one of the major factors in the continuation of mimosa webworm problems in climatic areas similar to those of this study. Further work is needed to determine the exact relationship of distance and survival.

The mobility of second-generation mimosa webworm larvae and their ability to travel long distances before pupation underscores the importance of planting honeylocust trees considerable distance from heated structures in a climate similar to that of the study area if mimosa webworm problems are to be minimized. We recognize that many other factors are involved in determining plant placement and selection but encourage the arborist or urban forester to be aware of the overwintering habits of the mimosa webworm when planting ornamental honeylocust in northern urban settings where this insect is present. Even more important, the results of this study and their implications emphasize the ecological differences between the urban forest and the native forest of an area and, especially, the need for continuation of specific studies in the urban environment.

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Department of Entomology
Iowa State University
Ames, Iowa 50011