Age-Specific Host Utilization in the Eastern Tent Caterpillar (Lepidoptera: Lasiocampidae)[1]

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Abstract Larval growth and survival of the eastern tent caterpillar, *Malacosoma americana* F., was assessed on its preferred host, black cherry (*Prunus serotina* Ehrhart), black locust (*Robinia pseudoacacia* L.), hackberry (*Celtis occidentalis* L.), white oak (*Quercus alba* L.), and white pine (*Pinus strobus* L.), and on the herbaceous biennial poison hemlock (*Conium maculatum* L.). Larvae grew largest and had the greatest pupation and survival rates when fed black cherry and white oak. They did not grow well on black locust or white pine, but survival rates were relatively high, suggesting that both plant species could potentially serve to sustain tent caterpillar populations. Growth and survival was so low on hackberry and poison hemlock that they pose little chance of sustaining outbreaking caterpillar populations.

Key Words Host range, herbivory, population management, Mare Reproductive Loss Syndrome

The eastern tent caterpillar, *Malacosoma americanum* (F.) (Lepidoptera: Lasiocampidae), is a native tree-feeding folivore found throughout eastern North America. It is a specialist with respect to oviposition behavior, utilizing almost exclusively Rosaceous trees and favoring those in the genus *Prunus* (Dethier 1980, Fitzgerald 1995). Eastern tent caterpillars prefer foliage of black cherry, *P. serotina* Ehrh. (Drooz 1985), which grows abundantly along forest edges, pastures, and roadsides. Caterpillars feed gregariously and construct silken tents that increase in size with development. At endemic levels, caterpillars forage only as far as necessary to feed (Fitzgerald et al. 1988) and may remain in their natal tree throughout development (Fitzgerald 1995). However, as populations increase to outbreak levels and preferred hosts are defoliated, larvae forage greater distances to obtain food, and host plant requirements become less stringent (Stehr and Cook 1968, Tietz 1972). Thus, although adults are oviposition specialists, caterpillars are capable of exploiting a wider range of host material, and over 53 species are listed as potential food sources (Tietz 1972). These secondary hosts may become more important in caterpillar population dynamics as primary hosts are depleted or removed. Because the eastern tent caterpillar is implicated in reproductive failure associated with equine Mare Reproductive Loss Syndrome, alternative approaches to managing caterpillar populations are needed (Townsend 2002).

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The objective of this study was to assess age-specific differences in survival and host utilization on common fencerow tree species by third and fifth instars of the eastern tent caterpillar. My ultimate goal is to determine the feasibility of farm-wide or local-area suppression of this pest through removal of host plants.

Materials and Methods

Experiments were conducted in April and May of 2002, coinciding with the natural period of caterpillar development, using field-collected eastern tent caterpillars from outbreaking populations that were obtained by clipping intact tents from cherry trees in and around Lexington, KY (Fayette Co.). Caterpillars were held in growth chambers (23°C, 15:8 L:D) and fed fresh, field-collected cherry foliage as needed. Caterpillars were aged by measuring the width of the head capsules (Fitzgerald 1995), and third and fifth instars were isolated for use in feeding trials. All apparently healthy caterpillars used in tests were deprived of food for 24 h prior to use.

Plant species were selected for use based on their prevalence along roadsides, pasturelands, and in woodlots, and included the preferred host, black cherry, the deciduous black locust, *Robinia pseudoacacia* L., hackberry, *Celtis occidentalis* L., and white oak, *Quercus alba* L., and the coniferous white pine, *Pinus strobus* L. Typical pasture fencerows in the region are dominated by black cherry, black locust, and hackberry (Choate and Rieske, unpubl.). All trees sampled were growing at the University of Kentucky's Horticultural South Farm, and were at least 6 yr old. Although competing vegetation was periodically mowed, no fertilizer, soil amendments, or irrigation had been applied. In addition, the herbaceous biennial poison hemlock, *Conium maculatum* L., growing abundantly in the same location, was included in the study. Two branches at the midcanopy level on the south side of each tree (5 per species) were designated for use in feeding trials, and using a fine mesh cage (36 × 61 cm), cohorts of 10 caterpillars were confined on each branch. Each cohort was group-weighed prior to being placed in cages, which were then closed at the base to prevent access by natural enemies or caterpillar escape. Thus, 10 third-instar caterpillars and 10 fifth-instar caterpillars were caged on separate branches on each tree, for a total of 50 insects per age cohort and plant species. The mesh cages confining caterpillars on poison hemlock enveloped the entire plant, and were secured at ground level. Because of the relatively small size of the poison hemlock, separate plants were used for each age cohort. Caged caterpillars were monitored at 2 d intervals, and if food became limiting, cages were moved within the same area of the canopy to incorporate additional foliage, taking care not to disturb or lose feeding caterpillars. After 8 d, the cages were disassembled, and all insect and plant material removed. Caterpillars were frozen, and cadavers and frass were oven-dried (40°C) for 5 d. Dried caterpillars were again group-weighed, and individual dry weights were calculated [(group dry wt)×(number of caterpillars present)$^{-1}$]. Linear regression was used to assess the relationship between caterpillar fresh weight and caterpillar dry weight, to allow calculation of initial dry weight. Relative growth rate was calculated on a per caterpillar basis [RGR = caterpillar biomass gained (mg dry wt)×(initial caterpillar wt (mg dry wt)]$^{-1}$×[time (d)]$^{-1}$×(number of surviving insects)$^{-1}$. In addition, pupation and survival rates (%) were calculated.

Caterpillar performance was analyzed using two-way analysis of variance (Abacus Concepts 1989), with plant species and age cohort as main effects, and caterpillar growth and survival as response variables. Within each age cohort, a one-way analysis of variance of insect performance on each host plant was conducted. The insect relative growth rate data were transformed [log (x)] to adjust for heterogeneous variances, and significant differences were assessed using Fisher's protected LSD (Abacus Concepts 1989).

Results and Discussion

Of the common fencerow and woodlot species tested, eastern tent caterpillars grew largest and had the greatest pupation and survival rates when fed black cherry, their preferred host. However, their performance was not significantly better than those caterpillars fed white oak. Caterpillar growth was significantly influenced by host plant (F = 31.92; df = 5, 48, P < 0.0001) and age cohort (F = 9.25; df = 1, 48; P = 0.004), with a significant host plant × cohort interaction (F = 4.56; df = 5,48; P = 0.002). Growth rate was greatest for those fed black cherry and white oak, which were statistically equivalent (Table 1). Caterpillars fed black locust exhibited intermediate growth, followed by those fed white pine. Hackberry and poison hemlock were the poorest hosts of the species tested, producing caterpillars with the lowest growth and survival rates.

Third-instar caterpillars outpaced their fifth-instar counterparts with respect to relative growth rates across all plant species (P = 0.004), and the trends in caterpillar growth were consistent across age cohorts. In general, for those caterpillars fed the more optimal cherry and white oak hosts, growth rates were greater for third instars than fifth instars. This was strongly significant for caterpillars fed black cherry, but only moderately so for those fed white oak (Table 1). In contrast, on the less optimal hackberry and white pine, growth rates of fifth instars were greater than for third instars. These age-specific differences may be attributed to the physiological state of the insects, phenological differences in the host plants, or both. Third-instar caterpillars are actively foraging and feeding gregariously, reaching the peak of their consumption and growth. In contrast, fifth-instar, penultimate caterpillars have passed the stage of gregarious foraging (Fitzgerald 1995), and may be seeking appropriate sites in preparation for pupation. Older caterpillars may also be able to better detoxify novel foliar defense compounds found in less optimal hosts. However, foliar characters were not measured in this study.

Pupation occurred only in those fifth-instars fed black cherry and white oak foliage (Table 1). The pupation rate of eastern tent caterpillars reared on black cherry ranged from 20 to 60% ($\bar{x}$ = 40 ± 19%). For caterpillars fed white oak, the pupation rate ranged from 10 to 70% ($\bar{x}$ = 44 ± 24%) Caterpillars fed the remaining plant species did not pupate over the 8 d assay period.

Larval survivorship also varied with host plant (F = 161.31; df = 5, 47; P < 0.0001) and age cohort (F = 9.14; df = 1, 47; P = 0.004), and there was a significant interaction between the two (F = 3.05; df = 5, 47; P = 0.02). Across both cohorts, caterpillar survivorship was greatest on cherry and white oak, which were statistically equivalent (Table 2). Survivorship was intermediate on black locust, followed by white pine, and lastly, hackberry and poison hemlock. These trends remained consistent within age cohorts, and survival of fifth instars was greater than that of third instars across all plant species (P = 0.002). Survivorship was equivalent across age groups for the most acceptable (i.e., black cherry and white oak) and for the least acceptable hosts (i.e., hackberry and poison hemlock). However, cohort-specific differences in caterpillar survivorship were evident with caterpillars fed black locust and white pine, hosts with

Table 1. Development of third- and fifth-instar eastern tent caterpillars reared on various hosts

Plant species	Relative growth rate*		Between-age differences (F_{df}/P)	Pupation rate†
	Third-instar	Fifth-instar		
Black cherry	0.50 (0.05) a	0.25 (0.03) a	$F_{1,8} = 13.63/P = 0.006$	40
Black locust	0.14 (0.05) b	0.13 (0.01) b	$F_{1,8} = 0.06/P = 0.82$	0
Hackberry	−0.01 (0.004) d	0.03 (0.003) d	$F_{1,8} = 58.1/P < 0.0001$	0
Poison hemlock	0.05 (0.01) c	0.02 (0.002) e	$F_{1,8} = 11.0/P = 0.01$	0
White oak	0.50 (0.11) a	0.23 (0.02) a	$F_{1,8} = 4.0/P = 0.08$	44
White pine	0.04 (0.004) c	0.07 (0.003) c	$F_{1,8} = 28.46/P = 0.0007$	0
Between species differences** (F_{df}/P)	$F_{5,24} = 16.16/P < 0.0001$	$F_{5,24} = 43.20/P < 0.0001$		

* Relative growth rate: $[(mg) \times (mg)^{-1} \times (d)^{-1}]$.
** Mean separations performed on log-transformed data.
† Percent of fifth instar caterpillars pupating.
Means between species (within columns) followed by the same letter are not significantly different.

Table 2. Survivorship of third- and fifth-instar eastern tent caterpillars reared on various hosts

Plant species	Survivorship (%)		Between-age differences (F_{df}/P)
	Third-instar	Fifth-instar	
Black cherry	85.6 (3.3) a	82.4 (3.7) a	$F_{1,8} = 0.42/P = 0.53$
Black locust	55.0 (5.3) b	74.4 (5.15) b	$F_{1,7} = 6.78/P = 0.04$
Hackberry	0.0 (0.0) c	0.0 (0.0) d	--------
Poison hemlock	3.2 (1.9) c	0.8 (0.8) d	$F_{1,8} = 1.29/P = 0.29$
White oak	75.2 (2.9) a	87.2 (7.1) a	$F_{1,8} = 2.45/P = 0.16$
White pine	11.2 (8.2) c	31.2 (4.6) c	$F_{1.8} = 4.49/P = 0.07$
Between species differences (F_{df}/P)	$F_{5,23} = 77.6/P < 0.0001$	$F_{5,24} = 87.4/P < 0.0001$	

Means between species (within columns) followed by the same letter are not significantly different.

intermediate levels of acceptance. Fifth-instar caterpillars had significantly higher survival than did third instars that were fed black locust, and to a lesser extent, white pine (Table 2).

Both third- and fifth-instar caterpillars readily utilized black cherry and white oak as hosts. Cherry foliage contains significant levels of cyanogenic compounds, but these are effectively detoxified by the caterpillars (Fitzgerald 1995). Oaks typically have high tannin content (Schultz et al. 1982), but mid- and late-instar eastern tent caterpillars apparently can detoxify these, as can many polyphagous early-season defoliators (Mattson and Scriber 1987, Hunter 1992). Caterpillars did not grow well on black locust, but the survival rate was relatively high in both age cohorts. Similarly, caterpillars did not grow well on white pine, but survival of fifth instars exceeded 30%. Foliar alkaloids are prominent in the less optimal black locust (Gibbs 1974); whereas, white pine is rich in terpenes (Robinson 1991). These data suggest that both plant species could potentially serve to sustain eastern tent caterpillar populations, serving as 'bridge' hosts following extensive removal of primary host material. Foliar alkaloids are also prominent in the least optimal hackberry (Gibbs 1974) and poison hemlock (Panter et al. 1992). However, caterpillar growth and survival was so low on these that they pose little chance of sustaining outbreaking caterpillar populations.

In summary, several common fencerow and roadside tree species could sustain eastern tent caterpillar populations. However, adult moths are oviposition specialists on Rosaceous hosts, and I found no evidence of oviposition on any of the plant species assayed. Although removal of black cherry from fence rows would eliminate the primary oviposition host, highly mobile wandering caterpillars could successfully complete development on other common fencerow species.

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