J. Acad. Entomol. Soc. 8: 71-73 (2012)

NOTE

Vertical distribution of Pale-winged Gray moth (*Iridopsis ephyraria*) eggs and larvae on eastern hemlock trees in Nova Scotia

Meggy Hervieux, Christopher M. Buddle and Dan Quiring

Defoliation of eastern hemlock by the pale-winged gray (*Iridopsis ephyraria* Walker (Lepidoptera: Geometridae)) in southwest Nova Scotia occurs primarily in the mid and lower crown (Pinault et al. 2012). In contrast, Pinault et al. (2007) reported that the highest density of eggs (per surface area of bark) occurred in the upper crown. However, the surface area of bark is highest at the base of trees, and thus it is possible that the greatest proportion of eggs are laid in the mid and lower crown, where egg density (per surface area of bark) is lower than in the upper crown, but where the surface area of bark is greater, due to the larger diameter of the tree's main stem.

In this paper we present results from field studies carried out to evaluate the influence of female preference for oviposition sites and early-instar larval preference for feeding sites on the observed distribution of defoliation on mature eastern hemlock trees (hereafter hemlock). More explicitly, we estimated the absolute number of eggs and larvae throughout different crown regions of mature hemlock to determine if they were highest in the mid and lower crown, where defoliation is highest.

Pinault et al. (2007) reported that egg density increases linearly from the bottom to the top of the bole ($y = 1.82x+0.44$, y = log egg density per 1000cm^2 and x = proportion of the distance up the bole). To estimate the number of eggs in the lower bole below the foliated crown and in the lower, mid and upper foliated crown, we estimated the bark surface area in each crown region (see below) of 5 mature trees at Maitland Bridge (44°29'4.45"N, 65°13'4.91"W) and in 5 mature trees at South Brookfield (44°23'18.84"N, 64°58'28.30"W) in southwest Nova Scotia, in 2010 and inserted these data into the linear regression from Pinault et al. (2007). These estimates were used to calculate the proportion of eggs laid in the upper, mid and lower foliated crown and in the lower bole.

We estimated the bark surface area within each of the four crown regions by multiplying the mean bole circumference by the length of the bole using the formula for a cylinder ($2\pi rh$ where "r" is the mean bole circumference and "h" the length of the bole). A hypsometer (Laser technology Inc., SN#102090) was used to measure total tree height and the length of each of the four regions within trees. The lower bole was defined as the portion of the main tree stem extending 1.3 m above ground level to the foliated crown. The length of the bole in the foliated crown area was divided into three sections of equal length. Depending on tree height, the lower crown extended from 5—9 m (i.e., lower limit) to 9—14 m (upper limit) above ground level. The boundary between the mid and upper crown was located 14—17 m above ground level. Trunk area for the bottom 1.3 m and last 1.5 m of the tree bole was not included in the bark surface area calculation as they were omitted in the Pinault et al. (2007) linear regression.

A single rope technique was used to climb the selected study trees and measure the circumference of the main stem at the lower and upper boundaries of the four crown regions. The mean of the two measurements per crown region were used to calculate the mean bole circumference for that region. The bark surface area in the upper crown was slightly overestimated because only the circumference of the lower boundary was included in the calculations, due to the weakness of the top of the bole, which could not support our weight. However, only small variations in bole diameter could be seen at this height (personal observation 2010).

Received 2 June 2012. Accepted for publication 18 October 2012. Published on the Acadian Entomological Society website at www.acadianes.ca/journal.html on 26 October 2012.

Meggy Hervieux[1] and Christopher M. Buddle: Department of Natural Resource Sciences, McGill University, MacDonald Campus, Ste-Anne-de-Bellevue, QC H9X 3V9.

Dan Quiring: Population Ecology Group, Faculty of Forestry and Environmental Management, PO Box 4400, 28 Dineen St., University of New Brunswick, Fredericton, NB E3B 5A3.

[1]Corresponding author (email meggy.hervieux@mail.mcgill.ca).

Due to time constraints, larval samples were only taken from two crown levels. As defoliation is lowest in the upper crown and highest in the lower crown (Pinault et al. 2012), we evaluated the influence of larval preference on intracrown variations in defoliation by measuring larval densities in these two crown regions. A "beating-sheet" technique was used to estimate the density of young larvae in the upper versus lower crown of mature trees at each of the two study sites. On 8 and 9 June 2010, when larvae were mainly in the first instar, four trees were haphazardly selected at each site. In each of the two crown levels, three branches were selected and beat five times with a wooden stick. The number of larvae that fell on a 1m² beating sheet that was held just below the branch was recorded and used to estimate the number of larvae per branch. On 19 June 2010, when most larvae were second or third instar, larvae were counted using the same procedure on six different trees at each of the same two sites.

To test the influence of crown region and collection date on the number of larvae per beating-sheet sample, we used a generalized linear mixed model with the glmer function for poisson distribution (lme4 package in the R statistical program). The best model had the smallest AIC and did not include date and crown level interactions. Sites were considered a random effect in the model.

In contrast to egg density, which is higher in the upper crown (Pinault et al. 2007), the absolute number of eggs, estimated by multiplying the number of eggs per 1000 cm² of bark from Pinault et al. (2007) by the mean surface area of bark per crown level, estimated during the present study, was highest in the mid and lower crown (Figure 1). Thus our results strongly suggest that absolute numbers of eggs are lowest in the upper crown of hemlock, presumably because less trunk area was available for females to lay their eggs.

First-instar larvae were more abundant in the lower than upper crown (z-value = -3.582, $P < 0.001$) (Figure 2). Although mean larval density declined markedly between the first (2.5 ± 0.7 larvae per beating sheet sample) and second (1.1 ± 0.3) sampling periods (z-value = -2.825, $P < 0.01$), presumably because of natural mortality factors, second and third instars were also more abundant in the lower than upper crown. Thus our results suggest that both first- and mid-instar larvae prefer to feed in the lower versus upper crown of hemlock. Presumably, larvae that emerged from eggs laid in the lower bole crawl up the bole and primarily colonize the lower and mid crown. This could explain why early and mid instar densities were approximately 2.5 times higher (Figure 2), but egg abundance was only 1.5 times higher (Figure 1), in the lower than upper crown.

Figure 1. Mean (±SE) proportion of eggs (estimated absolute number of eggs per crown region / estimated total number of eggs per tree) laid by *Iridopsis ephyraria* on the lower unfoliated bole and in the lower, middle and upper foliated crown of eastern hemlock during summer 2010.

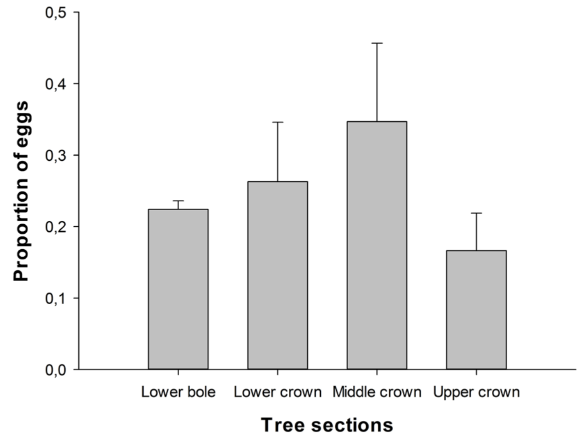
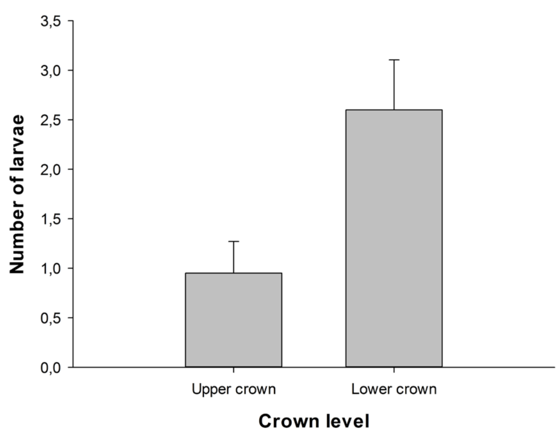


Figure 2. Mean (±SE) numbers of early and mid-instar *Iridopsis ephyraria* larvae per branch (beating sheet sample) in the upper versus lower crown of eastern hemlock (collection dates are merged) during summer 2010. Three branches in each crown level were sampled on 8 (early instars) and 12 (late instars) trees.



In summary, our results suggest that high levels of defoliation in the mid and lower but not upper crowns of hemlock are due, at least in part, to preference by ovipositing females and young feeding larvae for the mid and lower crown. Results of manipulative experiments carried out to evaluate whether these preferences are adaptive will be reported elsewhere.

ACKNOWLEDGEMENTS

We thank Dorothy Maguire, Rob Johns and Drew Carleton for technical assistance and helpful discussion, Jim Crooker and Mersey River Chalets for access to field sites and McGill University, FQRNT (scholarship) and NSERC (PGS to

MH and Discovery Grants to CMB and DQ) for funding.

REFERENCES

Pinault, L., Georgeson, E., Guscott, R., Jameson, R., LeBlanc, M., McCarthy, C., Lucarotti, C., Thurston, G., and Quiring, D. 2007. Life history of *Iridopsis ephyraria*, (Lepidoptera: Geometridae), a defoliator of eastern hemlock in eastern Canada. Journal of the Acadian Entomological Society **3**: 28-37.

Pinault, L., Thurston, G. and Quiring, D. 2012. Vertical distribution of Pale-winged Gray moth (*Iridopsis ephyraria*) defoliation on eastern hemlock trees in Nova Scotia. Journal of the Acadian Entomological Society **8**: 68-70.

Pinault, L. 2007. Population ecology and management of the pale-winged gray moth, *Iridopsis ephyraria* Wlk. (Lepidoptera: Geometridae). Masters Thesis, University of New Brunswick. 81 pp.