# NOTE

## Weight Change of Overwintering Nantucket Pine Tip Moth (Lepidoptera: Tortricidae) Pupae in the Georgia Piedmont and Coastal Plain[1]

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The Nantucket pine tip moth, *Rhyacionia frustrana* (Comstock) (Lepidoptera: Tortricidae), is one of the most ubiquitous pests of pine plantations in the southeastern U.S. (Berisford 1988, pp. 142-161 *In* Berryman (ed.), Dynamics of Forest Insect Populations: Patterns, Causes, and Implications. Plenum Pub.). The moth attacks several species of southern yellow pines, but is especially common on loblolly (*Pinus taeda* L.), shortleaf (*P. echinata* Mill.), and Virginia (*P. virginiana* Mill.) pines. Under natural conditions the moth appears to cause relatively minor damage. However, under intensive forest management conditions tip moths can be a serious pest (Berisford 1988; Asaro et al. 2003, J. Entomol. Sci. 38: 1-40), and populations are more unstable (Nowak et al. 2003, For. Sci. 49: 1-7). Life history and host damage have been reported by Berisford and Kulman (1967, For. Sci. 13: 428-438), Hedden and Clason (1980, For. Res. Rep. 1979, L.S.U. Agric. Exp. Sta. N. La. Hill Farm Exp. Sta.), Yates et al. (1981, USDA For. Insect and Dis. Leafl. 70), Stephen et al. (1982, Ark. Farm Res. 31: 10), Cade and Hedden (1987, South. J. Appl. For. 11: 128-133), and Fettig et al. (2000, USDA For. Serv. Res. Pap. SRS-18). Gibson (1968, Ann. Entomol. Soc. Am. 61: 786-787) suggested that severe winter weather may have been important in a population crash of *R. frustrana* in Ohio. However, little is known of the potential effects of overwintering on tip moth pupae in the southern part of its range. Winter conditions in the Georgia piedmont can differ substantially from those of the Georgia coastal plain, and studies of overwintering tip moths in these 2 physiographic regions could provide important information on tip moth winter ecology under different environmental conditions. The objective of this study was to examine patterns of weight change of overwintering tip moth pupae in the Georgia piedmont and coastal plain.

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The study was conducted from October 1999 to February 2000 at 4 study sites, 2 in Oglethorpe Co. (site 1: 33°49" N, 83°03" W; site 2: 33°47" N, 83°00" W), in the Georgia piedmont, and 2 in Tatnall Co. (site 3: 32°16" N, 82°02" W; site 4: 32°15" N, 82°02" W), in the Georgia coastal plain. All study sites were loblolly pine plantations. The Oglethorpe Co. plantations had completed 3 growing seasons, with mean tree heights of 1.69 ± 0.16 and 1.61 ± 0.13 m. The Tatnall Co. sites had completed 2 growing seasons, with mean tree heights of 1.30 ± 0.10 and 1.34 ± 0.11 m. At each site, temperature data were collected with a Hobo® H8 Pro Temperature Logger (Onset, Bourne, MA) set to record temperature (in degrees Celsius) every 3 min. Loggers were operated from 27 October to 20 February at the Oglethorpe Co. sites, and from 9 November to 15 February at the Tatnall Co. sites. Tip moth-damaged shoots were collected at each site every 2-3 wks. Trees were selected by walking a randomly determined distance and direction within the stand. All damaged shoots were collected from each tree. These collections began in early October at the piedmont sites and early November at the coastal plain sites, just after the onset of pupal overwintering. Collections continued throughout the winter, ending in late February at the piedmont sites and mid-February at the coastal plain sites, just before spring emergence of adults. A total of 9 collections were conducted at each of the piedmont sites, and 7 collections at each of the coastal plain sites. Shoots were dissected in the laboratory, and tip moth pupae were collected, sexed, and weighed. For each site and collection date, number of pupae weighed ranged from 20-30 for each sex. For each

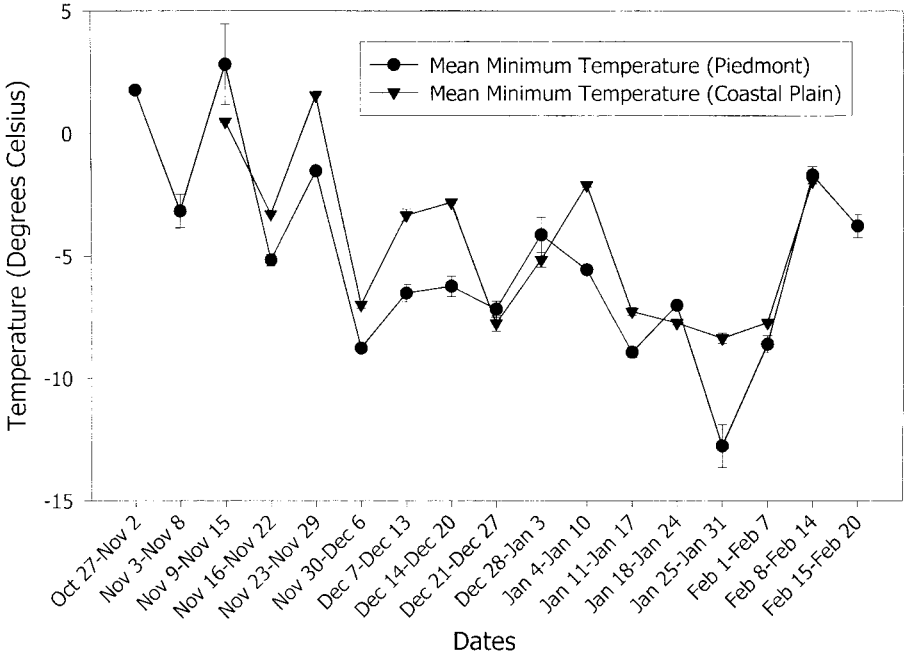


Fig. 1. Mean minimum temperatures (± SE) recorded at piedmont and coastal plain sites from October 1999 to February 2000.

**Table 1. Mean pupal weights (±SE) of overwintering male and female Nantucket pine tip moth pupae at 4 loblolly pine plantations in Oglethorpe County (sites 1 and 2) and Tatnall County (sites 3 and 4), GA**

| Location and sex | Mean pupal weights (mg)* | | |
|---|---|---|---|
| | Initial** | Mid-season** | Final** |
| Site 1 | | | |
| Males | 6.86 ± 0.25 a | 6.03 ± 0.19 b | 5.94 ± 0.25 b |
| Females | 9.51 ± 0.24 a | 8.09 ± 0.28 b | 8.61 ± 0.31 ab |
| Site 2 | | | |
| Males | 6.73 ± 0.27 a | 6.05 ± 0.20 a | 5.89 ± 0.23 a |
| Females | 8.64 ± 0.28 a | 7.47 ± 0.26 b | 8.39 ± 0.41 ab |
| Site 3 | | | |
| Males | 6.04 ± 0.24 a | 6.32 ± 0.18 a | 5.75 ± 0.21 a |
| Females | 9.01 ± 0.35 a | 8.45 ± 0.37 a | 9.38 ± 0.28 a |
| Site 4 | | | |
| Males | 5.75 ± 0.24 a | 5.87 ± 0.18 a | 5.88 ± 0.20 a |
| Females | 8.14 ± 0.30 a | 7.87 ± 0.28 a | 8.33 ± 0.36 a |

* Means within a row followed by the same letter are not significantly different ($P > 0.05$; Turkey HSD procedure)

** Initial = 7 October for sites 1 and 2, and 9 November for sites 3 and 4. Mid-season = 22 November for sites 1 and 2, and 22 December for sites 3 and 4. Final = 20 February for sites 1 and 2, and 6 February for sites 3 and 4.

region, data from three sampling dates (initial, midseason, and final mean pupal weights) were sufficient to evaluate weight change patterns, and those data are presented here. For each site and sex, one-way analysis of variance (Sigma Stat Version 2.0, Jandel Scientific, San Rafael, CA; Sokal and Rohlf 1995, Biometry, Freeman and Co.) was used to compare mean pupal weights from these three dates. Tukey's honestly significant difference procedure (Tukey's HSD) was used for mean separation.

Mean fall/winter temperatures for piedmont sites 1 and 2, based on temperature logger recordings, were 8.37°C and 8.12°C, respectively. Means for coastal plain sites 3 and 4 were 10.21°C and 10.29°C, respectively. Lowest minimum temperatures for the piedmont sites were recorded during late January, whereas lowest minimum temperatures for the coastal plain sites occurred during late November to early December, late December, and mid-January to early February (Fig. 1).

Analysis of variance revealed significant differences in mean pupal weights of males and females at both piedmont sites based on time of sampling (site 1 males, $F = 4.887$; df = 2, 62; $P = 0.011$; site 1 females, $F = 6.183$; df = 2, 63; $P = 0.004$; site 2 males, $F = 3.760$; df = 2, 57; $P = 0.029$; site 2 females, $F = 4.490$; df = 2, 58; $P = 0.015$). Midseason weights were significantly lower than initial weights in all cases except males at site 2. Final weights were lower than initial weights in all cases, but

significantly so only among males at site 1, based on Tukey's HSD (Table 1). These results differed from those of Asaro and Berisford (2001, Environ. Entomol. 30: 999-1005), who found no significant weight changes among overwintering male or female tip moth pupae at 3 sites in the Georgia piedmont. However, they found that overwintering females had statistically lower weights than those of subsequent generations in one sample of pupae.

There were no significant weight losses among overwintering pupae at either of the coastal plain sites (site 3 males, $F = 1.819$; df = 2, 73; $P = 0.169$; site 3 females, $F = 1.902$; df = 2, 59; $P = 0.158$; site 4 males, $F = 0.114$; df = 2, 67; $P = 0.892$; site 4 females, $F = 1.200$; df = 2, 79; $P = 0.307$) in our study (Table 1). This suggests that winter conditions of the piedmont region may have a greater effect on pupal weight than do coastal plain winters. However, our results indicate that most winter weight loss among tip moth pupae occurs before the onset of lowest winter temperatures (Fig. 1), and is probably caused primarily by some other factor, such as possible dehydration due to drier winter air. Further studies are needed to clarify the potential relationships among tip moth overwintering physiology, geographic/climatic factors, and pupal weight change.

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