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## ADULT FEMALE SPRUCE BUDWORM, *CHORISTONEURA FUMIFERANA* (LEPIDOPTERA: TORTRICIDAE), DRY WEIGHT IN RELATIONSHIP TO PUPAL FRESH WEIGHT AND CASE DIAMETER

W. J. Mattson, C. N. Koller, and S. S. Slocum<sup>1</sup>

The weights of adult insects are often measured in production and population studies in order to estimate such variables as growth rates, food conversion efficiencies, fecundity, and others. For the eastern spruce budworm, *Choristoneura fumiferana* (Clemens), both pupal fresh weights and pupal case diameters have been measured as indicators of adult fecundity and adult dry weights (Miller 1957). However, there are no reports explicitly showing the relationship between these metric pupal variables and adult dry weights. This is the goal of this note.

### METHODS

Budworm pupae and adults for this study were derived from two sources: (1) second instar, lab stock larvae from the Great Lakes Forest Research Centre in St. Marie, Ontario, which were reared on a variety of natural hosts in Minnesota (eg. *Picea glauca* (Mill.) B.S.P., and *Abies balsamea* (L.) Mill.) and artificial diet, and (2) wild, late stage larvae collected from *A. balsamea*, and *P. glauca* in New Hampshire and then reared to pupation on artificial diet. Pupae were weighed fresh within 24 h after pupation. Adults, likewise, were collected within 24 h after emergence and then frozen in preparation for freeze drying to constant weight. Diameter ( $D_1$ ) and height ( $H$ ) of the first abdominal segment immediately below the wing pads were measured on the dorsal side of the empty pupal case. We also measured the diameter ( $D_2$ ) of this segment from the lateral perspective as did Miller (1957).

### RESULTS

Adult female dry weight (FWT) was clearly a linear function of fresh pupal weight (PPWT) (Fig. 1):

$$\begin{aligned} \text{Lab stock: } FWT_{\text{mg}} &= -0.915 + 0.244 PPWT_{\text{mg}} \quad r^2 = .99, n = 129, S_{x,y} = 1.234 \\ \text{Eastern wild: } FWT_{\text{mg}} &= -7.009 + 0.293 PPWT_{\text{mg}} \quad r^2 = .88, n = 101, S_{x,y} = 2.423 \end{aligned}$$

However, the two regressions have significantly different intercepts as well as slopes. Examination of Figure 1 shows that this difference results from the fact that the small (< 75 mg) eastern wild pupae produced smaller adults than similarly small lab stock pupae. However, at higher pupal weights (> 75 mg) both groups yielded adults of about the same size. Without more data it is impossible to explain the source of the apparent differences. It is possible, however, that different budworm populations may differ in their adult-pupal weight ratios, and that a universal equation relating these two variables may not exist.

Adult female dry weight (FWT) was clearly a nonlinear function of pupal case diameter ( $D_1$ ) (Fig. 2). This is not unexpected because dimensional analysis suggests that weight or volume of an object ought to be proportional to the cube of one of its linear dimensions.

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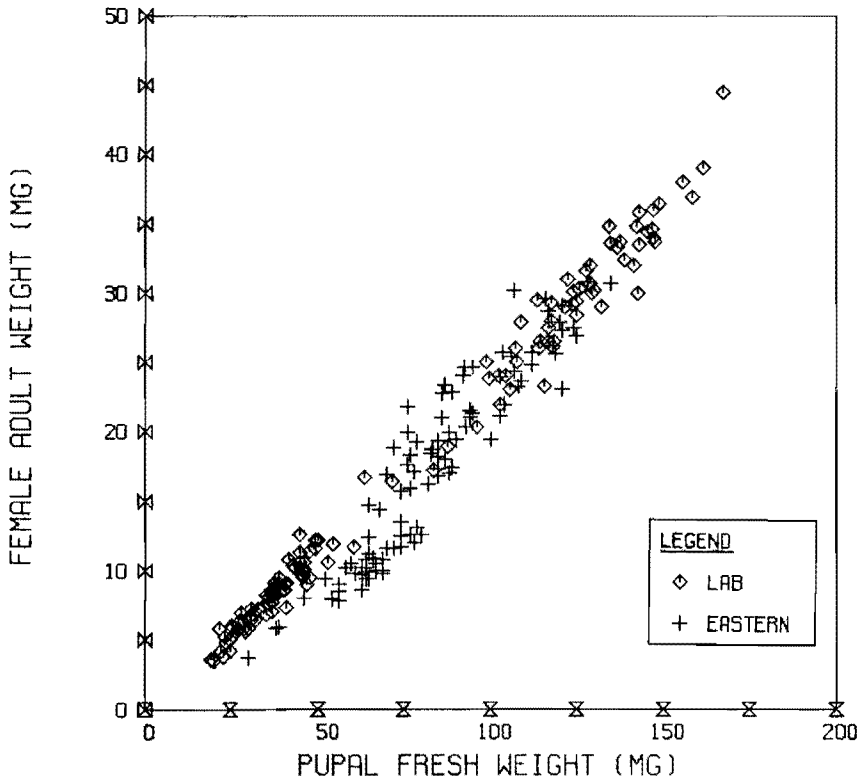


Fig. 1. Adult female spruce budworm dry weight (mg) plotted against fresh pupal weight (mg).

Lab Stock:  $\text{Ln}(\text{FWT}) = -0.9275 + 2.6747 \text{Ln}(D_1)_{\text{mm}}$   $r^2 = .95$ ,  $n = 316$ ,  $S_{x.y} = 0.099$

The regression coefficient (2.67) for the transformed variables (natural logs) is remarkably close to the coefficient (2.62) of the nonspecific or generalized weight (W)-length (L) regression for insects that was developed by Rogers et al. (1976):  $W = k L^{2.62}$ . Neither  $D_2$  nor H, either singly or in combination with one another or with  $D_1$  were significantly better in explaining variation in FWT than  $D_1$  alone. We did not save the pupal cases from the eastern wild stock collection.

We offer the results from this study for use in converting existing measures of pupal fresh weight and case diameters to adult dry weights. Since there may not be a single equation applicable to all populations of the eastern spruce budworm for converting pupal metric variables into adult weights, we offer our results as a benchmark and a stimulus for wider testing of these relationships in different parts of the budworm range.

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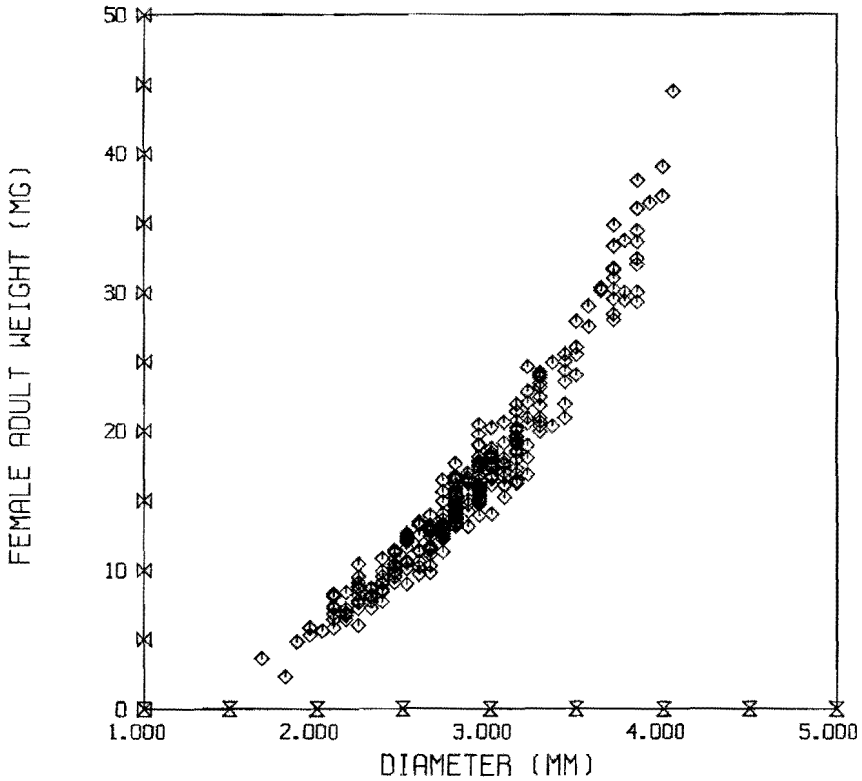


Fig. 2. Adult female spruce budworm dry weight (mg) plotted against dorsal diameter (mm) of the cast pupal case.

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