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## A SIMPLE CHARACTER FOR SEX DIFFERENTIATION OF PUPAE AND PUPAL EXUVIAE OF THE DOGWOOD BORER (LEPIDOPTERA: SESIIDAE)

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The dogwood borer, *Synanthedon scitula* (Harris) (Lepidoptera: Sesiidae), has the broadest host range of all species of Sesiidae and is an economically important pest of numerous ornamental, fruit and nut trees (Engelhardt 1932; Eichlin & Duckworth 1988; Johnson & Lyon 1991). Dogwood borer has become an important indirect pest of apple in the eastern United States and Canada (Riedl et al. 1985; Warner & Hay 1985; Weires 1986; Pfeiffer & Killian 1999; Kain & Straub 2001) due to increased plantings on clonal, size-controlling rootstocks in high-density apple orchards (Riedl et al. 1985; Kain & Straub 2001). These rootstocks promote formation of adventitious root primordia or burr knots near the graft union at the base of the tree (Rom 1970, 1973) that appear to be preferred oviposition sites for female dogwood borer (Riedl et al. 1985; Warner & Hay 1985; Kain & Straub 2001). Continuous infestations lead to larval feeding over consecutive seasons resulting in consumption of burr knot tissue and feeding in the cambial layer, ultimately leading to tree death from girdling (Weires 1986). The increasingly important pest status of dogwood borer has led to recent research efforts into management options (Kain & Straub 2001) as well as refinement of the pheromone-based monitoring system (Bergh & Leskey 2003). Adult male and female dogwood borers can be differentiated by the

more robust abdomen with mostly yellow coloration on ventral segments four, five and six, and the more yellow brush-like anal tuft of females (Eichlin & Duckworth 1988). Sex differentiation of the pupal stage of dogwood borer has never been described specifically, but a generalized description of pupae of sesioid species by Eichlin & Duckworth (1988) indicates that pupae are highly modified to facilitate extrication from host plant tissue, with double rows of posteriorly projecting spines on abdominal segments 2-6 and on segment 7 of males, and single rows on remaining segments 8-10.

Pupae and pupal exuviae of dogwood borer were obtained by excavating larvae from burr knot tissue of apple trees with obvious signs of infestation including frass and entry wounds in Jefferson and Berkeley Counties, WV, USA. Larvae were reared individually in the laboratory on general purpose Lepidopteran diet (Bioserv, Frenchtown, NJ) in an environmental chamber at 25°C and 14L:10D. We followed 20 pupae to adulthood and determined the sex of moths, as described by Eichlin & Duckworth (1988). The pupal exuviae left by each moth was then examined under Leica GZ4 (7-30×) and Nikon SMZ 1500 (7.5-112.5×) stereomicroscopes for sex-related differences in pupal characteristics. These differences were then confirmed on live pupae. Microscopic examination revealed distinct differences between sexes in the

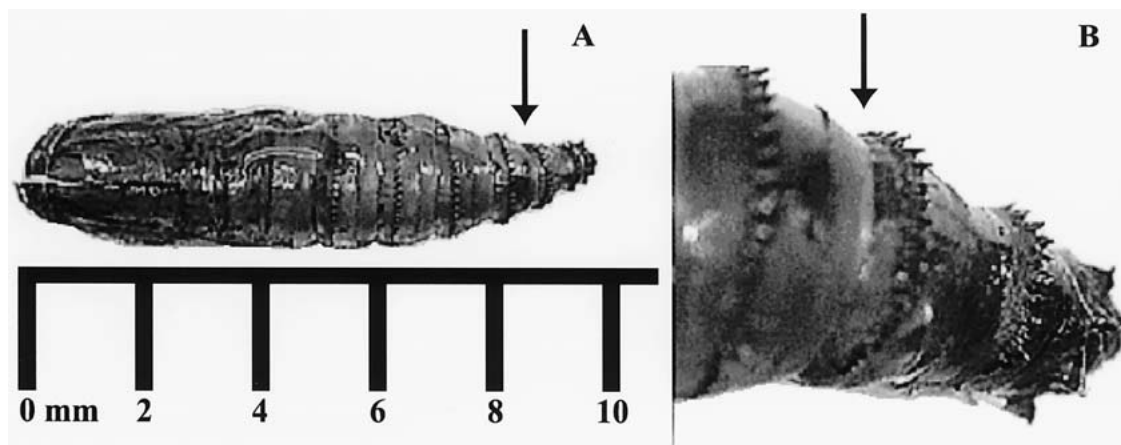


Fig. 1. (A) Caudal view of entire pupal exuviae (10×) and (B) lateral view (50×) of fused terminal abdominal segment (segments 8-10) with 3 rows of posteriorly projecting spines of the pupal exuviae of the male dogwood borer. Arrows indicates suture between fused segments.

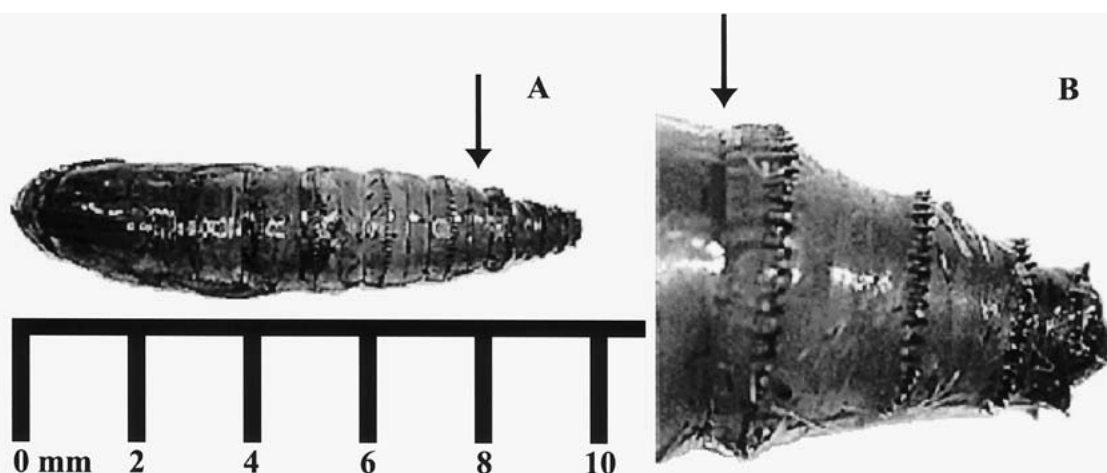


Fig. 2. (A) Caudal view of entire pupal exuviae (10 $\times$ ) and (B) lateral view (50 $\times$ ) of fused terminal abdominal segment (segments 7-10) with 4 rows of posteriorly projecting spines of the pupal exuviae of the female dogwood borer. Arrows indicates suture between fused segments.

fused terminal abdominal segment. In males, this fused segment is composed of segments 8-10 and has three distinct single rows of posteriorly projecting spines (Fig. 1). By contrast, in females, it is composed of segments 7-10 and has four distinct single rows of posteriorly projecting spines (Fig. 2). These differences allow easy and accurate sex differentiation of dogwood borer pupal exuviae and pupae. The total number of rows of spines on the abdomen of both males and females was in agreement with the generalized description of pupae of sesioid species (Eichlin & Duckworth 1988). Female and male pupae had 14 and 15 rows, respectively. However, Eichlin & Duckworth (1988) made no mention of variation among species with regard to the presence of fused abdominal segments and/or the number of rows of spines present on the fused abdominal segments. Counts of the total number of rows of spines on the abdomen of pupae as described by Eichlin & Duckworth (1988) could be used to differentiate pupal sex. However, this method is more cumbersome and potentially less reliable because of the greater number of rows to be counted and because the second row of spines on abdominal segments 2 and 3 is fairly subtle on the dogwood borer, contributing to misidentifications.

Our method of sexing pupae was very useful for determining the gender of adults to be used in laboratory experiments studying mating behavior of the dogwood borer. Furthermore, this character was useful in identifying the sex of pupal exuviae recovered from apple trees in commercial orchards to establish seasonal phenology and to examine protandry. Sexual dimorphism of the fused terminal abdominal segments of pupae of other sesioid species may exist, although it was not examined in this study.

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#### SUMMARY

The sex of dogwood borer pupae and pupal exuviae can be easily differentiated based on characteristics of the fused terminal abdominal segment. In males, it is composed of segments 8-10 and has three distinct rows of posteriorly projecting spines. By contrast, in females, the fused terminal abdominal segment is composed of segments 7-10 and has four distinct rows of posteriorly projecting spines.

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