Small Hive Beetle (*Aethina tumida* Murray) Weight, Gross Biometry, and Sex Proportion at Three Locations in the Southeastern United States

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ABSTRACT

This study was designed to appraise differences in sex proportion and mean body width, length, and weight between sexes of small hive beetles (SHB) from Clemson, SC; Wadmalaw Island, SC; and Richmond Hills, GA. Adult female beetles were significantly longer than males within each location. Overall means did not differ for width between sexes. Due to small variation in width between sexes, width may be an important factor when designing exclusion or trapping devices for SHB. Overall, female beetles weighed significantly more than males. There tended to be more females than males at each location.

small hive beetles / *Aethina tumida* / Coleoptera: Nitidulidae / biometry / sex proportion

INTRODUCTION

There is little published information on the gross biometry of either sex of the small hive beetle (SHB) (*Aethina tumida* Murray). Lundie (1940) states that adult beetles vary in size, but most measure approximately 3/16 in (~ 4-5 mm) long and are 2/3 as wide as they are long. Lundie implies that variation in beetle size is due in part to the maturation time of beetle larvae, with faster maturing larvae developing into larger beetles and slower maturing larvae developing into smaller beetles. This present study was designed to appraise differences in mean body width, length, and weight between sexes of SHB in three locations of the southeastern United States. Sex proportion at each location as well as the yearly fluctuations of sex ratio and sex proportion at one location were also analyzed. This information may aid in characterizing populations of *A. tumida* in the southeastern United States and assist beekeepers and researchers in designing devices for SHB control.

MATERIALS AND METHODS

Length and width data: Beetles were collected with a hand-held aspirator from apiaries near Clemson, SC on 25 and 27 July; Wadmalaw Island, SC on 24 August; and Richmond Hills, GA on 30 October 2000. One thousand two hundred three (1203) beetles from all locations were divided by sex, after which length and width measurements (mm) were made using a vernier caliper (Fig. 1). In length measurements, individual beetles were measured from the anterior to posterior termini. In determining the width, the pronotum was measured at its widest margins.

Weight data: Six hundred twenty-one (621) beetles used for weight data were collected with an aspirator from apiaries near Clemson on 13 November; on Wadmalaw Island on 20 November; and in Richmond Hills on 6 December 2000. Weights (mg) were obtained by weighing individual beetles using a Mettler digital balance to the nearest 0.1 mg. Because sexing beetles involves squeezing them to express genitalia, unavoidably expressing body fluids as well, weights were determined before the insects were sexed.

Sex proportion data: Adult hive beetles were collected on Wadmalaw Island between April 1999 and November 2000 using either an aspirator or interior hive beetle traps containing apple cider vinegar or mineral oil (Hood, 2001). Sample size ranged from 56-500 beetles (140.4 ± 25.4, mean ± standard error). Adult beetles from each sample were sexed and percentage females determined. Sex proportion data were collected from Wadmalaw Island for two consecutive years and plotted (Fig. 2).

Analysis: Data for length, width, and weight were analyzed with the GLM procedure (SAS Institute 1992) recognizing location and sex as independent variables. The interaction of location *x* sex was the error term for location and sex unless the terms interacted, in which case analyses were run separately by location and residual error employed. Where applicable, multiple means were separated with Tukey's test.

RESULTS AND DISCUSSION

General: Parameter means and standard errors are reported in Table I. There was a location *x* sex interaction for length (F=6.8; df=2,1197; P=0.0012), so analyses were run separately by location for this variable. There was no location *x* sex interaction for width (F=1.5; df=2,1197; P=0.2273). Neither did overall means for width differ between sexes (F=3.7; df=1,2; P=0.1954). There was no location *x* sex interaction (F=0.3; df=2,615; P=0.7182) for weight. There were location effects for the variables weight and width (F=23.9-49.9; df=2,2; P=0.02-0.04). Owing to disparities in sample size for sex proportion among locations, we did not analyze this variable but present mean values in Table I.

Length: Adult female beetles were significantly longer than male beetles within each location (F=5-96.5; df=1,203-498; $P \leq 0.03$) (Table I). The location x sex interaction is explained by a smaller magnitude of difference between females and males in Richmond Hill compared to other locations. Although female SHB were longer than male SHB in each location, designing a universal, sex-specific control device or trap for SHB based on sexual differences in length would likely not afford great benefit since male beetles from some locations are as long as female beetles from others. Such controls and traps would have to be location-specific which we deem impractical.

Width: There was no location x sex interaction for width (F=1.5; df=2,1197; P=0.2273). Neither did overall means differ for width between sexes (F=3.7; df=1,2; P=0.1954). This suggests that width is less variable for both sexes than length. This is help-

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		length (mm)	width (mm)	weight (mg)	% of popn
Clemson,	m	5.6±0.04 (101)b	3.2±0.03 (101)	11.7±0.3 (113)	49.6±4.4 (3)
SC	f	5.8±0.04 (104)a	3.2±0.02 (104)	13.2±0.3 (125)	50.4±4.4 (3)
Wadmalaw	m	5.6±0.02 (330)b	3.3±0.01 (330)	13.1±0.3 (76)	46.6±2.3 (20)
Island, SC	f	5.8±0.03 (170)a	3.3±0.02 (170)	15.0±0.3 (146)	53.4±2.3 (20)
Richmond	m	5.5±0.02 (250)b	3.1±0.02 (250)	12.4±0.3 (75)	47.4±0.8 (2)
Hill, GA	f	5.6±0.02 (248)a	3.2±0.02 (248)	14.1±0.3 (86)	52.6±0.8 (2)
overall	m	5.5±0.01 (681)	3.2±0.009 (681)a	12.3±0.2 (264)b	47.1±1.9 (25)
means	f	5.7±0.02 (522)	3.2±0.01 (522)a	14.2±0.2 (357)a	52.9±1.9 (25)

Table I. Gross biometry by sex (m, f) and sex proportion of *A. tumida* from three populations in the southeastern United States. Values are mean ± standard error. Numbers in parentheses, *n*. For length, values within location with different letters are significantly different at the $\alpha \leq 0.05$ level. For width and weight, overall means with different letters are significantly different. Analyses were not run for sex proportion because of unequal sample size among locations.

ful information for the package bee industry and for others wanting to design SHB trapping or exclusion devices. Baxter *et al.* (1999) examined various methods for treating beetles in packages but their efforts were frustrated by the beetles' ability to move in and out of packages freely and avoid pesticide exposure. Since there is little variability in width for either sex, package producers may benefit from standardizing to a smaller gauge of screen. Ellis *et al.* (2002a) describe a method for reducing SHB invasions by replacing the regular entrance of a hive with a ¾-inch (2-cm) PVC pipe located 3-4 inches (7.6-10.2 cm) above the bottom board. The authors noted some undesirable effects of using PVC pipe entrances: debris on hive bottoms, reduced brood production, and evidence that restricted entrances impair the ability of bees to thermoregulate the nest. Ellis *et al.* (2002a) speculated that it may be possible to mitigate these problems by ventilating hives with a screened bottom board (Pettis and Shimanuki, 1999; Ostiguy *et al.*, 2000; Ellis *et al.* 2001). Our present findings indicate that the mesh for such screens should be ≤3.0 mm. Otherwise, SHB could enter colonies through larger screens, rendering the PVC pipe entrances ineffective.

Weight: Overall, female beetles weighed significantly more than males (F=146.3; df=1,2; P=0.0068) (Table I), and this held true across locations. This is consistent with our finding that within each location females were longer than males.

Location effects: Wadmalaw Island beetles (14.4 ± 0.2 mg) weighed significantly more than beetles from either Richmond Hill (13.3 ± 0.2 mg) or Clemson (12.5 ± 0.2 mg). Similarly, Wadmalaw Island beetles (3.3 ± 0.009 mm) were significantly wider than beetles from Richmond Hill (3.2 ± 0.01) and Clemson (3.2 ± 0.02 mm). The differences in gross biometry we note between Richmond Hill and Wadmalaw Island are congruent with the data of Evans *et al.* (2000) who determined that beetles from these areas fit into two different U.S. haplotypes based on variation in mitochondrial DNA. Beside genetic differences, we cannot exclude the possibility of diet or other environmental factors contributing to biometric variation between these locations.

Sex proportion: There tended to be more females than males at each location, a finding consistent with the work of Neumann *et al.* (2001) and Ellis *et al.* (2002b) in which females exceeded males in laboratory-reared populations. Figure 2 shows percentage females for Wadmalaw Island for the 1999 and 2000 seasons. Some minima and maxima appear coincident between years, but more data are required to firmly elucidate any annual cycles.

CONCLUSIONS

We present here the first extensive survey of gross biometry of *Aethina tumida* in North America. In general, adult female beetles

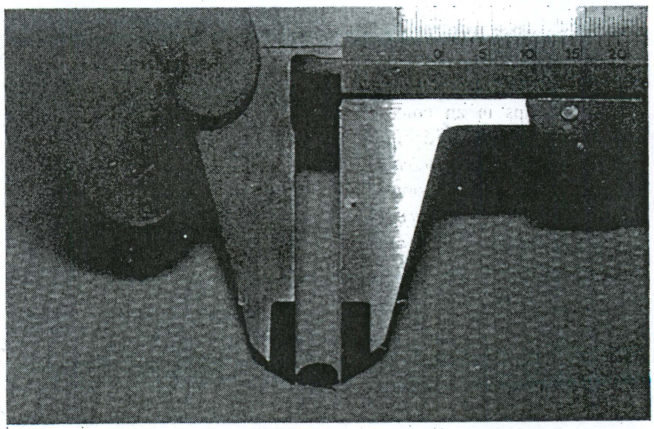

Figure 1. Length and width measurements (mm) were determined using a vernier caliper.

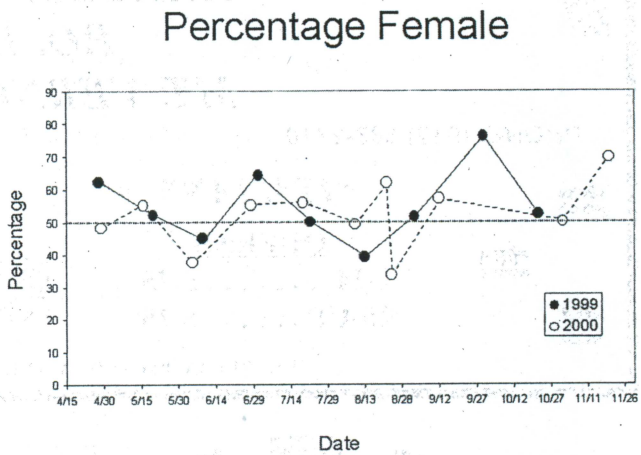

Figure 2. Percentage of sampled adult *A. tumida* determined to be female across two seasons at Wadmalaw Island, South Carolina, USA. The average percentage female exceeded 50% on twelve of twenty sampling dates.

outnumber males in local populations and tend to be longer and heavier than males. Body width tends to be similar between sexes and rarely drops below 3.0 mm. Thus, we suggest that screen used for SHB exclusion or trapping devices should be ≤3.0 mm.

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