Method for Determining Age Structure of Adult Populations of the Lesser Cornstalk Borer (Lepidoptera: Pyralidae)

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ABSTRACT Laboratory experiments were conducted to develop methods for determining age structure of *Elasmopalpus lignosellus* (Zeller) adults. Oöcyte development in the ovaries was used to establish five female classes: (1) no mature oöcytes; (2) ca. 25% of oöcytes mature; (3) ca. 50% of oöcytes mature; (4) >75% of oöcytes mature, >30 mature oöcytes; and (5) >75% of oöcytes mature, <30 mature oöcytes. At 26.7°C, 96.6% of the adult females in age classes 1, 2, 3, 4, and 5 were within the age intervals of ca. 0 to 2, 2 to 4, 4 to 6, 6 to 8, and 8 to 10 days of adult age, respectively. Fat body depletion in the abdomen was used to construct three male age classes: (1) much fat body material, ca. 0 to 25% depleted; (2) moderate fat body material, ca. 50% depleted; and (3) little fat body material, >75% depleted. At 26.7°C, 90.9% of the adult males in age classes 1, 2, and 3 were within the age intervals of ca. 0 to 4, 6 to 8, and 8 to 10 days of adult age, respectively. These physiologically based, female and male classification systems appear suitable for determining chronological age structure of feral populations.

THE LESSER cornstalk borer (LCB), *Elasmopalpus lignosellus* (Zeller), is polyphagous; numerous native plants and cultivated crops in the southern United States serve as hosts. Crops severely damaged each year include peanuts, soybeans, corn, and grain sorghum. LCB injury to each of these crops was reviewed in Tippins (1982). Adults typically are present in fields during the early seedling stages of crop growth and, in some crops, during the later phenological periods of crop development (Funderburk, unpublished data). Undoubtedly, some adult infestations in crops result from movement out of other nearby habitats. Because of the wide host range, LCB adults that invade crop fields could emanate from numerous crop and noncrop habitats. Elucidation of such adult movements would strengthen efforts to manage LCB in agricultural systems.

Spatial and temporal patterns of population age structure provide information about an insect species' basic ecology (e.g., adult movements between habitats). Lopez et al. (1978) identified habitats that were sources and sinks of adult female *Heliothis zea* (Boddie) by determining the age structure of adult populations. They used ovarian development and mating status to determine physiological age of the adult females. Showers et al. (1974) also used a system based on ovarian development and mating status to quantify age structure of adult populations of *Ostrinia nubilalis* (Hübner).

Our study was done to develop methods which adequately depict different ages of adult female and male LCB. Such methods would allow for determinations of age structure in feral LCB adult populations.

Materials and Methods

From preliminary investigations, classes were constructed which indicated various ages of adult LCB. Oöcyte development in the ovaries was used to establish five female classes: (1) no mature oöcytes (Fig. 1a); (2) ca. 25% of oöcytes mature (Fig. 1b); (3) ca. 50% of oöcytes mature (Fig. 1c); (4) >75% of oöcytes mature, >30 mature oöcytes (Fig. 1d); and (5) >75% of oöcytes, <30 mature oöcytes (Fig. 1e). This female classification system is similar to that used for other lepidopteran species (Showers et al. 1974, Myers and Pedigo 1977, Lopez et al. 1978). Fat body depletion was used to establish three male age classes: (1) much fat body material, ca. 0 to 25% depleted (Fig. 2a); (2) moderate fat body material, ca. 50% depleted (Fig. 2b); and (3) little fat body material, >75% depleted (Fig. 2c).

LCB adults were reared in the laboratory to determine approximate chronological ages of adult LCB assigned to each of the physiological age classes. Most adults used for these observations were reared from locally collected larvae. Additional adults were obtained from a laboratory colony at

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the Department of Entomology and Fisheries, Georgia Coastal Plain Experiment Station, Tifton. Within 12 h after emergence, adults were placed in cylindrical, wire mesh cages (30 cm high by 10 cm wide). More males than females were placed in each cage (five females, seven males) to ensure mating of females. Vitamin-enriched, diluted beer was provided as a food source. Cages were placed randomly within a growth chamber and maintained at a constant 26.7°C and a photoperiod of LD 16:8.

At room temperature, mean longevity of mated male and female LCB adults was reported as ca. 10 days (Leuck 1966). Therefore, 24 to 35 adults (ca. half males and half females) were selected randomly from the wire mesh cages on each of six 2-day intervals from adult emergence to day 10, inclusive. These adults were dissected by using 7 to 30× magnification. Then the appropriate age class was determined for each adult, after the ovarian development or the amount of fat body material was noted. The mating status of each female also was determined by examining the bursa copulatrix for spermatophores (Beals and Berberet 1976).

Results and Discussion

Percentages of female LCB adults in each designated female age class at 2-day age intervals from pupal emergence to day 10, inclusive, are shown in Fig. 3. Chi-square (χ^2) analyses were used to detect frequency changes in the age classes by adult age. Age classes with <4.0 observations in expected values were pooled with adjacent classes before calculation of χ^2. These analyses demonstrated that age class frequencies changed significantly every 2 days (χ^2_{1df} = 20.7, 13.1, 15.5, 8.4, and 4.0 for 2, 4, 6, 8, and 10-day old females, respectively; $P <$ 0.005, 0.005, 0.005, 0.0005, and 0.05, respectively). Ovaries of recently emerged female adults did not contain mature oöcytes and were designated class 1. Maturation of some oöcytes in the proximal ends of the ovaries began soon after adult emergence for most females, and by 2 days of age, most females were class 2. Nearly all oöcytes had matured for most females at 4 days of age. Between 4 and 6 days of adult age, oviposition was greatest; consequently, the ovaries of most females were partially depleted of eggs after 6 days of age. By 8 and 10 days, the ovaries of most females were nearly depleted of eggs.

Females usually mated soon after pupal emergence; by 2 days of age, ca. 80% were mated, and >95% of the 4-day-old females had mated. Multiple matings per female were common, and five was the greatest number of spermatophores observed in a female. The number of spermatophores was not a reliable indicator of chronological age. Typically, two to three spermatophores were observed in females at 2 and 4 days of age, and two to four spermatophores were observed in females after 6, 8, and 10 days of age.

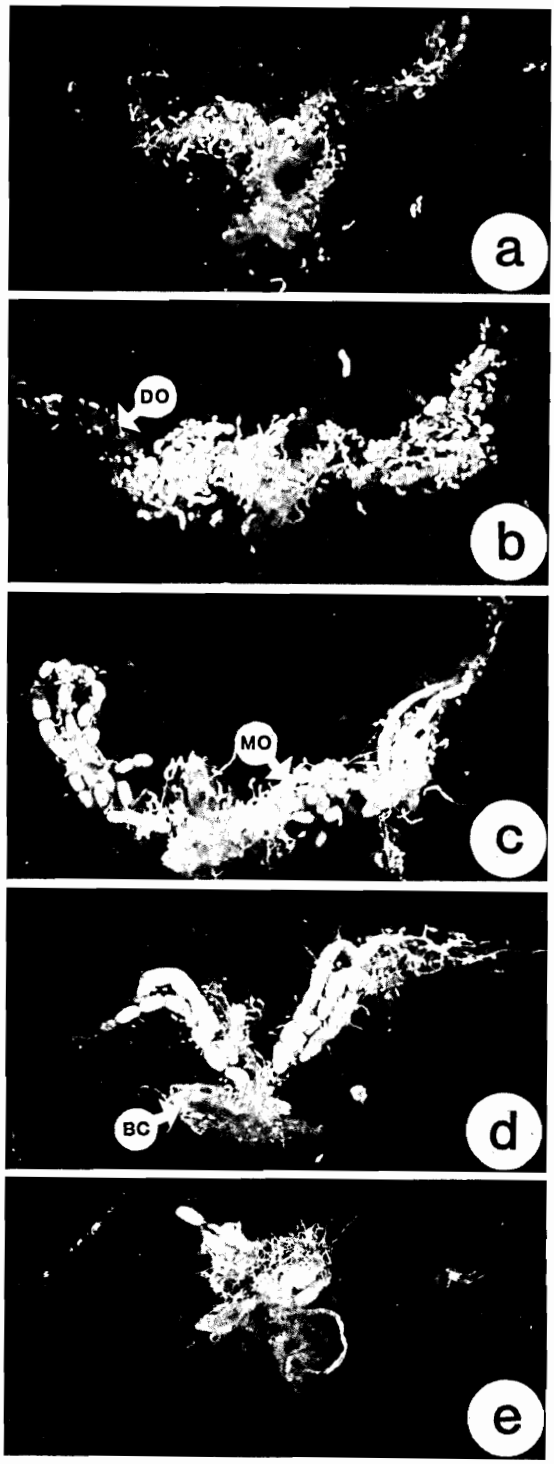

Fig. 1. Female age classes 1 through 5 are represented by a through e, respectively. BC, Bursa copulatrix; DO, developing oocyte; MO, mature oocyte.

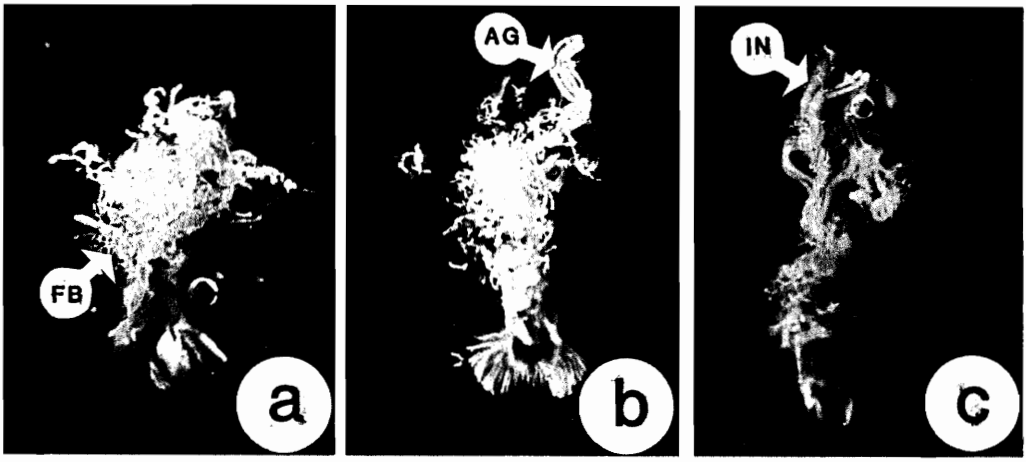

Fig. 2. Male age classes 1 through 3 are represented by a through c, respectively. IN, Intestine; AG, accessory gland; FB, fat body.

The percentages of male LCB adults in each of the constructed male age classes at 2-day age intervals from pupal emergence to day 10, inclusive, are shown in Fig. 4. As with females, χ^2 analyses were used to detect frequency changes in age classes based on adult age, and age classes with <4.0 observations in expected values were pooled with adjacent classes before calculation of χ^2.

Fat bodies of all recently emerged males contained much fat material and were designated class 1. Further, age-class frequencies did not change significantly after 2 and 4 days of age (χ^2_{1df} = 1.1 and 1.2, respectively). Between 2 and 4 days of adult age, 92.0% of males were class 1 and 8.0% were class 2. Fat body depletion was substantial in older males. Age-class frequencies changed significantly for 6-day-old males, (χ^2_{1df} = 6.9, $P < 0.01$). For 8-day-old males, 7.1, 35.7, and 57.1% were class 1, 2, and 3, respectively. Age-class frequencies were similar for 8- and 10-day-old males (χ^2_{1df} = 1.7). At 10 days of age, 18.2 and 81.8% were class 2 and 3, respectively.

Female age classes were excellent indicators of adult age. Overall, 96.6% of females in the age classes 1, 2, 3, 4, and 5 were within the age intervals of ca. 0 to 2, 2 to 4, 4 to 6, 6 to 8, and 8 to 10 days of adult age, respectively. Many adult ages were discriminated from each other by the female

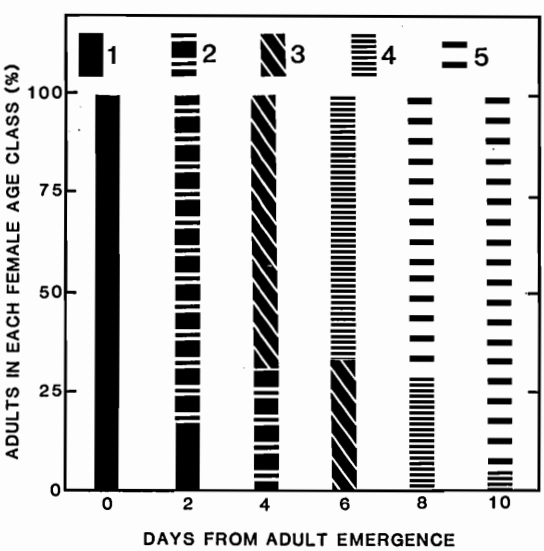

Fig. 3. Female age class frequencies for adult LCB at 2-day intervals from pupal emergence (day 0) to day 10, inclusive.

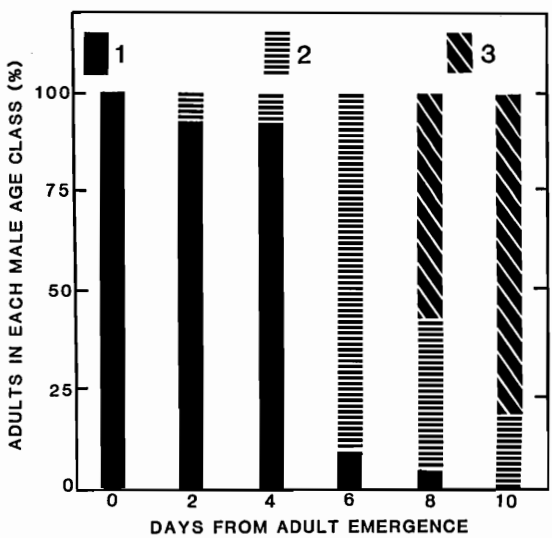

Fig. 4. Male age class frequencies for adult LCB at 2-day age intervals from pupal emergence (day 0) to day 10, inclusive.

age-classing system. Male age classes also were indicators of adult age, thereby demonstrating that fat body reserves were depleted with age. Overall, 90.9% of males in age classes 1, 2, and 3 were within age intervals of ca. 0 to 4, 6 to 8, and 8 to 10 days of adult age, respectively. Therefore, both young and early middle-aged adults were contained within class 1 of the male age-classing system, but other adult ages were fairly well discriminated from each other.

The time for categorizing an adult into the appropriate age class was short and averaged ca. 0.08 human-hours per adult for both males and females. Therefore, the time necessary to determine age structure of a feral adult population should not be prohibitive, even if a large number of samples are needed.

In many areas of the southeastern United States, there is little day-to-day variation in temperature during the summer growing season, and mean temperatures for each month, May to September, are ca. 26.7°C. For example, the mean temperatures in Gadsden County, Fla., are 23.4, 26.3, 26.9, 26.8, and 25.2°C for May, June, July, August, and September, respectively (Davis and Mickelson 1969). Therefore, these laboratory results at 26.7°C should be reasonable indicators of actual adult age during typical summer growing conditions in the southeastern United States. At other mean temperatures, the age of an adult relative to other adults in the population could be determined by using these age classes.

Therefore, the physiologically based, female and male classification systems appear suitable for determining chronological age structure of feral populations. The female age-classing system based on ovarian development demonstrated distinct advantages over the male age-classing system based on fat body depletion. First, the female age-classing system was a more precise indicator of actual adult age than was the male age-classing system. Second, more adult ages were discriminated from each other by the female age-classing system than by the male age-classing system. For these reasons, the female system would be preferable, whenever possible, to determine feral age structure of LCB adult populations.

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