SEASONAL ABUNDANCE OF THE FREE-LIVING STAGES OF THE LONE STAR TICK (*AMBLYOMMA AMERICANUM*) IN CUMBERLAND COUNTY, TENNESSEE

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ABSTRACT—Adults, nymphs and larval masses of the lone star tick *Amblyomma americanum* (L.) were collected with flannel tick drags and cloth CO_2 traps between 1994 and 1996 in Cumberland County, Tennessee. Adults and nymphs were first collected in March and were present until August (adults) and September (nymphs). Larval masses were first present in July, but were not commonly collected until late August and disappeared by the end of October. There were no consistent trends of increase or decrease in the numbers of any life stage among years. More adult females were collected with CO_2 traps than with tick drags, and more nymphs were collected with drags than with CO_2 traps. More adult males, males and females combined, and nymphs were collected in the woods habitat than in the grass habitat. The influence of the number of frost-free days on seasonal occurrence of the lone star tick is discussed.

The lone star tick *Amblyomma americanum* (L.), is the second most common tick encountered by humans in Tennessee (Gerhardt, unpublished data). In those areas where it does occur, it can be the most prevalent species and can result in considerable annoyance to homeowners, hikers, hunters, and others who encounter it. Lone star ticks are especially common in those areas with large white-tailed deer (*Odocoiles virginianus* Zimmerman) populations. However, they parasitize a wide range of mammals and birds and will attach to humans in all three free-living stages (larva, nymph, and adult) (Felz et al., 1996). After attachment, all stages can leave a discolored, thickened sore on human skin which can remain annoying for weeks. In addition to the physical annoyance caused by lone star ticks, they also are suspected of transmitting *Ehrlichia chaffeensis* Anderson, Dawson, Jones & Wilson, the causative organism of human monocytic ehrlichiosis (HME) (Anderson et al., 1992). Eleven cases of HME occurred in Cumberland County, Tennessee in the spring and summer of 1993. Among the risk factors for exposure to *E. chaffeensis* were tick bite, golfing, high golf score and not using insect repellent. Preliminary tick collections indicated that lone star ticks were the predominant tick in the affected area (Standaert et al., 1995).

Published records for free-living lone star tick seasonal activity in Tennessee are limited to nine monthly collections during a 13-month period in woods and old field habitats at the Land Between the Lakes in Stewart County (Zimmerman et al., 1987). Seasonal abundance of lone star ticks in other areas of the United States has been determined with varying degrees of completeness in Arkansas (Lancaster, 1955), New Jersey (Schulze et al., 1986), Oklahoma (Hair and Howell, 1970; Semtner and Hair, 1973), Georgia (Davidson et al., 1994), Virginia (Sonenshine and Levy, 1971; Sonenshine et al., 1966), Mississippi (Jackson et al., 1996), and Texas (Drummond, 1967; Pound et al., 1996). The combination of latitude and elevation of Cumberland County results in an average frost-free period that is shorter than any of these localities except New Jersey and Arkansas (Anonymous, 1983). Data from both of these states were based on collections for one year only.

As part of a tick control program to reduce lone star ticks and HME prevalence, the seasonal abundance and occurrence of larval, nymphal, and adult stages of *A. americanum* were determined at three untreated control plots in Cumberland County, Tennessee between 1994–96. These data will be useful for determining when humans and animals would be at risk and when acaricidal treatments for any given life stage should be applied.

MATERIALS AND METHODS

The study area was in the community of Fairfield Glade, which has an area of 4900 ha and ca. 6000 residents. It is located on the Cumberland Plateau of eastern Tennessee and is bordered on the north by the Catoosa Wildlife Management Area. This community was begun in 1970 and was built within a second-growth mixed mesophytic forest. It has an average elevation of 600 m and currently consists of home sites, golf courses, forests, lakes, roads, and recreational parks. This area of the Cumberland Plateau has an average of less than 180 frost-free days each year (Anonymous, 1983). The forests consist of hard woods and pines with an overstory of sourwood (*Oxydendrum arboreum* L.), white oak (*Quercus alba* L.), white pine (*Pinus strobus* L.), shortleaf pine (*P. echinata* Miller), hickory (*Carya* spp.), and black gum (*Nyssa sylvatica* Marsh). Understory vegetation (when present) consisted of blueberry (*Vaccinum* sp.), holly (*Ilex* sp.), wandering jew grass (*Microstegium vimineum* Nees), white pine, shortleaf pine, white oak, and red maple (*Acer rubrum* L.) seedlings. The road shoulder or grassy areas were fescue grass with occasional roadside weeds which were mowed 3–4 times during each year.

Adults (males, females, and males and females combined), nymphs, and larval masses of lone star ticks were sampled biweekly at three untreated sampling sites from March–October 1994 and April–October 1995–96. Each sampling site was ca. 10 ha and consisted of two general habitats: woods, and associated grassy road berms (shoulders). Adult and nymphal ticks were sampled with CO_2 cloth traps (Grothaus et al., 1976) for at least one hour in both the woods and on the grassy berms at each sampling site (total of 6 traps) during each sampling period. Each CO_2 trap consisted of a 1 m square piece of white, slick nylon cloth with ca. 0.45 kg dry ice placed in the middle. Ten, 10 meter drags were made in both the grass and the woods at each site at the same time as the CO_2 trapping. The drags were made of 1 m^2 white flannel cloth attached to 2.5 cm diameter wooden dowels and were dragged behind a collector with a rope (Zimmerman et al., 1987). Tick drags sampled adults, nymphs and larval masses. When larval masses appeared each year, the number of drags was increased to 20. Adults and nymphs were counted only for the first 10 drags and the number of larval masses adjusted to 10 drags. All collected ticks were identified, counted, and released, except for the larvae on the drags and the adults and nymphs, which were frozen by the dry ice. Larvae collected on the drags were counted as individual "larval masses" regardless of the number of individuals in the mass and were removed from the cloth with masking tape. Larval masses ranged in size from 8 to >500 individuals. Collections were made between 1000 and 1600 h CDT on days with temperatures above 21°C, when dry vegetation and calm conditions were present.

Data were transformed using log (log(x+1)) and analyzed using Procedure GLM with repeated measures over time (SAS, 1989) and year, collection site, sampling method and habitat as class variables. The linear model used was

$$y_{thsi} = Y_i + B_t + C_h + D_s + Y \cdot B \cdot C \cdot D_{thsi} + e_{thsi}$$

where B_t = collection site, C_h = habitat, D_s = sampling method, Y_i = year, and y_{thsi} = tick life stage. Differences in means were determined using a Duncan's Grouping, alpha = 0.05. Figures and means are presented as untransformed data.

RESULTS AND DISCUSSION

Amblyomma americanum was the predominate tick species collected during 1994–96 in this study. Only three adult female American dog ticks, *Dermacentor variabilis* (Say), were collected (May 1994). Mean capture rates on tick drags were 0.41 males, 0.32 females, 0.73 males and females combined, 7.03 nymphs, and 1.65 larval masses/collection date. Adjusted one hour cloth CO_2 trap collections were 0.35 males, 0.63 females, 0.97 males and females combined, and 2.21 nymphs/collection date. There were significant differences among years only for males and nymphs, but there were no consistent trends which would indicate increasing or decreasing populations [males, (1994 = 1996) < 1995; nymphs, (1995 = 1996) < 1994]. Minimum temperature and/or moisture conditions for adult and nymphal activity did not occur on any attempt to collect until 31 March in 1994 and mid-April in 1995 and 1996. Adults were first collected in March, and were most numerous from April through June. Adult numbers decreased in July and had essentially disappeared by August. Collection method was significant for females only ($\bar{X}$ CO_2 traps = 0.64, $\bar{X}$ drags = 0.33) (Fig. 1A). Males and combined adults were more commonly collected in the woods habitat than in the grassy road sides (males, $\bar{X}$ woods = 0.48, $\bar{X}$ grass = 0.28; combined adults, $\bar{X}$ woods = 1.06, $\bar{X}$ grass = 0.67).

Tick drags collected 3-times more nymphs than CO_2 traps ($\bar{X}$ drag = 6.46; $\bar{X}$ CO_2 = 2.24), and nymphs were 8-times more commonly collected in the woods compared to the grass ($\bar{X}$ woods = 7.75; $\bar{X}$ grass = 0.97) samples. Nymphs were present as early in the season as adults but in relatively low numbers in March and April and persisted until October (Fig. 1B). The increase in the CO_2 collection in September and in drag collections in July and August are the result of a single large CO_2 collection and single 10 m drag collections on each date and probably do not represent a late season "peak".

Larval masses were rare in July and did not appear in substantial numbers until late August, reaching maximum numbers in September (Fig. 1C). Larval masses were collected in October but generally had fewer individuals than earlier collections. There were no significant differences between the number of larval masses collected in the woods and grass habitats.

These results are, in general, consistent with those of other researchers. The differential in female collections using CO_2 and tick drags has been reported previously and is considered to be the result of differences in questing behavior that occur as the temperature increases in the spring. Female ticks tend to run across the ground (toward CO_2 traps) at cooler temperatures and climb upon understory vegetation as the temperature increases (Kinzer et al., 1990). We could not verify a late summer peak of nymphal activity that was reported in Arkansas, Oklahoma, and Mississippi (Lancaster, 1955; Hair and Howell, 1970; Semtner and Hair, 1973; Jackson et al., 1996), nor did we collect any larvae in the spring (Schulze et al., 1986). The earliest adult collections in this study were at the end of March in 1994. This was later in the year than reported in Mississippi (Jackson et al., 1996) and Texas (Drummond, 1967; Pound et al., 1996), March and February, respectively. Larval masses were not collected in significant numbers until the end of August in Cumberland County. This date is 1–2 months later than has been reported for Georgia, Mississippi, Texas (Davidson et al., 1994; Jackson et al., 1996; Drummond, 1967; Pound et al., 1996), and some but not all habitats in Oklahoma (Semtner and Hair, 1973). This is probably due to the later start in adult questing in the spring. Both occurrences may be a result of the elevation and latitude of Cumberland County, causing this area to have a shorter frost-free season than any of the areas for which seasonal activity has been reported (Anonymous, 1983). Fayetteville, Arkansas and Monmouth County, New Jersey are the only areas with a similar frost-free season and lone star tick seasonal occurrence (Lancaster, 1955; Schulze et al., 1986).

The implications for lone star tick control from this study are two fold. First, in Tennessee the time during which lone star ticks are active is shorter than in other localities studied, and as a result, control aimed at any given stage would have to be sustained for less time. On the other hand, the concentration of larval masses in late summer and early fall immediately precedes white-tailed deer hunting season. This could limit the time deer could be fed systemic acaricides to control attached larvae due to the requirement for a withdrawal time before hunting season.

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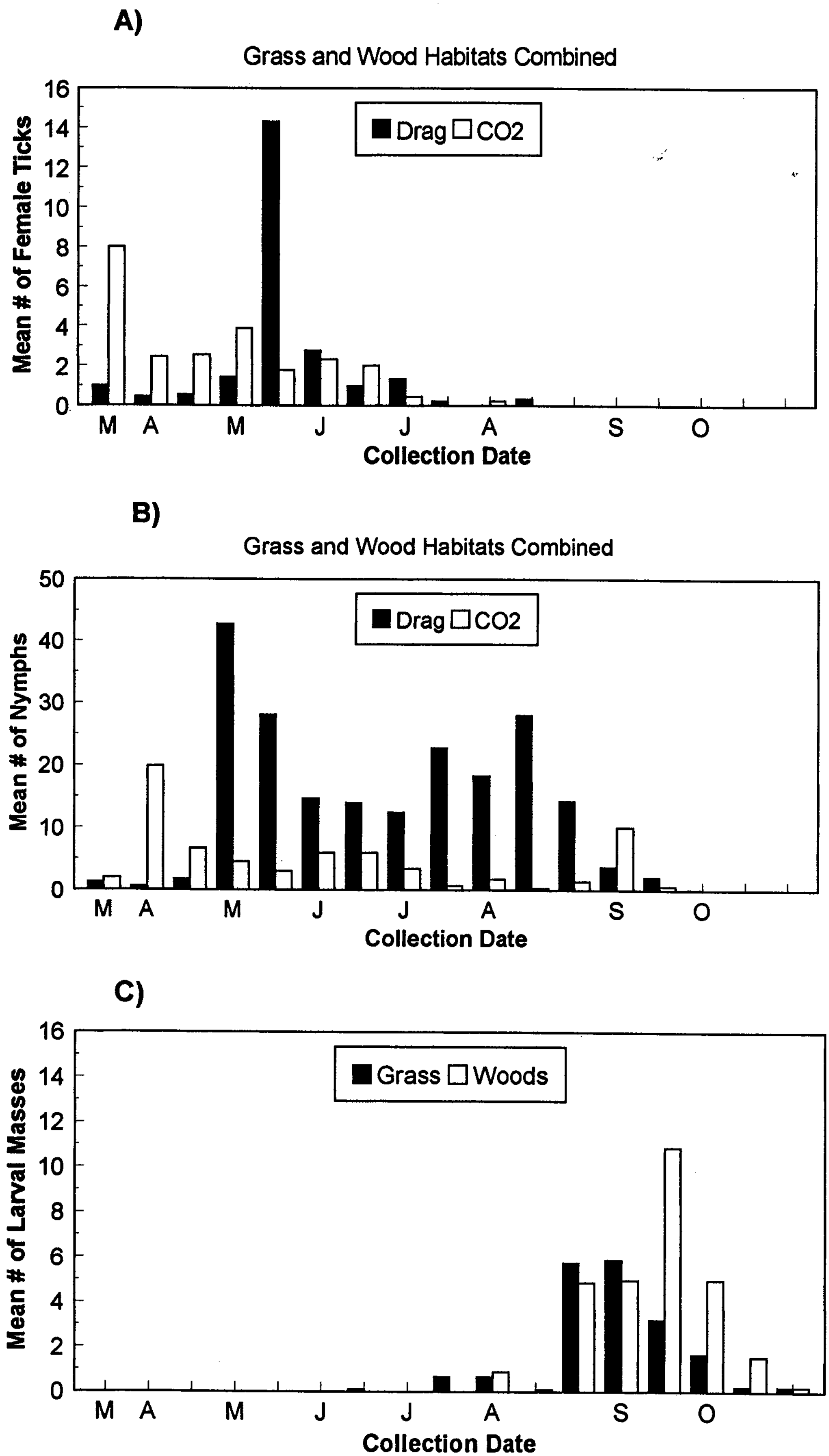
A)
Grass and Wood Habitats Combined
Drag
CO2
Mean # of Female Ticks
M A M J J A S O
Collection Date
B)
Grass and Wood Habitats Combined
Drag
CO2
Mean # of Nymphs
M A M J J A S O
Collection Date
C)
Grass
Woods
Mean # of Larval Masses
M A M J J A S O
Collection Date

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FIG. 1. Mean number of *Amblyomma americanum* collected per collection date, 1994–1996, Fairfield Glade, Cumberland County, Tennessee. (A) Mean number of adult females per 10, 10 m drags and 1 h CO_2 sampling, grass and wood habitats combined. (B) Mean number of nymphs per 10, 10 m drags and 1 h CO_2 sampling, grass and wood habitats combined. (C) Mean number of larval masses per 10, 10 m drags.