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Bot fly (*Cuterebra* sp.) Parasitism of White-footed Mice (*Peromyscus leucopus*) in Southern Illinois

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ABSTRACT

Bot fly (*Cuterebra* sp.) data were collected from white-footed mice (*Peromyscus leucopus*) trapped in bottomland forests of southern Illinois in 1998 and 1999. Of 1297 white-footed mice examined, 125 individuals (9.6 %) were parasitized by 1 or more bot fly larvae. Parasitism occurred exclusively in the scrotal region, with most individuals (93.6 %) containing one larvae. The rate of parasitism in adult mice 1998 (11.6 %) was significantly higher than the rate of parasitism over the same months in 1999 (5.6 %; $X^2 = 3.85$ d.f. = 1, P = 0.05). Parasitism rates were higher in adult males than females in 1998 ($X^2 = 4.7$, d.f. = 1, P = 0.031) and no difference was detected in 1999 ($X^2 = 0.45$, d.f. = 1, P = 0.502). This is the first study to document parasitism rates in bottomland forests of southern Illinois.

INTRODUCTION

White-footed mice (*Peromyscus leucopus*), lagomorphs, and other rodent species are natural hosts for bot fly larvae (*Cuterebra* spp.; Timm and Cook, 1979; Sabrosky, 1986). The genus *Cuterebra* is only found in the New World and consists of 72 species (Catts, 1982). Incidents of this genus infecting dogs, cats, cattle, sheep, deer, and humans have been reported, however, they are rare (Sabrosky, 1986). Reported effects of bot fly larvae on infected rodents include increased risk of predation, reduced testes development in male subadults, and tissue damage (Payne and Cosgrove, 1966; Getz, 1970; Timm and Cook, 1979). Some studies have reported a correlation between high bot fly infestation rates one year and low population sizes the next year (Wilson, 1945; Wecker, 1962), while other studies have reported finding few to no adverse effects on small mammals parasitized by bot fly larvae (Clough, 1965).

Infestation occurs when the host comes into physical contact with bot fly eggs, which are often laid in vegetation near small mammal burrows (Beamer, 1950; Catts, 1967; Catts, 1982). Eggs adhere to the host and rapidly hatch into larvae after being cued by body temperature (Xia and Millar, 1990). Hatched larvae enter the host through the nose, eyes, mouth, or wounds and migrate through the body, often settling in the groin region (Wecker, 1962; Miller and Getz, 1969; Catts, 1982; Xia and Millar, 1990; Wolf and Batzli, 2001). Because infestation occurs through physical contact with eggs, individuals that are more mobile and transverse across large geographic areas should be more likely to come into contact with eggs (Timm and Cook, 1979; Xia and Millar, 1990). Male white-footed mice have been documented to travel more extensively then females, prompting the hypothesis that males would be more heavily infested than females.

MATERIALS AND METHODS

Small mammals were trapped in the 6 southwestern-most counties of Illinois (Alexander, Johnson, Massac, Pope, Pulaski, and Union). Sixty study sites, located in deciduous bottomland forest patches with similar microhabitat composition were sampled (see Barko, 2000). Sites were trapped between May 1998 - January 1999 and April - August 1999 using Sherman live traps (8 by 9 by 23.5 cm; H.B. Sherman Co., Florida). A linear transect was established at each site and was comprised of 50 trap stations. Two traps were set at each station (100 traps per site), with stations 10 m apart. Traps were baited with sunflower seeds and cracked corn, operated for 3 consecutive days (300 trap nights per site), and checked daily between 0600 and 1100 hours. Sites were only trapped once; hence, different sites were trapped in 1998 and 1999. Thirty-six sites were sampled in 1998 and 24 sites were sampled in 1999. *Peromyscus* sp. were toe-clipped for individual identification and age, sex, and number of bot fly larvae were recorded. All animals were released at the point of capture.

Chi-square analyses were used to test for differences in the rate of parasitism ($P \leq 0.05$) between the years, months, and sexes (Steel and Torrie, 1980; Sokal and Rohlf, 1995). Only months sampled both years (May, June, and July) were used in the analysis to compare infestation rates between the years. Because infestation rates were low at the study site level, no analyses were performed to test for differences between sites. The expected number of infected individuals for each sex was calculated by multiplying the observed sex ratio by the number of infected individuals captured. The expected number of infected individuals for each year was calculated by determining the percent of the total number of mice captured during May, June, and July in 1998 and 1999. This percent was then multiplied by the number of infected mice captured over these months.

RESULTS

During 18,000 trap nights, 1307 individual white-footed mice were examined and toe-clipped. Because of missing data, only 1297 individuals were included in the analyses (1998: n = 1085 and 1999: n = 212). Over 86 % percent of the sites sampled in 1998 contained one or more infected *Peromyscus* sp. compared to 25 % of the sites sampled in 1999. One hundred and twenty-five individuals were parasitized by bot fly larvae (1998: n = 116 and 1999: n = 9), comprising 9.6 % of all mice captured. Only 8 of the 125 parasitized mice (6.4 %) had more than 1 bot fly larvae and all larvae were located in the groin region. Adults comprised 97.6 % of all parasitized individuals (n = 122). The rate of adult parasitism (11.6 %) in 1998, during May, June, and July, was significantly higher than the rate of adult parasitism during the same months in 1999 (5.6 %; $X^2 = 3.85$ d.f. = 1, P = 0.05). The expected number of infected adult mice during these months was 62 individuals in 1998 (observed 69) and 26 individuals in 1999 (observed 9). In 1998, the sex ratio was 51 % males and 49 % females. Of the 113 infested adult mice captured, we expected 59 mice to be male (observed 69) and 57 mice to be female (observed 44). Parasitism rates were higher in males than females in 1998 (X^2 = 4.7 d.f. = 1, P = 0.031). However, no significant differences between the sexes were detected within sample months (Table 1). In 1999, the sex ratio was 53 % male and 46 % female. Of the 9 infected adult mice captures, we expected 5 to be male (observed 4) and 4 to be female (observed 5). No differences in parasitism rates between male and female adult mice were found in 1999 (X^2 = 0.45, d.f. = 1, P = 0.502) so monthly comparisons were not made. The highest rates of parasitism were in October (1998), November (1998) and July (1999; Fig. 1).

DISCUSSION

Previous studies conducted on bot fly parasitism of white-footed mice have reported infestation rates ranging from 0.3 - 73 % (Brown, 1965; Miller and Getz, 1969; Timm and Cook, 1979). The percent of mice parasitized in southern Illinois (11.6 % in 1998 and 5.6 % in 1999) was comparatively low. The reduction in the number of parasitized mice could have been the result of differences in *Peromyscus* sp. abundance, environmental factors, or differences in bot fly larval density. There was a reduction in trap success in 1999 (2.94 %) when compared to 1998 (10.05 %) that could have been the result of the higher infestation levels in 1998. After standardizing total abundance by trap effort, it is evident that more mice were captured in June and July in 1998 when compared to the same months in 1999 (Fig. 2). Wilson (1945) and Wecker (1962) both reported a correlation between high bot fly infestation rates one year and low host population sizes the next year. An alternative explanation is the influence of environmental factors, such as a poor mast crop or better sites in 1998. Although mast production was not measured in our study, Ostfeld et al. (1996) and Wolff (1996) reported annual fluctuations in the abundance of white-footed mice with annual fluctuations in acorn production. These studies suggest that a large acorn crop in fall correlates with high mouse abundance the following summer, while a small crop correlates with low mouse abundance. Schmid (1998) also reported finding a decrease in white-footed mouse abundance during the second year of her study (1997) in upland forests of southern Illinois. The density of bot fly larvae could also affect parasitism rates. For example, if fewer bot fly larvae were present within the study sites, one would expect fewer mice to become parasitized. The same is true if fewer mice existed in the population in 1999 (as suggested above). Dalmat (1943) found bot fly larvae were highly localized, suggesting densities can differ among sites within the same year. Because different sites were sampled each year, I am unsure how “patchy” bot fly larvae distribution is in southern Illinois.

I found a significant difference in parasitism rates between the sexes in 1998, but no difference was detected in 1999. Previous studies on differences in bot fly parasitism between male and female white-footed mice have produced conflicting results. Some studies have found no significant differences in the rate of parasitism between the sexes (Wecker, 1962; Hunter et al., 1972) while others have reported differences in rates of parasitism (Sealander, 1961; Goertz, 1966; Xia and Millar, 1990). The difference detected in 1998 may have been a chance event. Timm and Cook (1979) found evidence to suggest that bot fly larvae do not seek out a particular sex of host, but instead attach itself to the first mouse encountered. This would support the hypothesis that male mice have a higher rate of infestation because male white-footed mice travel more extensively than females, providing a greater opportunity for contact with bot fly eggs (Stickle, 1968). The lack of difference between the sexes in 1999 was likely the result of a small sample size in 1999 (n = 9). However, it could have also been the result of temporal or spatial effects not addressed in this study.

Because this is the first study to report rates of bot fly parasitism of *Peromyscus* sp. in bottomland forests of southern Illinois, it can serve as a baseline for future studies. In addition, because both this study and Schmid (1998) found annual fluctuations in white-footed mouse abundance in two distinct habitat types, additional research is necessary to better understand if bot fly parasitism, or other environmental factors contribute to the annual fluctuations observed in white-footed mouse abundance.

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Table 1. Results of Chi-square analyses calculated by comparing monthly bot fly parasitism rates between the sexes (M = male and F = female). Observed (obs.) and expected (exp.) values were calculated based on male:female sex ratios.

Month	% M	% F	exp. M	exp. F	obs. M	obs F	X^2	P
May-98	56.5	43.5	0.0	0.0	0.0	0.0	*	
June-98	50.0	50.0	8.5	8.5	11.0	6.0	1.47	0.23
July-98	52.3	47.7	27.7	23.5	30.0	23.0	0.40	0.53
Aug-98	61.0	39.0	6.0	4.0	6.0	4.0	*	
Sept-98	62.0	38.0	2.5	1.5	4.0	0.0	2.40	0.12
Oct-98	61.0	39.0	9.8	6.2	12.0	4.0	1.29	0.26
Nov-98	28.0	72.0	2.0	5.0	3.0	4.0	0.70	0.40
Dec-98	36.0	64.0	2.2	3.8	3.0	3.0	0.46	0.50

Figure1. Total abundance and number of white-footed mice parasitized by bot fly larvae in bottomland forests of southern Illinois in 1998 and 1999. No sampling was conducted from February-March 1999. Total abundance values were standardized by monthly trap effort (per 100 trap nights) and are presented under the total abundance (N) in parentheses.