PEST CHIGGER, *EUTROMBICULA ALFREDDUGESI*, INFESTATION OF SMALL MAMMALS IN PIEDMONT HABITATS OF GEORGIA[1] (ACARINA: TROMBICULIDAE)

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ABSTRACT

More than 2600 *Eutrombicula alfreddugesi* larvae were taken from 40 of 596 individual small mammals of 20 species over a 23 month period. Mammals were infested during June, July, and August only, with maximum rate of infestation in June and severity of infestation in July. Male and female *Sigmodon hispidus* had equal rates and severities of infestation during the chigger season. Infrapopulations of *E. alfreddugesi* are positively associated with host body size. Amount of time spent in arboreal activity by mammal species played no role in determining pest chigger infestation.

Key Words: *Eutrombicula alfreddugesi*, pest chigger, parasitic mite, ectoparasite, host-parasite ecology.

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INTRODUCTION

In the southern United States, the pest chigger, *Eutrombicula alfreddugesi* (Oudemans), is widely distributed and medically important (Jenkins 1949; Crossley and Proctor 1971). Infestive larvae of this mite cause dermatitis in man and some animals, resulting in economic losses (Wharton and Fuller 1952). Recreation, forestry operations, and military training may be adversely impacted by dense populations of chiggers (Martinko 1974; Southern Region Agricultural Research Service 1976). In this report, we focus on *E. alfreddugesi* because it is the most common and abundant chigger on the Georgia piedmont. Over 95% of *Eutrombicula* we examined were of this species, making it the only pest chigger of any importance in this region.

The life history of trombiculid mites is complex, with three active stages: parasitic larvae and predaceous deutonymphs and adults (Crossley 1960). Larvae are obligate ectoparasites and individuals are unable to complete the life cycle without engorging on a vertebrate host. Despite the critical nature of this parasitic interaction, little is known of the host relationships of *E. alfreddugesi* in Georiga. We report here on host-parasite relationships of *E. alfreddugesi* larvae and small mammal hosts in piedmont habitats of Georgia. Specifically, we assess the roles that seasonality, host size, host sex, and host activity play in determining *E. alfreddugesi* infestation.

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METHODS AND MATERIALS

Mammals were collected from 80 sites in the piedmont region of Georgia. Sites were selected to encompass a broad range of habitat types, including old fields, hardwood forests and swamps, mixed mesophytic forest, pine plantations, logging slash, and suburban home sites. Mammals were collected by snap traps and live traps, killed if necessary by cervical dislocation or with chloroform, placed in individual sealed plastic bags and stored for 24 to 72 hours under refrigeration. Recovery efficiency was enhanced by this storage process, which allows epidermal tissue to deteriorate and permits easy removal of engorging chiggers. Wrenn (1974) found that several species of trombiculid mites abandon mammal carcasses soon after death of the host. We found quite the opposite with *Eutrombicula*. It was difficult to dislodge the mites, which died in place if not recovered from the carcass within a week or two. After storage, hosts were washed using a modification of the methods of Lipovsky (1951) and Henry and McKeever (1971). Hosts were placed in individual containers on a shaker table and covered with a solution of 1.3% Palmolive® dishwashing detergent in tap water, shaken for 30 minutes, and the liquid poured into a separatory funnel. A few ml of 95% ethanol were sprayed on the detergent solution to break up foam and free mites trapped at the surface. After a 30 minute settling time, two 10-ml samples were drawn from the separatory funnel and examined for parasites. Each individual mammal was washed twice.

Trapping was conducted from March 1980 to January 1982. Each site was sampled at least once during each of winter, spring, summer and fall quarters over the 2-year period. Trap lines consisted of 15 to 30 traps, and between 50 to 200 traps were set at any given time.

Data were pooled by month in all analyses. Comparisons were restricted to hosts taken during months in which *E. alfreddugesi* were recovered from hosts in both trapping years. Size of mammal species was taken as the midpoint of the range of head-body lengths given in Burt and Grossenheider (1976). Adult (full size) animals only were used in the size comparisons. Mammals were classified into size categories and individuals of all species pooled within each category.

Comparison of *E. alfreddugesi* infestation by sex was conducted only for *Sigmodon hispidus* because this was the only mammal species of which a sufficient number (22) of infested individuals was taken.

Since questing *Eutrombicula* larvae are primarily terrestrial in nature, arboreal habitats should offer a "refuge" from infestation. Mammals of each species were placed in one of four categories based on observations of their behavior and on information summarized in Hamilton and Whitaker (1979). Size specific *Eutrombicula* loads were determined by dividing the number of mites recovered by the length (as described above) of the animal. This provides a means of comparison without confounded effects of size.

We anticipated that our data would violate assumptions of parametric statistical analyses, therefore, all hypotheses were tested nonparametrically. Size and activity were tested by Kruskal-Wallis one way analysis of variance by ranks (Zar 1974) and significant differences further analyzed by *a posteriori* multiple comparison (Gibbons 1976). Sex differences were compared by Mann-Whitney two sample test (Zar 1974).

RESULTS

A total of 2624 *E. alfreddugesi* larvae was taken from 40 of 596 mammals examined during the 23 month sampling period (Table 1). Twenty species of mammals were taken, of which 7 (35%) served as hosts for *E. alfreddugesi*. *E. alfreddugesi* were taken from mammals in June, July, and August only, with maximum rate of infestation in June and severity in July (Table 2). Only five mammal species had ten or more individuals trapped during the chigger season. Of these, *Sylvilagus floridanus* and *Sigmoden hispidus* had highest rates and severities of infestation (Table 1).

Of the total of 164 *S. hispidus* examined during the chigger season over 2 years, 70 were male and 94 were female. Infestation rate (15.7% of females, 11.7% of males) was not clearly different between sexes. Severity of infestation (6.9 $\pm$ 2.6 per infested female, 18.1 $\pm$ 11.3 per infested male, $\bar{x}$, and SE in each case) was not significantly different ($\mu = 68.5$, $0.20 < p$).

Size classes, species included and infestation data are summarized in Table 3. Infestation rate increased with host body size, and the largest hosts (body size > 20 cm) were infested at a rate three to five times that of hosts in the smaller size classes. Infestation severity was significantly different among the size classes ($H = 6.016$, $0.01 < p < 0.05$). Multiple comparison suggested that the largest size class was significantly different ($0.05 < p < 0.10$) and that the lower size classes were indistinguishable. Significance is accepted at larger alpha levels in the *a posteriori* test because of increased chance of making Type I errors in the multiple comparison (Gibbons 1976).

Rate of infestation is not clearly related to activity category (Table 4). The greatest difference among categories is less than 15% and is among adjacent categories (1 vs. 2). Highest infestation rates occur at opposite extremes of the activity scale (1 vs. 4). There is an apparent trend in infestation severity for less arboreal mammals to carry increased density of *Eutrombicula* (Table 4). This trend is, however, nonsignificant ($H = 2.715$, $0.25 < p < 0.50$).

DISCUSSION

Eutrombicula alfreddugesi larvae are reported to have an "active season" from April to October over most of the Georgia piedmont (Jenkins 1948). Although mammals are infested during June, July and August only, we have found questing larvae from May through November. The reasons for this lack of correspondence are not entirely clear, but reptiles are infested with *E. alfreddugesi* over a much longer period of the year than are mammals.

Males of many species of mammals range over wider areas than females (Mohr 1961). This led Mohr (1961) to hypothesize that males should encounter and accumulate heavier loads of ectoparasites than females. Worth (1951) demonstrated differential infestation of sexes in *Sigmodon hispidus* by six species of mesostigmatid mites. Worth (1951) did not find a sexual difference in *E. alfreddugesi* infestation. Our data support the null hypothesis that sex of *S. hispidus* plays no role in *E. alfreddugesi* infestation. We suggest that this is due to the relative lack of host specificity in *E. alfreddugesi* and their general abundance in suitable terrestrial habitats. Mites listed by Worth (1951) are rather specialized parasites of mammals and may be associated with runs and feeding areas frequented by potential hosts.

Table 1. Small mammals examined from March 1980 to January 1982 for infestation by *Eutrombicula alfreddugesi*.

Mammal species	Total number examined	Total number examined during June, July and August	Total number infested during June, July and August	Percent infested	Mean (SE) number per infested host
*Blarina carolinensis**	22	14	0	0	0
*Cryptotis parva**	7	0	0	0	0
Didelphis marsupialis	1	1	0	0	0
*Eptesicus fuscus**	7	7	0	0	0
*Lasiurus borealis**	5	5	0	0	0
Microtus pennsylvanicus	8	4	0	0	0
Mus musculus	47	23	4	17.4	4.2 (1.7)
Neotoma floridana	14	7	4	57.1	4.5 (2.8)
Ochrotomys nuttalli	18	2	0	0	0
Peromyscus leucopus	146	47	2	4.3	2.0 (1.0)
Peromyscus polionotus	2	0	0	0	0
Pitymys pinetorum	2	1	0	0	0
Procyon lotor	2	2	1	50.0	18 (n.a.)†
Rattus norvegicus	4	1	0	0	0
Rattus rattus	4	1	0	0	0
Reithrodontomys humilis	1	1	0	0	0
Sciurus carolinensis	6	4	1	25.0	6 (n.a.)†
Sigmodon hispidus	278	164	22	13.4	13.0 (6.0)
Sylvilagus floridanus	15	12	6	50.0	345.3 (251.2)
Tamias striatus	7	4	0	0	0

* Bats and shrews have specific and specialized trombiculid associates and are not included in any further analyses.
† One infested host individual.

Table 2. Infestation of small mammals (excluding bats and shrews) by *Eutrombicula alfreddugesi* in relation to month of chigger season during 1980 and 1981 in the piedmont region of Georgia.

Month	Number of individual mammals examined	Number of individuals infested	Percent individuals infested	Mean (SE) number per infested individual
June	69	17	24.6	10.8 (4.3)
July	109	20	18.4	81.2 (54.0)
August	96	4	4.2	1.5 (0.5)

Spatial distribution of infestive larvae of *E. alfreduggesi* appears to be independent of distribution of mammals or their ranges. Runs, burrows, and nests are no more or less likely to contain infestive larvae than other portions of the range. The low rate of infestation of *S. hispidus* in our samples (Table 1) may reflect a proportion of the animals taken from sites unoccupied by *E. alfreddugesi.*

Eutrombicula alfreddugesi infrapopulations are positively associated with host body size and hosts greater than 20 cm head-body length have significantly greater *E. alfreddugesi* loads (Table 3). Mohr (1961) partitioned host body size effects into two categories: i) "frontage" area by which parasites perceive and mount the host, and ii) surface available for parasite settlement. The second factor should only affect infrapopulations which are approaching density saturations on individual hosts. The low infestation severities which we found for most host species (Table 1) suggest that host saturation does not occur. *Eutrobmicula alfreddugesi* does not appear to have well defined parasitopes on mammals (Loomis 1956) and engorgement sites may be determined more by host removal responses than by parasite preference (Nelson et al. 1975). The alternative hypothesis — that the key parameter is "frontage" of hosts that may be perceived by questing larvae — also fails to explain our results. The potential for perception of hosts by questing larvae is a function both of the area of host "frontage" and the time it is exposed for potential perception. If perception of hosts by larvae is a determinant of infestation, then increasing time spent in arboreal activities should be associated with decreased infestation rate and severity. Arboreal activity has no effect on larval infrapopulations. We conclude that neither available settling area nor perception of hosts are parameters of interest in host size effects, and suggest a third working hypothesis. If engorgement time were increased such that infrapopulation turnover time were increased, infrapopulations would build. We speculate that epidermal structures of large mammals provide a less suitable or less available food supply for *E. alfreddugesi* larvae. Physical attributes of the skin influence the choice of feeding site on the host, and thickness of epithelia and keratinization are of particular importance (Jones 1950; Cross 1964). Perhaps *E. alfreddugesi* engorging on thicker skinned larger mammals must increase engorgement and/or salivation time in order to reach tissue suitable for feeding or to accumulate enough food from more refractory surface layers. Larvae mounting larger hosts at the same rate at which they mount smaller ones would thus build up larger infrapopulations. This hypothesis is speculative, but suggests a working model that would bear investigation. Mammals skins vary greatly in composition and structure (Sokolov 1982) and could well play an important part in pattern and process of trombiculid parasitism.

Table 3. Size of small mammals in relation to *Eutrombicula alfreddugesi* infestation during June, July and August of 1980 and 1981 in the piedmont region of Georgia.

Head-body length category	Small mammal species	Number of individuals examined	Number of individuals infested	Percent of individuals infested	Mean (SE) number of *Eutrombicula* per infested individual
0 - 10 cm	*Mus musculus* *Ochrotomys nuttalli* *Peromyscus leucopus* *Peromyscus pinetorum* *Reithrodontomys humilis*	74	6	8.1	3.5 (1.2)
10 - 20 cm	*Microtus pennsylvanicus* *Rattus rattus* *Sigmodon hispidus* *Tamias striatus*	173	22	12.7	13.3 (6.0)
> 20 cm	*Didelphis marsupialis* *Neotoma floridana* *Procyon lotor* *Rattus norvegicus* *Sigmodon carolinensis* *Sylvilingus floridanus*	27	12	44.4	176.2 (132.4)

Table 4. Arboreal activity of small mammals in relation to *Eutrombicula alfreddugesi* infestation during June, July, and August of 1980 and 1981 in the piedmont region of Georgia.

Host activity category	Species included	Number of individuals examined	Number of individuals infested	Percent of individuals infested	Mean (SE) Number of *Eutrombicula* per cm of infested individuals
I) Nests off ground, forages on and off ground	*Ochrotomys nuttalli* *Procyon lotor* *Sciurus carolinensis*	8	2	25.0	0.28 (0.02)
II) Nests on and off ground	*Didelphis marsupialis* *Neotoma floridana* *Peromyscus leucopus* *Rattus rattus*	58	6	10.3	0.21 (0.09)
III) Nests on or near ground, forages on and off ground	*Mus musculus* *Rattus norvegicus* *Reithrodontomys humilis* *Tamias striatus*	33	4	12.1	0.51 (0.20)
IV) Nests on ground, forages on ground	*Microtus pennsylvanicus* *Pitymys pinetorum* *Sigmodon hispidus* *Sylvilagus floridanus*	181	28	15.5	2.40 (1.37)

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