External Parasites of *Neotoma magister* Baird (Allegheny Woodrat) in the Cumberland Mountains and Plateau, Tennessee

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Abstract - We examined external parasites of *Neotoma magister* (Allegheny Woodrat) from the Royal Blue Wildlife Management Area in the Cumberland Mountains and Big South Fork National River and Recreation Area on the Cumberland Plateau of Tennessee from November 2003 to August 2005. Typically associated with rocky habitats such as clifflines and cave entrances, the Allegheny Woodrat is considered a species of concern in Tennessee. We found external parasites on 26 out of 40 Allegheny Woodrats (prevalence = 65%), including 2 *Epitedia cavernicola* Traub (woodrat fleas—from 2 separate woodrats; prevalence = 5%), 63 *Orchopeas pennsylvanicus* Baker (woodrat fleas—collected on all 26; prevalence = 65%, intensity = 2.4/woodrat), and 5 *Ixodes woodi* Bishopp (Woodrat Ticks—collected from 1 woodrat; prevalence = 2.5%). Our collection represents a state record for Woodrat Ticks in Tennessee. The external parasites collected from Allegheny Woodrats in east Tennessee were considered woodrat-specific parasites and exhibited low species diversity.

Introduction

Neotoma magister Baird (Allegheny Woodrat) is a medium-sized rodent that dens and forages in and around rock habitats such as clifflines, colluvial boulderfields, and cave entrances, and occasionally uses abandoned human structures. Historically, Allegheny Woodrats ranged throughout the Appalachian Mountains (Castleberry et al. 2006). Allegheny Woodrats have been extirpated from New York and Connecticut, and have declined in the northern and western parts of their range (Balcom and Yahner 1996, Castleberry et al. 2006). Allegheny Woodrats appear to be more common in the central and southern parts of their distribution (Castleberry et al. 2006). The Allegheny Woodrat is considered a species deemed in need of management in Tennessee (Tennessee Wildlife Resources Agency 2005). The rank in Tennessee may be due to the general lack of information on population status in the southern extent of the range. The decline of the Allegheny Woodrat has

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been attributed to several factors including parasitism, predation, reduced food availability, and loss of habitat due to land-use change (Castleberry et al. 2006).

Several studies have documented the flea and tick fauna associated with woodrats in the southeastern United States. Most early research was conducted when Allegheny Woodrats were considered a subspecies of *N. floridana* Ord (Eastern Woodrat). Subspecific status was recognized until Hayes (1990) evaluated morphological and genetic characteristics suggesting Allegheny Woodrat should be considered a separate species. However, flea and tick species have been reported from Allegheny Woodrats in Indiana (Cudmore 1986, originally reported as Eastern Woodrat) and West Virginia (Castelberry et al. 2003), and reported from Eastern Woodrats in Georgia (Durden et al. 1997), Mississippi (Clark and Durden 2002), South Carolina (Durden et al. 1997, 1999), and Tennessee (Durden and Kollars 1997). *Orchopeas pennsylvanicus* Baker and *Epitedia cavernicola* Traub have been reported as host-specific fleas of *Neotoma* species in the southeast United States (Castelberry et al. 2003; Durden et al. 1997; Lewis 1974, 1975). However, most ticks reported from *Neotoma* in the Southeast have been considered generalist species (Castleberry et al. 2003; Clark and Durden 2002; Cudmore 1986; Durden et al. 1997, 2000).

Allegheny Woodrats may have a higher degree of flea-host specificity compared to Eastern Woodrats due to their specific habitat requirements involving rocky areas (Castleberry et al. 2003). Allegheny Woodrats also might have less contact with other small mammals, reducing the chance of transmission of generalist parasites. In contrast, Eastern Woodrats build large stick nests, which harbor other rodents that may facilitate transfer of fleas (Castleberry et al. 2003). Fleas often choose specific hosts that build nests (Benton 1980). After a blood meal, fleas lay their eggs on the host, and the eggs eventually fall into the nest. After the eggs mature, the newly emerged fleas can infest the host and offspring in the nest (Benton 1980). This adaptation results in a flea-host specificity.

Our goal was to determine the external parasitic species infesting Allegheny Woodrats in the Cumberland Mountains and Plateau area of eastern Tennessee. This area occurs in the southern end of the range for Allegheny Woodrats. Although the ranges of Allegheny Woodrats and Eastern Woodrats do not overlap, the available habitat used by both species is similar. Therefore, we were also interested in comparing external parasites of Allegheny Woodrats in Tennessee to those of Allegheny Woodrats in more northern areas and to Eastern Woodrats.

Study Areas

We set traps for Allegheny Woodrats in the Royal Blue Wildlife Management Area (RBWMA), located in the Cumberland Mountains and comprised of 20,235 ha in Scott and Campbell counties, TN (36°20'N, 84°17'W) and the Big South Fork National River and Recreation Area (BSFNRRA), located on the Cumberland Plateau along the Tennessee and Kentucky border (36°29'N, 84°41'W). Both sites were located in the Appalachian Highlands Physiographic Division (Fenneman 1916, Parker 2006). We trapped in the Tennessee portion of BSFNRRA within Fentress, Scott, Morgan, and Pickett counties.

Royal Blue WMA is dominated by mixed mesophytic forest, with openings occurring on less than 3% of the landscape (Tennessee Wildlife Resources Agency 2000). The BSFNRRA contains more mixed oak types than RBWMA, though pockets of mixed mesophytic forest are present in BSFNRRA as well (National Park Service 2005). The climate of both sites is humid with mild winters and warm-to-hot summers. We located trapping sites along rock bluffs, boulderfields, and abandoned human structures with current or recent historic woodrat “sign” such as food caches, communal latrines, and middens (Castleberry et al. 2006).

Methods

Trapping procedures

We live-trapped Allegheny Woodrats at 19 sites on RBWMA and BSFNRRA between November 2003 and August 2005. The University of Tennessee Institutional Animal Care and Use Committee approved all trapping and animal procedures (UT-IACUC 1200). We placed Tomahawk live traps (40.6 x 12.7 x 12.7 cm [16 x 5 x 5 in]; TL201 Tomahawk Live Trap, Tomahawk, WI) at 10-m intervals along the base of the rock bluffs and along the perimeter of boulder structures. We also placed traps within abandoned vehicles and buildings and set them at 10-m intervals along the perimeter of the structures. We baited live traps with sliced apples and black oil sunflower seeds. We used cotton or polyester batting as bedding material in all traps.

We trapped each site once during winter (November to March) and summer (April to August). We set approximately 10 to 20 Tomahawk live traps at each site depending on the extent and size of the emergent rock, cliffline, or human structures. We set traps and checked them in the morning for 2 to 3 consecutive days. Most traps were checked between 7:00–10:00 am; however, on occasion, workup of woodrats delayed checking traps until 12:00–1:00 pm.

Parasite collection and identification

We restrained captured woodrats in a cloth bag by scruffing the fur along the neck and administering isoflurane via nose cone inhalation (Parker et al. 2008). While woodrats were immobilized, we collected external parasites using forceps. We combed the fur back, and all visible parasites were collected and stored in labeled vials containing 70% ethanol (Castleberry et al. 2003, Durden et al. 2004). The catch bag and bedding were also checked for parasites. If a woodrat was caught in the trap, then the bedding was replaced before the next trapping session.

We mounted flea specimens on slides using saline mounting solution and identified them using a microscope. We placed larger external parasites, i.e., ticks, in petri dishes and identified them using a dissecting microscope. We followed Benton (1983), Fox (1940), and Keirans and Litwak (1989) for specimen identification. We calculated mean prevalence as percentage of individuals infested and the mean intensity as the mean number of ectoparasites per infested host animal.

Results

All parasites were collected directly from the woodrats or the catch bag. We collected 63 fleas and 5 ticks from 26 out of the 40 Allegheny Woodrats trapped (prevalence of external parasites = 65%) during 1031 trap nights. We deposited voucher specimens with the University of Tennessee Insect Museum. Fourteen woodrats did not have any visible fleas or ticks. Except for 2 female woodrat fleas, all fleas were *O. pennsylvanicus* (18 males, 43 females). We collected the woodrat fleas on 2 December 2003 in BSFNRRA and 8 December 2004 in RBWMA (prevalence = 5 %). We collected the *O. pennsylvanicus* at all sites during both seasons, and intensity was 2.4 fleas/woodrat (prevalence = 65%). We collected all 5 ticks from a single woodrat trapped on 25 November 2003 at BSFNRRA at a steep bluff with many shrubs and pines (prevalence = 2.5%). The ticks were female and nymphal *I. woodi* (2 adult, 3 nymph).

Discussion

Orchopeas pennsylvanicus and *E. cavernicola* are host-specific fleas common to eastern and western woodrat species (e.g., *Neotoma albigula* Hartley [White-throated Woodrat], *Neotoma cinerea* Ord [Bushy-tailed Woodrat], *Neotoma fuscipes* Baird [Dusky-footed Woodrat]; Durden et al. 1997). Our flea collections from Allegheny Woodrats were similar to those documented by Castleberry et al. (2003) in West Virginia, where there was 100% prevalence of *O. pennsylvanicus* in woodrats, whereas only one *E. cavernicola* was documented. Cudmore (1986) also reported *O. pennsylvanicus* (originally reported as *O. sexdentatus*) as the predominant flea and *E. cavernicola* as a common flea infesting Allegheny Woodrats in Indiana; however, he also found 2 other more general fleas on the woodrats. Flea species found on Eastern Woodrats have been considered more wide-ranging in their host preference (Clark and Durden 2002; Durden et al. 1997, 2000).

The one tick we found, *I. woodi,* was considered a host-specific tick of eastern and western woodrats (Durden et al. 1997). However, *I. woodi* also has been reported from other mammalian species and therefore may not be as host-specific as previously assumed (Allan 2001). Durden and Kollars (1992) hypothesized that *I. woodi* could occur in Tennessee, but it had not been previously reported. Reeves et al. (2007) reported *Ixodes* spp. on Allegheny Woodrats in Blount County, TN, but there was no indication of the species. Therefore, this is the first report of *I. woodi* in Tennessee.

Ixodes woodi was collected from Allegheny Woodrats in Indiana (Cudmore 1986), but, the most common tick was *Dermacentor variabilis* Say (American Dog tick). Castleberry et al. (2003) documented one tick species, *Ixodes angustus* Neumann (Squirrel Tick), when collecting parasites from Allegheny Woodrats in West Virginia. Studies of Eastern Woodrats in the Southeast have all shown mostly generalist ticks present (Clark and Durden 2002; Durden et al. 1997, 2000).

Durden et al. (1997) suggested eastern woodrats have had less time to evolve with specific ectoparasites. Woodrats apparently evolved in western North America and have more recently colonized eastern North America. As the woodrats dispersed eastward, some of the ectoparasites may have not adapted to eastern climate. Therefore, eastern woodrats (including Allegheny Woodrat and Eastern Woodrat) may have lower diversity than their western counterparts. Of the 6 species and subspecies of eastern and western, woodrat-specific ectoparasites described by Durden et al. (1997), we found 3 of these in the Allegheny Woodrats of Tennessee.

Eastern Woodrats use a more diverse, wide-ranging habitat than Allegheny Woodrats, which prefer rocky areas (Whitaker and Hamilton 1998). Castleberry et al. (2003) suggested that Allegheny Woodrats might have a higher degree of host-specific fleas compared to Eastern Woodrats due to their requirement for rock bluffs and assumed limited interaction with other mammals. A companion study found high numbers of *Peromyscus* spp. in the same areas of RBWMA and BSFNRRA where we trapped for woodrats (C. Hedio and W.T. Parker, University of Tennessee, Knoxville, TN, unpubl. report). Even with the high numbers of *Peromyscus* spp. in the rocky areas, the fleas found on Allegheny Woodrats were all considered to be specific to woodrats. However, the *Peromyscus* spp. and other trapped species were not checked for parasites.

Interestingly, fleas found on Allegheny Woodrats in West Virginia (Castleberry et al. 2003) and our study showed more host specificity than those in Indiana (Cudmore 1986). Perhaps future work should examine whether the limestone escarpments near the Ohio River where Allegheny Woodrats occur in Indiana (reviewed in Castleberry et al. 2006) have favored ectoparasite diversity. The Indiana site was located in the Interior Plains Physiographic Division (Fenneman 1916). In contrast, the Allegheny Woodrats in West Virginia and Tennessee both occurred in the Appalachian Highlands Physiographic Division of the Appalachian Mountains (Fenneman 1916).

Conclusion

External parasites of Allegheny Woodrats in Tennessee were all considered woodrat-specific. This finding is in contrast to ectoparasites found in Eastern Woodrats, which tend to be generalists that colonize multiple host species (Clark and Durden 2002; Durden et al. 1997, 2000). The diversity we found in Tennessee was similar to Allegheny Woodrats in West Virginia, which also were studied in the Appalachian Highlands Physiographic Division (Castleberry et al. 2003), but was less diverse than that observed by Cudmore (1986) in Indiana in the Interior Plains Physiographic Division. Tennessee has great diversity of ticks (Durden and Kollars 1992) and fleas including several species of boreal fleas specific to the Appalachian Mountain area (Durden and Kollars 1997). Therefore, the lack of diversity in fleas and ticks on the Allegheny Woodrats in Tennessee is noteworthy.

However, we probably did not collect all external parasites with our sampling design. We were not specifically looking for mites. Evaluating mite diversity may enhance our understanding of woodrat host specificity given the high number of species found on Eastern Woodrats (Durden et al. 1997). There seems to be greater ectoparasite diversity in Eastern Woodrats, especially when you consider mites (Durden et al. 1997). Future studies should compare ectoparasites of Eastern and Allegheny Woodrats to the surrounding mammals in the Appalachian Highlands.

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