Comparison of arboreal behaviors in *Peromyscus maniculatus gracilis* and *P. leucopus noveboracensis* in northern Michigan

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Abstract –

For at least one hundred years, the deer mouse *Peromyscus maniculatus* and the white-footed mouse *P. leucopus* have coexisted stably in northern Michigan, despite occupying similar ecological niches. It has been suggested that *P. maniculatus* and *P. leucopus* avoid competition via differences in the nature and extent of arboreal behavior, and previous studies have found *P. maniculatus* to be more readily caught in trees. We investigate arboreal behaviors in the two *Peromyscus* by a trapping survey utilizing ground level and elevated traps, and by tracking the movements of captured and released mice using a line and spool method. Of the one-hundred elevated traps set in our study, none produced mice. No significant differences in arboreality were observed between ground-caught *P. maniculatus* and *P. leucopus* in the line and spool experiment, though use of trees was confirmed for both species.

Michigan is located at a boundary between two ecologically distinct regions. Coniferous forests north of Lake Superior and deciduous forests south of Clare represent different biomes and support substantially different faunas (Kurta, 1995). A gradual transition between these extremes begins at a 'tension zone' which runs roughly from Muskegon to Tawas (Kurta, 1995; Myers et al., 2009). As you travel north from this line, typically-boreal species increase and typically-austral species decrease in relative abundance (Myers et al., 2009).

Two cricetid mice of the genus *Peromyscus* co-occur in forest habitats north of the tension zone. *Peromyscus maniculatus gracilis* is a boreal subspecies of the common deer mouse, and in Michigan occupies a range extending from Missaukee County to the Keweenaw Peninsula (Baker, 1983). The white-footed mouse *Peromyscus leucopus noveboracensis* is historically associated with deciduous forests and forest-edge (Baker, 1983; Kurta, 1995), but has been present in mixed forests of the northern Lower Peninsula for at least 100 years (Myers et al., 2009).

During most of the last century, relative numbers of *maniculatus* and *leucopus* have been stable (Myers et al., 2009). This is surprising because the two species occupy similar ecological niches (Baker, 1983; Barry et al., 1984; Kurta, 1995; Long, 1996; Wolff, 1996). Classical ecological theory predicts that when two species compete for an identical niche, one species – the worse competitor – will be driven to local extinction or will alter its habits to avoid competition.

Peromyscus maniculatus gracilis and *P. l. noveboracensis* may avoid direct competition by differing in the extent to which they utilize trees for nesting and foraging (Barry et al., 1984; Graves et al., 1988). Barry et al. (1984) found that *maniculatus* is more commonly trapped in trees than *leucopus*, and suggested that a smaller average body size and a longer tail may be adaptations in *maniculatus* for arboreal life. Previous studies of arboreality in Michigan *Peromyscus* have been inconclusive (Hejna, 2006).

Based on the literature we hypothesized that, where *P. m. gracilis* and *P. l. noveboracensis* occur sympatrically, the species will utilize trees unequally and *maniculatus* will be more the arboreal. In August 2010, we tested this hypothesis by live trapping on the ground and in trees at a site in northern Michigan where populations of both *Peromyscus* coexist. We also used a spool and line method to track the movement of individual mice to determine if tree-use was comparable between species.

Methods and Materials

P. l. noveboracensis and *P. m. gracilis* were live trapped at Pigeon River Country State Forest east of Wolverine, Michigan. The forest is managed by the Michigan DNR to maintain browsing and grazing habitat for deer and elk, and stands of hardwoods (beach, maple, aspen) and pines are interrupted by clear-cuts.

We trapped on a previously established 400m X 400m grid in a wooded area dominated by mature beach, with a sparse understory of young maple and a regular carpet of leaf litter on the forest floor (45.240° N, 84.477^{o} W). Rows and columns of the grid were spaced 20m apart and grid points were marked with wooden stakes. Two-hundred live traps (large Sherman folding traps) were set along ten columns. In every case except one, non-adjacent columns were used so that the distance between trap lines was 40m. Traps were placed either directly on the ground or on wooden platforms nailed to the trunks of trees at a height of approximately 1.2m. Ground traps and tree traps were alternated within trap lines, and in all 100 of each were set.

Traps were set before sunset on August 8 and collected by 10:00am on August 9. Trapped *Peromyscus* were identified as *P.l. noveboracensis* or *P.m. gracilis* by examination of the ear and tail (*P.l. noveboracensis* has shorter ears and a shorter tail than *P.m. gracilis*, and displays a more abrupt shift from white ventral pelage to brown sides and back). Weight, sex, and reproductive condition were recorded for each animal. Seven mice were chosen to be used in the spool and line experiment (all males, no juveniles , three *leucopus*, three *maniculatus*, and one mouse of indeterminate species). We held the mice for the day, and in the evening prepared the line-and-spool mice. We trimmed fur from an area on the back of each selected mouse and used super glue to attach a spool of cotton thread (200m long).

All mice were released at the locations of capture on the evening of August 9. When a spooled individual was released, we tied the thread to a tree at the release site so that the spool unwound as the mouse escaped. We returned to the trap sites on the morning of August 10 and followed the thread-trails to trace the movements of the mice. We recorded the distance each mouse travelled before it climbed its first tree, as well as the maximum height to which each mouse climbed in any tree.

These data were supplemented with data from an experiment conducted in 2006 at a nearby site containing similar habitat (45.271°N, 84.436°W). The earlier experiment utilized a comparable method, but distance to first tree climbed was not recorded. The combined sample included nine *leucopus* and ten *maniculatus*. Statistical analyses (independent samples t-tests) were performed to compare arboreality between the two species.

Results

We caught twelve *Peromyscus*, four woodland jumping mice (*Napaeozapus insignis*), several shrews (*Blarina brevicauda*, *Sorex cenereus*), and seven chipmunks (*Tamias striatus*). No *Peromyscus* of either species was trapped in a tree. This was a surprising result, as preliminary trials conducted in an area where *leucopus* occurs independently of *maniculatus* yielded a capture rate of 50% in trees (unpublished data). Of the twelve *Peromyscus* caught on the ground, four were identified as *P. l. noveborancensis* (3 male, 1 female), three were identified as *P.m. gracilis* (all male), and five were juvenile animals for which species could not be determined with confidence (all male). The three *leucopus* males were scrotal, while only one *maniculatus* was scrotal. The solitary *leucopus* female showed a slight enlargement of the nipples and may have been pregnant.

Two out of seven spooled mice either lost the spool or broke the thread immediately after release. The five remaining mice each climbed at least one tree within 200m of the release site, and one (a *maniculatus*) climbed four trees. The longest distance travelled before first tree-climbing (127.4m) and the highest climbing (>10m) were achieved by the same *leucopus*, which went directly up a tall aspen and did not return to the ground. There was no difference between species in the average distance to the first tree climbed. *P. l. noveboracensis* climbed higher on average than *P. m. gracilis* (5.1m vs. 4.1m), but this result was not significant (independent samples t-test; $T=0.504$; $df=17$; $p=0.612$).

Discussion

Previous trapping surveys of *Peromyscus leucopus* have reported male-biased samples (Barry and Franq, 1980), but our eleven-to-one result is unusual. We suggest that female mice were less active on the night of our study, or are more wary of traps.

Our study is also remarkable in that no *Peromyscus* were captured in trees. This result is inconsistent with previous trapping surveys (Barry et al., 1984) and with our own preliminary studies (unpublished), which showed considerable utilization of trees by *P. l. noveborancensis*. We are unable to definitely explain the avoidance of elevated traps by both species, but we note that the area trapped was dominated by (and the traps themselves were located on) tall beech trees. If ample food resources exist near the ground, it may not be profitable for mice to expend considerable energy foraging in one towering tree at a time, and mice may not look to trees for food.

All of the mice observed in the spool and line experiment utilized at least one tree. We cannot, however, determine what they did there. Given the intensive handling of the mice required by the spool and line method, it is likely that at least some mice took to trees out of fear. If this is true, we can say that *Peromyscus maniculatus gracilis* and *Peromyscus leucopus noveboracensis* do not differ from each other in the extent to which they utilize trees as refugia. Given the small sample size, however, we do not confidently reject our hypothesis that the two species differ in some aspect (foraging, nesting, or predator avoidance) of arboreality.

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