Ecological Characteristics of Small Mammals at 3 Sites in Southeast Missouri

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Abstract: The small mammal populations at 3 sites in southeast Missouri were sampled during the summer of 1984. A total of 4000 trap nights resulted in the capture of 7 small mammal species. *Peromyscus leucopus, Microtus pinetorum* and *Cryptotis parva* were captured at all 3 sites. *Peromyscus leucopus* was the most abundant species overall. The diversity of small mammals at the 3 sites differed considerably. A principal components analysis revealed significant differences in habitat utilization with respect to canopy cover, shrub cover and ground cover among the 7 species. Reduced body weights and number of reproductively active mice were observed for *P. leucopus* when this species occured together with either *P. maniculatus* or *Ochrotomys nuttalli.*

Key Words: Small mammals, species diversity, habitat utilization, southeast Missouri

Introduction

The small mammal communities of southeast Missouri are of significant interest for several reasons. First, this portion of the state is composed of many different habitat types. Portions of the area are upland deciduous forests of the Ozark region while other portions are agricultural and oldfield habitats. A diversity of macro- and microhabitats are available for these small mammal communities.

Annual flooding in the lowland portions of southeast Missouri provides a unique opportunity to conduct "natural" experiments on faunal build up and community structure. Communities existing in flooded areas are subjected to severe perturbations every year and probably never reach a condition which even remotely resembles an equilibrium state. Information on temporal changes in these communities, habitat selection patterns and small mammal dispersal and invasions would provide a good foundation for long-term "natural" experiments on dynamic community structure.

In this study habitat utilization and abundance patterns of small mammals at 3 sites in southeast Missouri were determined. Ecological attributes of *P. leucopus* and *P. maniculatus* were characterized. This information will provide a foundation for future studies designed to explore small mammal community dynamics in southeast Missouri.

Methods

Three study sites were chosen in southeast Missouri including both upland and lowland habitats. The upland study site was located within the Holly Ridge Natural Area (northeast of Dexter, off Highway 25, Stoddard County) while the lowland sites were located at the Allred Lake Natural Area (24 km south of Poplar Bluff, and 9.7 km southeast of Neelyville, Butler County) and the Sand

Ponds Natural Area (6.4 km south of Naylor on Highway W and 0.8 km east on county road A, Ripley County). The general habitat characteristics of the 3 study sites differ considerably. Holly Ridge is composed of an upland deciduous forest, while Allred Lake and Sand Ponds are lowland areas subject to annual flooding. Also, Allred Lake is composed of deciduous forest and Bald Cypress swamp surrounded by an oldfield habitat and cultivated bean fields. The Sand Ponds site has considerable oldfield acreage with patches of deciduous forest containing "sand ponds."

Within each study site 3 areas were chosen at random for intensive study. These areas reflected the diversity of microhabitats present within each study site. Each trap line configuration consisted of 2 intersecting (45°) 40-station trap lines. For area "A" at the Holly Ridge site there were 15 m between trap stations, while at all other areas there were 10 m between trap stations. A single Sherman live-trap was placed at each trap station for 4 consecutive nights, and checked each morning and evening. Following the 4 nights of live-trapping, Museum Special and Victor mouse traps were used on 2 of the trapping configurations at Holly Ridge and Allred Lake, and on all 3 trapping configurations at Sand Ponds. Snap-trapping was conducted for 2 nights at each area. A total of 1280 trap nights were run at the Holly Ridge and Allred Lake study sites and 1440 trap nights were run at the Sand Ponds study site. Also, within each study site a complex of intersecting 30-m drift fences and 20-liter pit-fall traps (2 per fence) were installed and were operated for 7 consecutive days at each study site.

Each animal captured during the live-trapping phase was identified to species, weighed, sexed and toe clipped with a unique number. *Peromyscus leucopus* and *P. maniculatus* were distinguished on the basis of tail characteristics. The tails of mice classified as *P. maniculatus* were approximately ⅓ of the total animal length and were strongly bicolored, while *P. leucopus* tails were approximately equal to ½ of the total length and were only weakly bicolored (Schwartz and Schwartz 1981). The trap station at which each animal was captured was noted and the animal released at the point of capture. Animals captured during the snap-trapping sessions were identified, weighed and sexed.

The species diversity of each study site was estimated using the Shannon-Weaver diversity index (May 1976). Differences in body weights between the 3 *P. leucopus* populations and the *P. maniculatus* population were assessed using a 1-way ANOVA, followed by Tukey's Studentized Range Test (Neter and Wasserman 1974) to determine which populations differed significantly from one another.

The vegetation at each area within each study site was characterized by performing a 10-m plant transect at each trap station. Plant cover was estimated at 4 levels above the ground: 0-0.5 m (surface cover), >0.5-1.0 m (herbaceous cover), >1.0-2.0 m (shrub cover) and >2.0 m (canopy cover). Separate cover values were recorded for each 1-m segment of each plant transect. Coefficients of variation for plant cover at each of the first 3 levels above the ground were also computed. Thus, for each trap station, the average cover and variability of cover at various levels above the ground were computed.

Habitat selection by the small mammals was evaluated with the aid of a principal components analysis (Morrison 1976). The factor scores for each species were compared with those of all trap stations combined. Thus, in the absence of habitat selection along a specific principal component, the mean factor score for a species will not differ significantly from 0. Using this methodology, it is possible to discern habitat use characteristics for species with sufficient numbers of captures. A canonical discriminant function analysis was performed on the vegetation data for those trap stations actually used by the small mammals. This analysis produced linear combinations of the vegetation variables which summarized between-species variation, thus permitting an evaluation of species differences with respect to the vegetation variables. Each linear combination of habitat variables was chosen to maximize the multiple correlation with the species, thus producing a canonical correlation. This procedure was repeated until the canonical correlations were no longer significant at the 0.05 level. All multivariate statistics were computed using SAS (Ray and Sall 1982).

Results

Three species of small mammals were captured at all 3 study sites: *P. leucopus, M. pinetorum* and *C. parva. Ochrotomys nuttalli* was captured only at the Holly Ridge study site while *Blarina brevicauda* was captured at Holly Ridge and Allred Lake. Both *P. maniculatus* and *Reithrodontomys megalotis* were unique to the Sand Ponds study site. The greatest abundance of *P. leucopus* was found at Allred Lake with 19 captures while Sand Ponds yielded only 15 captures. *Peromyscus maniculatus* was found only at Sand Ponds. All other species were considerably less abundant (Table 1). The Sand Ponds study site

Table 1. Capture summary for 7 species of small mammals at 3 sites in southeast Missouri.

Species	Holly Ridge	Allred Lake	Sand Ponds[a]
Peromyscus leucopus	15	19	14
Peromyscus maniculatus	0	0	20
Ochrotomys nuttalli	2	0	0
Reithrodontomys megalotis	0	0	2
Microtus pinetorum	5	3	1
Blarina brevicauda	1	1	0
Cryptotis parva	1	2	4

[a]Denotes the use of 480 trap nights rather than 320.

supported the most diverse small mammal community (H = 1.186). Holly Ridge had a species diversity value of H = 1.092, while Allred Lake had a value of H = 0.794.

In the habitat utilization analysis, the first principal component was composed of cover at 2 m above the ground and variability of cover within the intervals 0.5-1.0 m and >1.0-2.0 m (Table 2). This component accounted for 28.8% of the variance within the data set. Principal component 2 was

Table 2. Principal components for the vegetation data across all trap stations at the 3 study sites.

Variable	PC 1	PC 2	PC 3	PC 4
Surface cover	0.044	0.619	0.161	-0.042
Herbaceous cover	0.301	0.550	0.171	-0.022
Shrub cover	0.265	0.243	-0.690	0.600
Canopy cover	0.490	-0.358	-0.099	0.131
Surface patchiness	0.323	0.311	0.470	0.615
Herbaceous patchiness	0.480	0.144	0.375	-0.077
Shrub patchiness	0.512	-0.098	-0.312	-0.485
Variance	0.288	0.258	0.133	0.114
Cumulative variance	0.288	0.546	0.680	0.794

dominated by plant cover between 0 and 1 m and explained 25.8% of the total variance. The third principal component loaded most heavily on plant cover between 1.0 and 2.0 m, while the fourth component was also dominated by this variable as well as the variability of surface cover. The third and fourth principal components explained 13.3 and 11.4% of the total variance, respectively.

The distributions of the principal component scores for each small mammal species were used as indices of habitat selection and are shown in Fig. 1. The principal component scores for the overall distribution are standardized about 0, thus species distributions which show deviation from 0 are indicative of habitat selection. Along the first principal component, the distributions for *P. leucopus* and *O. nuttalli* are primarily or entirely within the positive region of the component. Since the first component is a "forest canopy" and "understory patchiness" variable, *P. leucopus* and *O. nuttalli* selected microhabitats with extensive canopy cover and patchy or variable understory. *Peromyscus maniculatus* and *C. parva* occupied the negative portions of this component and thus selected habitats with less canopy cover and more homogeneous understory vegetation.

The second principal component consisted primarily of vegetation cover between 0 and 1 m or "surface and herbaceous cover." *Peromyscus maniculatus* showed a distinct trend toward areas with less extensive cover while *M. pinetorum* and *C. parva* showed strong associations with areas with extensive cover. The single capture for *B. brevicauda* also occurred in such an area.

Principal component 3 had a strong negative factor loading for vegetation cover between 1.0 and 2.0 m, or shrub cover. *Peromyscus maniculatus* and *O. nuttalli* occurred in areas with greater shrub cover, while *C. parva* occurred in areas with less shrub cover.

The fourth principal component consisted of shrub cover and variability of surface cover between 0 and 0.5 m. No strong trends are apparent for the 7 species along this axis. However, there is some tendency for *P. maniculatus* to occupy habitats with more shrub cover and less variable surface cover.

The results of the canonical discriminant analysis on the trap station vegetation actually utilized by the 7 species of small mammals are presented in

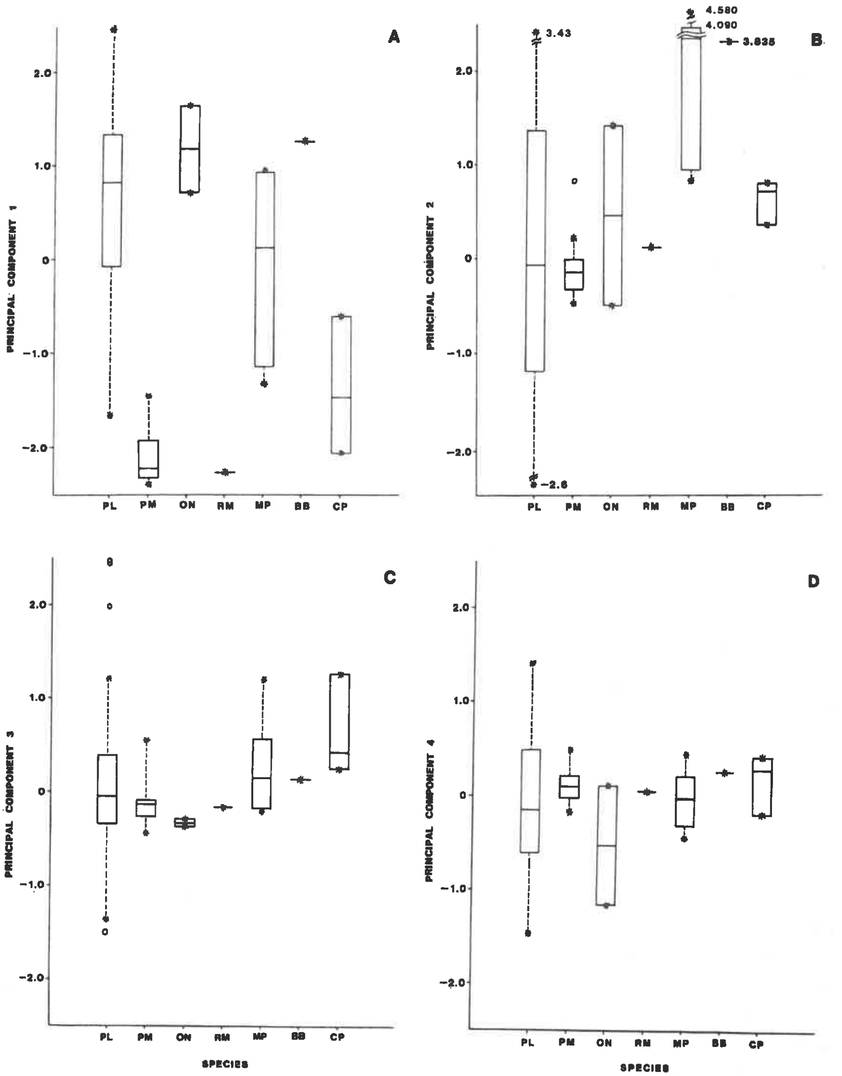

Fig. 1A-D. Nonparametric schematic plots (Tukey 1977) of principal axis factor scores. The principal components analysis was performed on the vegetation data for all trap stations at all 9 study areas. Coefficients for the factors are given in Table 2. The 3 horizontal lines in each box represent the third quartile, median and first quartile, respectively. The asterisks represent pseudo-standard deviations. PL = *Peromyscus leucopus*, PM = *Peromyscus maniculatus*, ON = *Ochrotomys nuttalli*, RM = *Reithrodontomys megalotis*, MP = *Microtus pinetorum*, BB = *Blarina brevicauda* and CP = *Cryptotis parva*.

Table 3. Because of the small sample sizes, these results must be interpreted with caution. As in the analysis of all trap station vegetation, the first canonical discriminant function is dominated by a positive coefficient for canopy cover. The second and third functions are influenced most strongly by herbaceous cover >0.5-1.0 m and variability of herbaceous cover between >0.5-1.0 m, respectively. Both of these coefficients are positive. The remaining canonical discriminant functions were not significant.

Table 3. Standardized canonical discriminant function coefficients for the vegetation data for trap stations at which the 7 species of small mammals were captured. The classification variable was species.

Variable	CDF1	CDF2	CDF3	CDF4	CDF5	CDF6
$\bar{X}$: 0.0-0.5 m	0.391	-0.005	0.541	-0.455	-0.408	1.015
$\bar{X}$: >0.5-1.0 m	-0.061	1.212	-0.512	0.251	-0.103	-0.739
$\bar{X}$: >1.0-2.0 m	0.283	-0.109	-0.283	0.029	0.807	0.623
$\bar{X}$: >2.0 m	1.152	-0.585	-0.438	-0.624	0.132	0.319
CV: 0.0-0.5 m	-0.043	0.150	0.264	1.059	-0.132	0.446
CV:>0.5-1.0 m	0.356	-0.036	0.879	-0.103	0.442	-0.543
CV:>1.0-2.0 m	0.698	0.045	0.029	0.149	-0.821	-0.394
R^2	0.739	0.388	0.059	0.025	0.008	0.002
F	3.912	1.466	0.341	0.208	0.116	0.055
P	0.0001	0.061	0.997	0.998	0.994	0.947

The plots of the first 3 canonical discriminant functions are given in Fig. 2. The distinct separation along the first 2 canonical discriminant functions is clear. *Peromyscus leucopus* and *O. nuttalli* and to a lesser extent *B. brevicauda* occupied areas with extensive canopy cover while *M. pinetorum* was intermediate and *C. parva*, *R. megalotis* and *P. maniculatus* were in low canopy cover areas. On the second function, *B. brevicauda* and *M. pinetorum* occurred in areas with extensive surface cover, while the remaining species were in areas with intermediate values for surface cover >0.5-1.0 m. Along the third canonical discriminant function *C. parva* occupied areas which exhibited considerable herbaceous cover variability, while *B. brevicauda* habitats were much less variable. The remaining species were intermediate.

Body weights for the small mammal species are presented in Table 4. The results of the ANOVA indicate significant differences ($F = 21.51$, df = 3,60, $p < 0.0001$) between the body weights of the 3 *P. leucopus* populations and the *P. maniculatus* population. A Tukey multiple range test showed that the mean body weights of *P. leucopus* at Holly Ridge were not significantly different from those at the Sand Ponds site and both of these populations had body weights which were significantly smaller than those of the *P. leucopus* at Allred Lake. Also, all *P. leucopus* mean body weights were significantly larger than those of *P. maniculatus*.

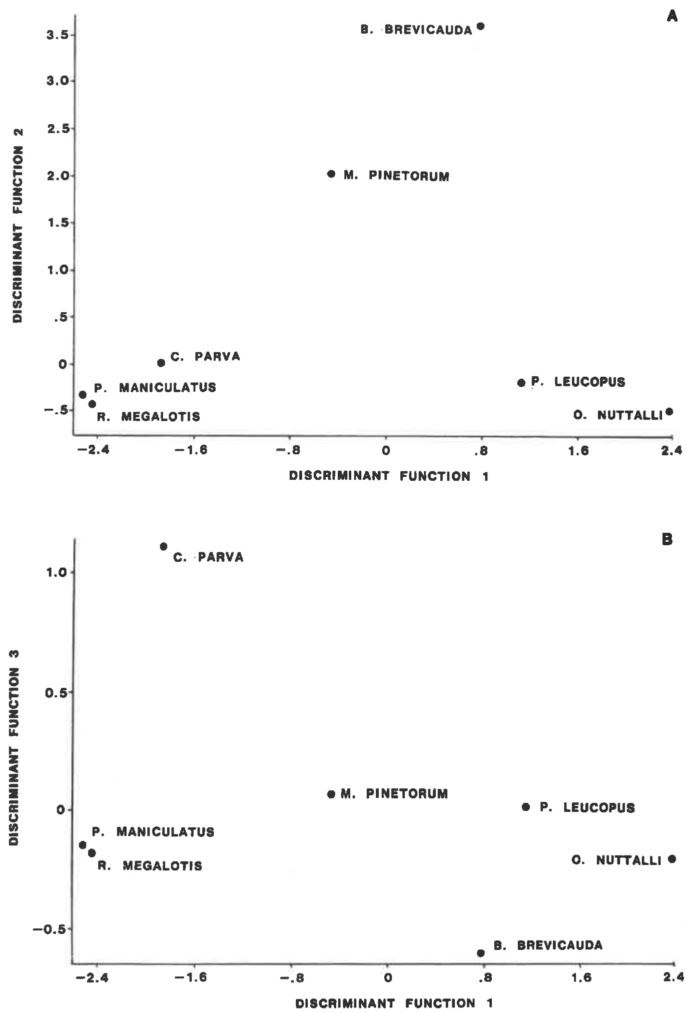

Fig. 2A-B. Plots of the 7 species in the space defined by the first 3 canonical discriminant functions for vegetation at those trap stations actually utilized by the small mammals. Coefficients for the discriminant functions are given in Table 3.

Table 4. Sample sizes, mean body weights and standard deviation of body weights for *P. leucopus* and *P. maniculatus*.

	P. leucopus			P. maniculatus		
Parameter	M[a]	F	Total	M	F	Total
Holly Ridge						
N	8	7	15	–	–	–
$\bar{X}$	19.81	18.00	18.97	–	–	–
sd	2.42	4.79	3.69	–	–	–
Allred Lake						
N	11	8	19	–	–	–
$\bar{X}$	25.18	24.00	24.68	–	–	–
sd	6.69	2.93	5.34	–	–	–
Sand Ponds						
N	9	3	12	11	7	18
$\bar{X}$	20.67	16.33	19.58	14.18	14.50	14.31
sd	2.74	2.08	3.18	2.44	3.01	2.66

[a]Male = M, female = F, sample size = N, mean = $\bar{X}$ and standard deviation = sd.

In addition to the differences in body weight for *P. leucopus* noted above, dramatic differences existed in terms of the number of reproductive adult *P. leucopus* at each site. At Holly Ridge, 14.3% of the females and none of the males were reproductively active as determined by palpitation, the presence of perforate vaginas or lactation for the females and scrotal testes for the males. At Sand Ponds, there were no reproductively active females and 11.1% of the males were reproductive. However, at Allred Lake, 62.5% of the females and 76.9% of the males were reproductive.

Discussion

Considerable separation occurred between *P. leucopus* and *P. maniculatus* along the first principal component. *Peromyscus leucopus* occurred in areas with significantly greater canopy cover than *P. maniculatus*. This suggests that *P. leucopus* occurs primarily in deciduous forest while *P. maniculatus* occurs in oldfield situations or open areas. Fleharty and Navo (1983) found that *P. maniculatus* and *R. megalotis* were resident species in irrigated cornfields in Kansas, while *P. leucopus* was transient. Also, Kirkland and Griffin (1974) found a significant negative correlation between "wet" trap sites and the abundance of *P. maniculatus*. Since the deciduous forest habitat at the Sand Ponds site is subjected to annual flooding, *P. maniculatus* may be responding to this feature of the habitat. Parren and Capen (1985) found that *P. maniculatus* utilized microhabitats which were relatively open while *P. leucopus* utilized more thickly vegetated microhabitats. These results are consistent with the findings of this study.

The habitat characteristics of *O. nuttalli* appear to be similar to those of *P. leucopus* (Figs. 1 and 2). However, Seagle (1985) found coexisting *O. nuttalli* and *P. leucopus* in a cedar glade habitat to utilize significantly different microhabitats. Specifically, *P. leucopus* was associated with non-shrubby wooded microhabitats, while *O. nuttalli* was associated with edge microhabitats. Seagle (1985) did not find these 2 species coexisting in a deciduous forest habitat.

Most of the *M. pinetorum* were captured at the Holly Ridge study site, an upland habitat. Similar results were obtained by Miller and Getz (1969). They trapped both *P. leucopus* and *M. pinetorum* in upland oak forests and lowland swamps and found that only a small percentage of their captures for *Microtus* occurred in lowland swamp habitats.

The second shrew observed in this study, *C. parva*, was most similar in its habitat utilization to *P. maniculatus* and *R. megalotis* and most distinct from *P. leucopus* and *O. nuttalli* (Figs. 1 and 2). In general, it occupied habitats with reduced canopy cover, considerable surface cover and minimal understory vegetation. Golley (1962) found the least shrew to prefer grasslands even when woodlands were available. Likewise, Porter and Dueser (1982) found that *C. parva* utilized habitats with reduced shrub cover and extensive herbaceous cover. At the same time, *P. leucopus* occupied areas with a greater shrub cover and less herbaceous cover than *Cryptotis*. These results are consistent with those found in my study.

Aside from the habitat utilization data, there is some circumstantial evidence which may indicate a competitive shift between *P. leucopus* and *P. maniculatus*. The lowest mean body weights for *P. leucopus* (19.583 g, 18.967 g) occurred at Sand Ponds and Holly Ridge, respectively. These sites also had species diversity values (H = 1.182, H = 1.092) which were considerably greater than the species diversity value of the Allred Lake site (H = 0.794). Thus, low body weights for *P. leucopus* corresponded to high species diversity. This result is consistent with the predictions of the competition hypothesis (May 1976, Pianka 1974). Although other factors such as habitat productivity may be responsible for the shifts in body weight, it is interesting to note that at both the Holly Ridge and Sand Ponds study sites closely related species with similar dietary patterns coexist with *P. leucopus*. *Ochrotomys nuttalli* coexists with *P. leucopus* at Holly Ridge while *P. maniculatus* coexists with *P. leucopus* at Sand Ponds. Furthermore, the body weights of *P. maniculatus* were considerably smaller than the mean body weights reported in the literature (Myers and Master 1983, Drickamer and Bernstein 1972, Dunmire 1960) again suggestive of a competitive shift.

The differences in body weights do not appear to result from reproductive conditions of the female mice, since at all 3 sites, weights of the males reflected those of the females (Table 4). At the site with low species diversity (reduced diffuse competition) body weights were high and most of the mice were reproductively active, while at the high diversity sites (greater diffuse competition) body weights were reduced and reproduction was minimal. However, these results are consistent with the hypothesis that the Allred Lake study site was a more productive or better habitat for *P. leucopus*.

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