

SEXUAL DIFFERENCES IN THE
HOME RANGES OF *PEROMYSCUS TRUEI*
AND *DIPODOMYS PANAMINTINUS* (RODENTIA)

JOHN S. SCHEIBE

ABSTRACT.—Home ranges of *Peromyscus truei* and *Dipodomys panamintinus* were investigated using circular and principal component estimation techniques. During the fall, winter and spring months male *P. truei* maintained home ranges which were significantly larger than those of the females. The home range sizes of both sexes increased significantly during the summer. This increase was noted for both adults and juveniles. Male *D. panamintinus* had annual home ranges which did not differ significantly in size from those of female *D. panamintinus*. Habitat differences existed between the home ranges of male and female *D. panamintinus* but not between those of *P. truei*.

The home range size of a species is influenced by compressive forces including predation risks and the energetic costs of movement, as well as expansive forces such as the need for resources (Murai et al., 1979). Factors such as population density have been related to home range size empirically (van Vleck, 1969; Maza et al., 1973; O'Farrell et al., 1975) and theoretically (Cooper, 1978a; Murai et al., 1979) while vegetation, habitat structure (Stinson, 1977) and the onset of reproduction (Hawes, 1977) probably also influence home range size. A knowledge of the spatial and temporal variation in home range size in conjunction with the selective forces affecting the home range should enable a more precise determination of the interactions occurring between an individual and its habitat, conspecifics and coexisting species.

METHODS.—The nocturnal rodent community of a Pinyon Woodland habitat in the Tehachapi Mountains of California was sampled on a monthly basis from August 1975 to August 1976 and during October 1976. The precise location of the study site and a description of the vegetation can be found in Scheibe (1984).

The rodents were live-trapped on a 12 by 12 station grid with 15 m trap spacing, and on eight assessment lines which bisected the grid following the methods of O'Farrell et al. (1977). Traps were baited with a mixture of wild bird seed and crushed apples and were supplied with cotton during the winter and spring months to reduce cold weather mortality. Grid traps were operated for three nights each month and were checked at two hour intervals throughout the night. Following the grid trapping session, traps were operated on the assessment lines for three nights and were checked each morning and evening.

Home range areas were estimated using both circular (Calhoun and Casby, 1958) and principal component methods (Jenrich and Turner, 1969). Both of these techniques provide 95 percent confidence configurations. The principal component technique does this by considering trap locations as points in two dimensional space. A factor analysis is then performed to obtain linear combinations of the two original dimensions that explain the greatest amount of variance. These two linear combinations are then treated as the major and minor axis of our ellipse. The size of the ellipse, or home range, is adjusted to include 95 percent of the capture points for each rodent. Home ranges were computed only for those animals captured three or more times at two or more trap stations. In the study, home range estimates which proved to be outliers (Tukey, 1977) were removed from the analysis.

The number of estimated home ranges for *P. truei* enabled an analysis by sex, season and age. Home range values for *D. panamintinus* are based on pooled estimates. Nonparametric schematic plots (Tukey, 1977) were used to evaluate normality and to present the data in a graphic fashion. A one-way ANOVA was used to assess seasonal home range size differences for *P. truei*. The two sided test was employed to examine differences between male and female, and adult versus juvenile home ranges of *P. truei*, as well as male and female home ranges of *D. panamintinus*. Whenever possible, statistical tests were performed on home ranges determined via principal components, although both determinations are presented for comparative purposes. The effect of sample size on the estimated home range areas was assessed with product moment correlations.

The habitat at each trap station was characterized by 9 m plant transects in each of the four cardinal directions. An importance value for each plant species at each trap station was calculated as the sum of the relative density, relative frequency and relative cover for that species. The importance values were used as predictor variables in stepwise multiple regression models. Sex and trap session (grid or assessment lines) were incorporated in the model as indicator random variables (Neter and Wasserman, 1974) in an effort to assess possible sex and trapping intensity effects. The dependent variable was the number of *P. truei* or *D. panamintinus* captures at that trap station. Only rodents which were captured three or more times at two or more trap stations were considered.

Information concerning rodent behavior within the home ranges was provided by a multiple regression of individual monthly persistence rates on sex and initial month of capture. The monthly persistence rate is composed of both survival rate and a measure of philopatry. The initial month of capture for each individual was used to adjust for the finite nature of the study and consequently, the biased persistence rate estimates for the animals first captured late in the study.

RESULTS.—Correlations between the number of captures and the size of the home range estimate (circular and principal component) were performed. None of the correlations were significant indicating the robust nature of these home range estimates with respect to the sample sizes utilized.

Seasonal estimates of the principal component home ranges of male and female *P. truei* are presented graphically in Fig. 1. The corresponding circular estimates are presented in Table 1 for the species as a whole, as well as on an age class basis. The home range estimates for males and females are presented in Table 2.

The annual male home range size of 0.48 ha (principal component computation) was significantly larger than the estimate of 0.28 ha for females ($p < .05$). Fig. 1 shows that this difference occurs primarily during the fall, winter and spring months. Overall shifts in home range size are not obvious during these seasons. However, summer home ranges are significantly larger than nonsummer home ranges (one-way ANOVA, $p < .001$, $df = 3,63$, $F = 12.56$, Fischer's least significant difference test). The increase in summer home range size results partially from the large home ranges of juveniles. The mean juvenile circular home range size of 1.12 ha was significantly larger than the mean summer home range size of adults ($p < .05$). A similar but less dramatic trend was exhibited by the principal component home ranges.

On an annual basis, the mean circular home range of *P. truei* was 0.45 ha. However, when the criteria of temporal and spatial home range stability of Cooper (1978b) were employed, or when the concept of extreme outliers (Tukey, 1977) was used, one large home range (6.37 ha) was removable. The recalculated mean home range area was 0.36 ha. The annual principal

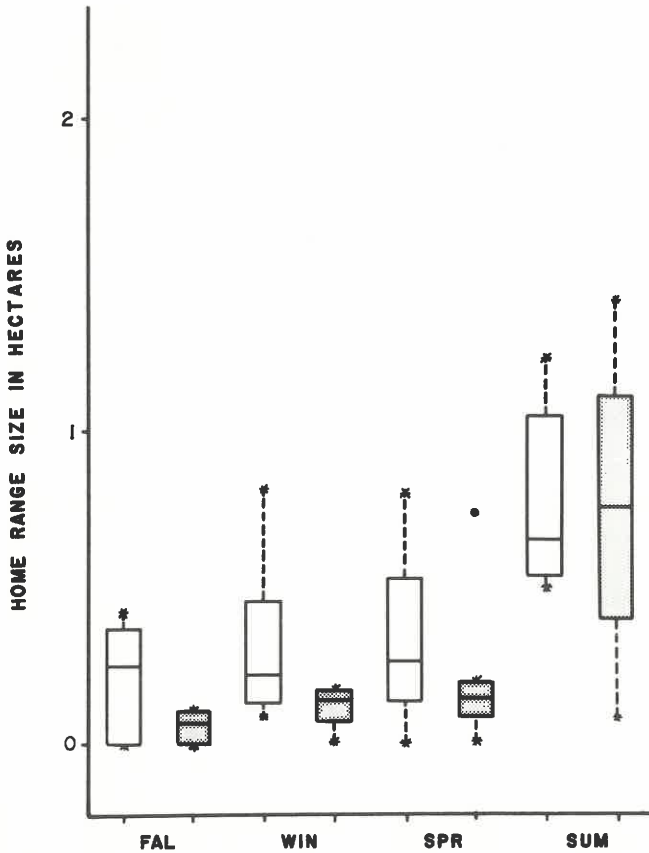


FIG. 1.—Nonparametric schematic plots of the seasonal principal component home range data of *Peromyscus truei*. The open boxes represent males, the stippled boxes females. The upper, middle and lower horizontal lines in each box represent the upper quartile, median and lower quartile respectively. The asterisks indicate the extent of the tails of each distribution. Extreme outliers are represented by closed circles.

component home range estimate for *P. truei* was 0.38 ha. The median home range size of both estimates was smaller than the mean (0.29 ha and 0.19 ha respectively). To a large extent, this skew in the distribution resulted from the presence of large summer home ranges.

The mean circular and principal component home ranges of *D. panamintinus* (0.96 ha and 1.44 ha respectively) were the largest observed during the study. The standard deviation of home range size was also large indicating considerable variation among individuals. This variation appears to be the result of a large disparity in some female home ranges. The mean circular home range size for females was 1.28 ha (Table 2) whereas the median was 0.90 ha. One female maintained a disproportionately large home range. If this home range is not considered, the mean becomes 0.61 ha, the median 0.54 ha, and the standard deviation is reduced by 57 percent. The male

TABLE 1.—Home range estimates (in hectares) for *P. truei* by season and age. Circular home range = CIRC, principal component home range = PRIN, n = sample size, \bar{X} = mean and sd = standard deviation.

		CIRC	PRIN
FALL	n	19	9
	\bar{X}	0.50	0.19
	sd	1.43	0.14
WINTER	n	21	13
	\bar{X}	0.25	0.23
	sd	0.29	0.22
SPRING	n	15	7
	\bar{X}	0.27	0.34
	sd	0.26	0.30
SUMMER	n	13	10
	\bar{X}	0.91	0.76
	sd	0.66	0.39
SUMMER ADULTS	n	6	3
	\bar{X}	0.65	0.65
	sd	0.80	0.50
SUMMER JUVENILES	n	7	7
	\bar{X}	1.12	0.81
	sd	0.45	0.36

circular home ranges (0.48 ha) were smaller than those of the females, although the difference was not significant when the largest female home range was removed. The removal of the largest female home range from the principal component computations resulted in a mean female home range size which was almost identical (0.87 ha) to that of the males.

The stepwise multiple regression analysis revealed significant differences between the home range habitat characteristics of male and female *D. panamintinus*, but not between the sexes of *P. truei*. Pinyon mice were positively associated with *Yucca brevifolia* and *Fremontodendron californicum* while kangaroo rats were negatively associated with *Pinus monophylla*,

TABLE 2.—Home range parameters for male and female *P. truei* (PT) and *D. panamintinus* (DP).

		CIRC	PRIN
PT MALES	n	35	19
	\bar{X}	0.59	0.48
	sd	1.11	0.32
PT FEMALES	n	33	20
	\bar{X}	0.29	0.28
	sd	0.41	0.36
DP MALES	n	6	2
	\bar{X}	0.48	0.88
	sd	0.49	0.55
DP FEMALES	n	9	4
	\bar{X}	1.28	1.72
	sd	1.85	1.74

TABLE 3.—Stepwise multiple regression models for botanical habitat characteristics of the rodent home ranges. Session (grid = 1, assessment lines = 0) and sex (male = 1, female = 0) were entered as indicator random variables. INT = intercept, PIN = Pinus monophyla, HAP = Haplopappus cooperi, ERI = Eriogonum fasciculatum, FLA = Fremontodendron californicum and YUC = Yucca brevifolia.

PARAMETER	<i>P. truei</i>	<i>D. panamintinus</i>
INT	1.483**	2.589**
SEX		1.293*
SESSION	0.768**	
PIN		-0.013*
HAP		-0.049**
ERI		-0.015**
FLA	0.013*	
YUC	0.078**	

Haplopappus cooperi and *Eriogonum fasciculatum*. Both regression models were highly significant ($p < .01$).

Female *P. truei* had significantly higher monthly persistence rates than their male counterparts (Table 4). A female captured during the first month of the study persisted an average of 1.51 additional months, while a male persisted only 1.28 months. No significant difference was found for *D. panamintinus*. Female kangaroo rats captured in the first month persisted an additional 2.52 months while males persisted on the study site 2.63 months.

DISCUSSION.—The home ranges of male *P. truei* were larger than those of the females during the fall, winter and spring months. Also, no significant differences were found between the microhabitats of male and female home ranges. The high energetic cost of female reproduction (Millar, 1978) should result in female home ranges which are larger or of higher quality than the corresponding male home ranges. The fact that this was not the case suggests that male home range size was influenced by factors other than just dietary requirements. Such a factor could be the travels of males over large areas in search of mates. This hypothesis is supported by the shorter persistence times of male *P. truei* relative to the females. Animals which travel over larger areas would be expected to move off the study site more frequently and would be exposed to greater predation pressures.

During the summer, both male and female home ranges increased in size. This increase corresponded to a large number of juvenile mice entering the population. The home ranges of juveniles were significantly larger than those of the adults. The introduction of juveniles into the population in

TABLE 4.—Multiple regression models for male-female "survival" rates. Sex was entered as an indicator random variable (male = 1, female = 0). FMO = first month of capture, ** = significance at .01 level, * = significance at .05 level.

SPECIES	INT	FMO	SEX
<i>P. truei</i>	1.541**	-0.034	-0.232*
<i>D. panamintinus</i>	2.703**	-0.185	0.115

conjunction with increased energy demands by lactating females may be sufficient to limit resources and require individuals to maintain larger home ranges. However, insects and annuals were abundant during the spring and summer. Also, overall nocturnal activity was at a low level for both sexes indicating a reduction in the amount of necessary foraging time (Scheibe, 1984). Information on resource abundance and resource requirements is necessary to establish the validity of the limiting resource hypothesis. The most plausible explanation for the summer increase in home range size appears to be exploratory behavior by juveniles and perhaps adults.

Dipodomys panamintinus was captured in predominantly open portions of the Pinyon Woodland and in the adjacent grassland and Joshua Tree Woodland. These areas supported an abundance of annuals and perennial shrubs which provided the kangaroo rats with the seeds necessary for their granivorous diet. In light of the foraging behavior and mode of locomotion for *Dipodomys* the relatively large home ranges of this species are not surprising.

In contrast with *P. truei*, female *D. panamintinus* maintained home ranges which were as large or larger than the corresponding male home ranges. Although no differences were detectable in the persistence rates of the two sexes, females occupied home ranges which had significantly fewer pinyon pines than those of the males. Qualitatively, areas with greater pinyon pine cover supported fewer annuals and other seed plants. These results suggest that female kangaroo rats may have responded to the energetic demands of reproduction by securing higher quality home ranges. No evidence was found to suggest differential home range utilization by males and females.

The results obtained in this study may be reflective of different reproductive strategies. *Dipodomys* is generally longer lived than *Peromyscus* and may have more opportunities for reproduction. Thus, *P. truei* may be maximizing the probability of producing a successful litter; the males by extensive movements and consequent encounters with females, the females by maintaining small well known home ranges and thus protecting their reproductive investment from predation events. The extensive morphological adaptations of *D. panamintinus* to predator avoidance and its longer life expectancy may enable this species to emphasize energy procurement and the production of high quality litters during productive years.

In conclusion, the home ranges of male and female *P. truei* differed with respect to size. The size differences and the lower persistence rates of males may be related to male reproductive behavior. The home ranges of male and female kangaroo rats differed with respect to habitat characteristics. Females may have offset the energetic cost of reproduction by securing higher quality home ranges.

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Address of author: Dept. of Biology, Univ. of New Mexico, Albuquerque, NM 87131. Present address: Dept. of Biology, Southeast Missouri State Univ., Cape Girardeau, MO 63701.

