Habitat Orientation and Interspecific Interaction of Microtus pennsylvanicus and Peromyscus leucopus

ABSTRACT: Various population combinations of *Microtus pennsylvanicus* and *Peromyscus leucopus* were subcutaneously injected with a 1-cm gold (Au 198) wire and released in a 44 x 36 m enclosed field. Data were obtained by locating the gold-injected mice with a hand-held Geiger counter and by direct observation.

M. pennsylvanicus had a strong habitat orientation for areas of dense vegetation while *P. leucopus* had an orientation for complex vegetational areas consisting of small dense clumps surrounded by expanses of sparse vegetation.

The distribution of *M. pennsylvanicus* influenced the distribution of *P. leucopus*. Increasing the population of *M. pennsylvanicus* within the enclosure resulted in a population shift of *P. leucopus* to more sparsely vegetated areas and an increased *P. leucopus* escape rate.

INTRODUCTION

Laboratory and field studies indicate that *Microtus pennsylvanicus* has a strong habitat orientation toward structurally dense vegetation (Eadie, 1953; Mossman, 1955; Wirtz and Pearson, 1960; and Root and Pearson, 1964). Studies by Wirtz and Pearson (1960) and Getz (1961) indicate that *Peromyscus leucopus* has no innate habitat orientation but is excluded from certain areas by *M. pennsylvanicus*. This study was an attempt to determine if: (1) *M. pennsylvanicus* and *P. leucopus* had habitat orientations toward vegetation of a specific structure, and (2) the presence of *M. pennsylvanicus* influenced the distribution of *P. leucopus*.

METHODS

The study site was located in the William L. Hutcheson Memorial Forest, Franklin Township, New Jersey. Equal areas of two adjacent fields were enclosed by a 44 x 35 m fence. The enclosed area was evaluated and mapped according to general vegetational categories of "sparse," "medium" and "dense." These categories represented a subjective evaluation of the vegetational density approximately 4 cm above the ground.

The northern half of the enclosure had been seeded with *Dactylis glomerata* 2 years previously. This grass was the dominant vegetation and grew in small dense tussocks 15-30 cm in diam. The physical structure in this half of the enclosure was determined primarily by the distribution of these tussocks. In areas designated as dense, the tussocks were so close together that the overlapping grass stems formed a thick vegetational mat. In areas designated as sparse, the tussocks tended to be smaller and widely scattered, forming "islands" on extensive areas of bare ground. Between these two extremes were areas designated as medium, which comprised approximately equal areas of vegetation and bare ground.

The southern half of the enclosure had not been cultivated for 8 years. At the time of this study, several plant species were codominant. Clover (*Trifolium* spp.), asters (*Aster* spp.) and scattered clumps of grass made up the areas designated as medium. The stems of most of these plants were more than 3 cm apart. Dead stems and small living plants covered the ground. The areas designated as dense were comprised of heavy continuous mats of grass or Japanese honeysuckle vines (*Lonicera japonica*).

A fence was constructed of hardware cloth (36 inches wide, 0.25 inch mesh). Two inches of the lower edge were folded at right angles to make a "shelf." The fence was then buried so that 28 inches remained above the sur-

face. This fence was supported by wooden stakes placed outside the enclosure. Eighteen-inch-wide aluminum screening was sewed to the hardware cloth fence so that 9 inches of screening extended over each side of the fence, forming a shelf perpendicular to the hardware cloth.

During the week prior to each experimental run, the animals within the enclosure were removed by live-trapping. Animals to be tested were live-trapped from various areas in New Jersey and held in the laboratory; thus, individuals selected from this laboratory pool had no prior experience within the enclosure. An attempt was made to maintain a 1:1 sex ratio during each experimental trial, but this was not always possible since there was difficulty in capturing enough animals. Each animal to be released in the enclosure was numbered by toe-clipping (Pearson, 1955) and coded by painting an area of its fur. The paint and fur were removed by most of the animals, resulting in areas of baldness. Individuals could be identified, with difficulty, by noting the location of these bald spots.

In each experimental trial, individuals of one of the two species were injected subcutaneously with a 1-cm gold wire activated to the radioisotope Au-198 (approximately 3.9 mC). The techniques followed closely those of Kaye (1960), except that ether was not used and the wire was implanted dorsally. Since animals from early trials were recovered with subcutaneous irritations associated with hair being implanted along with the gold wire, animals on subsequent trials were shaved at the site of injection. The number of animals used and the tagged species for each trial are summarized in Figure 1.

The mice were then released in the center of the enclosure. Data were obtained by direct observation and by parallel sweeping of the field with a survey meter and Geiger-Muller tube (Victoreen Survey Meter, Model 489; Victoreen Alpha-Beta-Gamma Probe Model 489-35) mounted on a pole as described by Kaye (1960). The geographic location of each contact was noted by a coordinate system with the origin at the NW corner of the fence. Later, these contact locations could be placed on the vegetational map. Chi-square was used to evaluate data as described by Dixon and Massey (1957).

RESULTS AND DISCUSSION

The effectiveness of the fence is of primary importance, since failure to enclose the population alters the experimental conditions. All radioisotope-tagged animals introduced into the enclosure should be observed each day and trapped at the end of each experimental run unless (1) they have escaped, (2) they have avoided contact with the observer, or (3) they have been removed by predators. When each species was tested alone, only 66% of the *M. pennsylvanicus* initially tagged and released was observable at the end of 5 days ($\text{percent} = \frac{\text{animals actually observed}}{\text{initial number tagged and released}} \times 100$). In a similar comparison, only 25% of the initial population of *P. leucopus* was observable at the end of 5 days. Direct observation and captures outside of the enclosure indicated that the fence impeded but did not eliminate the escape of mice.

Another critical factor involves the effects of the radioactive tag and the effects of the investigator on the physiology and behavior of the mice. If the presence of the observer in the enclosure has no effect upon the behavior of the mice, then all the tagged individuals within the enclosure would be contacted at each observation and the variability between successive observations would be slight. The variability in the number of contacts obtained in successive observations for both *M. pennsylvanicus* and *P. leucopus* (Fig. 1) indicates that both species may avoid the observer during the periods of activity. Note in

particular the fluctuations in the numbers of observations on successive time intervals.

Direct observations support the above data. During the night, *P. leucopus* was seen running from the observer for considerable distances. *M. pennsylvanicus* also fled but did not usually move into other vegetational areas. Analysis of the decrease of contact points on subsequent days when night observations were taken vs. the decrease of contact points when no night observations were taken indicates that night observations have the greatest effect on *P. leucopus*. More animals escaped from the enclosure when observations were taken during the nocturnal activity period. Because of the unreliability of the night contact points, they were excluded from the calculations of the percentage of reobserved contact points (Fig. 2).

$$\text{Percent} = \frac{\text{Animals Actually Observed}}{\text{Initial Number Tagged and Released}} \times 100$$

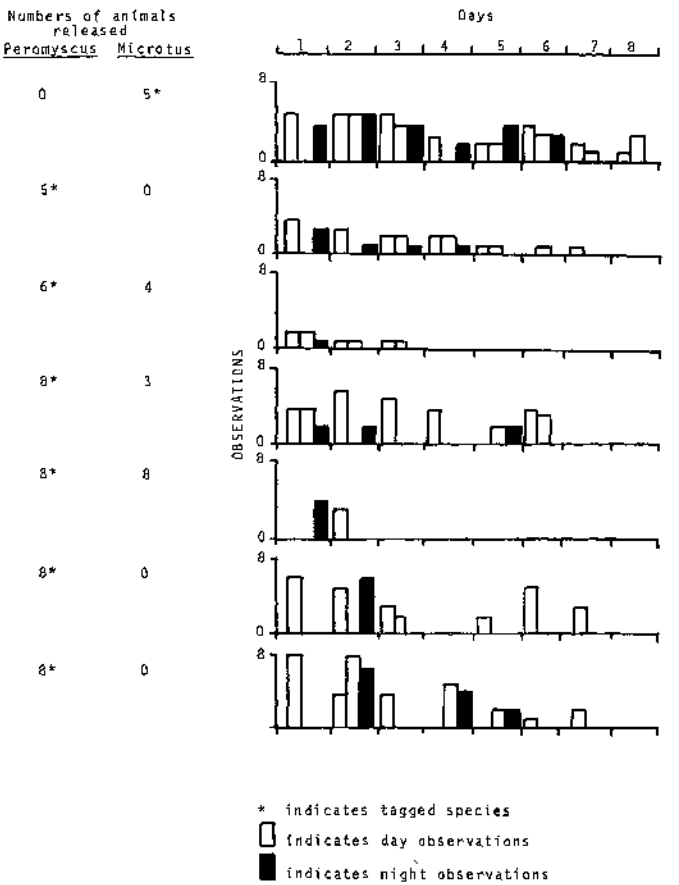

Fig. 1.—Number of tagged individuals located during each observation period

Less apparent are the possible physiological changes due to the radioactive gold wire. No impediment of movement was noted in those animals returned to the laboratory. However, four *P. leucopus* and two *M. pennsylvanicus* were recovered dead due to unknown causes. Hair loss, presumably due to radiation, occurred directly over the site of implantation in all animals after 3-5 days. Hair gradually regrew in all animals returned to the laboratory. In one animal, the regrown hair was nonpigmented, indicating a somatic mutation.

Orientation of M. pennsylvanicus.—If *Microtus* shows no orientation to a specific vegetational cover, then the distribution of activity in each cover type should be proportional to the amount of area covered by each vegetational category. However, the dense and medium cover areas have more contact points than expected (Table 1). Chi-square analysis of the observed distribution of *M. pennsylvanicus* contact points reveals a significant deviation from the expected random distribution towards dense cover ($X^2 = 41.71$, $p < 0.005$).

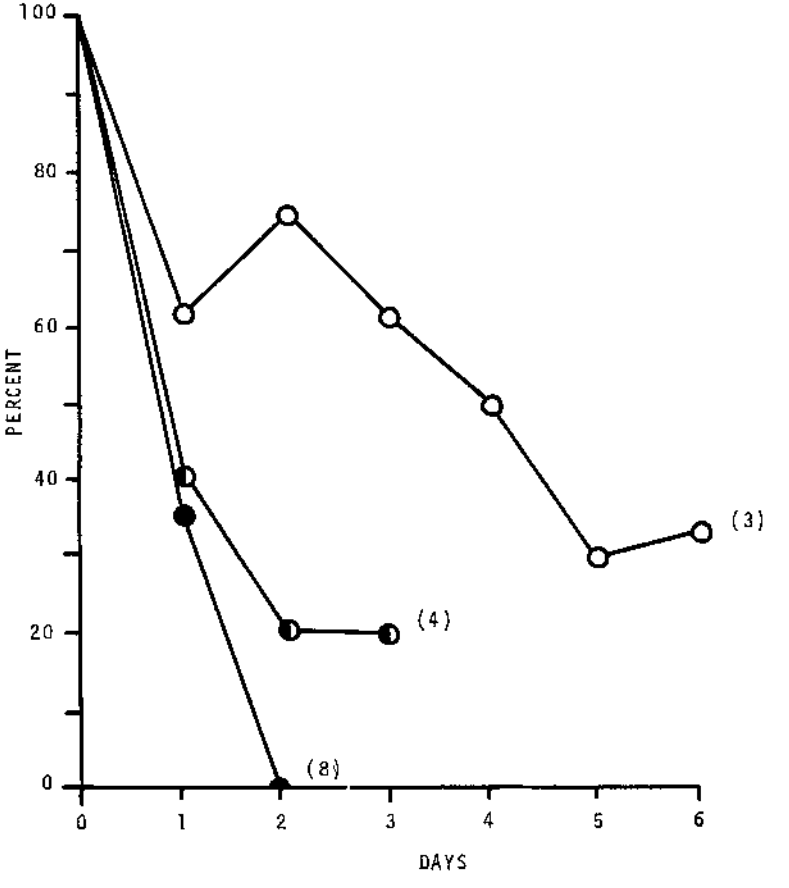

Fig. 2.—Percentages of reobservations of *P. leucopus* when tested with three (3), four (4), and eight (8) *M. pennsylvanicus*

Individuals rarely could be forced into open areas. *M. pennsylvanicus* was frequently observed within the same dense vegetational area on successive observational periods and would often return to the same general area when disturbed. Runways in dense areas were abundant.

Orientation of P. leucopus.—The habitat orientation of *P. leucopus* when alone was not as clear as that of *M. pennsylvanicus*. Comparisons of the distribution of observed vs. expected contact points in each vegetational category (Table 1) revealed no significant deviation from the null hypothesis ($X^2 = 3.44$, $X^2 = 4.05$; $0.10 < p < 0.20$).

Direct observations indicate that *P. leucopus* is associated with structurally heterogeneous areas containing both sparse and dense components. During the day, *P. leucopus* was most often found resting in dense areas. These dense areas of concealment were bordered by sparse areas. Whenever *P. leucopus* was disturbed, it would escape over these open areas, following the bare ground between vegetational clumps until it ran into a burrow or stopped beneath concealing vegetation. At night, *P. leucopus* was most often discovered running along open areas.

Interaction between M. pennsylvanicus *and* P. leucopus.—If *M. pennsylvanicus* is both dominant to *P. leucopus* and orients toward dense vegetation, then the introduction of *M. pennsylvanicus* into the enclosure should lead to a greater frequency of contacts of *P. leucopus* in sparse vegetation. When eight *P. leucopus* were inserted with three *M. pennsylvanicus*, there was a significant shift of *P. leucopus* into sparse areas (Table 1, $X^2 = 7.95$, $p < 0.025$). This shift indicates that *M. pennsylvanicus* does influence the distribution of *P. leucopus*, as hypothesized by Wirtz and Pearson (1960).

If *M. pennsylvanicus* influences *P. leucopus*, then this influence should be reflected in the escape rate of *P. leucopus* from the enclosure. Analysis of the percentage of reobservation for *P. leucopus* shows a direct relationship between the rate of decrease of *P. leucopus* on successive observations and the number of *M. pennsylvanicus* present (Fig. 2).

TABLE 1.—Comparison of observed with expected contact points within each vegetation type

		Vegetation structure			
Proportion of total area		Sparse .447	Medium .375	Dense .175	
Number of animals released					
8 *M. pennsylvanicus**	Obs.	19	17	33	$X^2 = 41.71$
	Exp.	31	26	12	
8 *P. leucopus**	Obs.	15	11	1	$X^2 = 4.05$
	Exp.	12	10	5	
8 *P. leucopus**	Obs.	19	25	7	$X^2 = 3.44$
	Exp.	23	19	9	
8 *P. leucopus**	Obs.	26	11	2	$X^2 = 7.95$
3 *M. pennsylvanicus*	Exp.	22	18	8	

* Tagged species

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Crayfish Marking with Fluorescent Pigment

ABSTRACT: Fluorescent granular pigment sprayed with 738 g/cm^2 (105 psi) for 5, 10 and 20 sec intervals was used to mark crayfish in a laboratory study. The pigment was retained by 100% of the unmolted crayfish 35 days after treatment and by 65% of the crayfish 56 days after treatment. Crayfish which were induced to molt after being sprayed generally lost the fluorescent pigment during the molt. Mortality (2%) due to the marking procedures was minimal.

INTRODUCTION

Crayfish, because of their importance as a natural fish food and their use as bait, have been studied in their natural environment. An assortment of crayfish-marking techniques has been employed. Within the last 20 years these methods have undergone several improvements. Certain crayfish appendages are now known which, when clipped, will produce a recognizable scar through three molts (Momot, 1966). Soldering irons are presently used to brand between 1-12 dots on the carapace to mark individually up to 999 crayfish (Abrahamsson, 1965). Numbering-machine inks are also being employed successfully to mark crayfish with a visible stain that will persist even after a crayfish has undergone a molt (Slack, 1955; Black, 1963). Recently, radioactive materials have been used (Merkle, 1969). The above methods each have their own advantage, but all require individual handling of each crayfish.

Fluorescent granular pigment imbedded in the dermis with compressed air is now used as a rapid, inexpensive method for marking large numbers of fish. The pigment is invisible in visible light, thus protecting the organism from predators, but readily visible under ultraviolet light. This method was first described by Jackson (1959) and has been further refined by Scidmore (1961), Phinney *et al.* (1967), Phinney and Mathews (1969), Mattson and Bailey (1969), Andrews (1972) and Phinney (1974). Benton and Lightner (1972)