greater proportion of habitat disturbed on Plot B using recent, more extensive stripping methods. However, Plot B is 12.7 percent (3.3 ha) smaller in total area than Plot A. Thus it can be argued that Plot A has a greater proportion of deciduous forest which would contribute to the higher population density of forest species found on Plot A. This discrepancy in size between the two plots would bias the number of forest birds in favor of Plot A. Had the total area of both plots been equal in size a direct comparison would be undisputed. Yet despite this criticism, a comparison of population densities is still justified. The difference in the size of the study plots would not entirely compensate for the lower density in Plot B.

The extent of disturbed habitat created by strip mining (Table 1) does not affect those species characteristic of disturbed areas nor those forest species able to invade and utilize a secondary habitat. The recent, extensive strip-mine procedures conducted on Plot B do not affect the ability of some species to establish territories on the strip-mine cuts and the spoils banks. Yet the differential use of the disturbed habitat within each plot was pronounced when the two plots were compared. Also, the population density of Plot A was higher than that of Plot B indicating that the proportion of forest habitat altered by strip mining has a marked effect on the avifauna of a larger geographical region. Therefore, to determine the environmental impact of an area affected by strip mining on breeding-bird populations, the extent of the disturbances created must be considered as well. It is seen that the proportion of undisturbed habitat is greater in areas strip mined in the 1950s in this region. and these areas have higher densities of breeding birds.

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LITERATURE CITED

Anderson, S. H. 1970. The avifaunal composition of Oregon white oak stands. Condor 72:417-423.

Bock, C. E., and J. W. Lynch. 1970. Breeding bird populations of burned and unburned conifer forests in the Sierra Nevada. Condor 72:182-189.

Garton, A. W. 1973a. A comparative study of breeding-bird populations on two strip-mined areas. Master's thesis, Univ. Tennessee. 94 pp.

———. 1973b. Upland mixed deciduous forest with strip mines. Amer. Birds 27:972-973.

Gleason, H. A. 1952. The new Britton and Brown illustrated flora of the Northeastern United States and Adjacent Canada. Lancaster Pennsylvania, Lancaster Press. Inc., 3 vol.

Hall, G. A. 1964. Breeding-bird census—why and how. Audubon Field Notes 18: 413-416.

James, F. C. and H. H. Shugart, Jr. 1970. A quantative method of habitat description. Amer. Birds 24:727-736.

Johnston, D. W. 1970. High density of birds breeding in a modified deciduous forest. Wilson Bull. 82:79-82.

Karr, J. R. 1968. Habitat and avian diversity on strip-mined land in East-Central Illinois. Condor 70:348-357.

Karr, J. R., and R. R. Roth. 1971. Vegetation structure and avian density in several New World areas. Amer. Naturalist 105:423-435.

Kendeigh, S. C. 1944. Measurement of bird populations. Ecol. Monogr. 14:67-106.

Lack, D. 1933. Habitat selection in birds with special reference to the effect of afforestation on the Breckland avifauna. J. Anim. Ecol. 2:239-262.

Martin, N. D. 1960. An analysis of bird populations in relation to forest succession in Algonquin Provincial Park, Ontario. Ecology 41: 126-140.

Nice, M. M. 1941. The role of territory in bird life. Amer. Midl. Naturalist 26:441-487.

Odum, E. P. 1950. Bird populations of the Highlands (North Carolina) Plateau in relation to plant succession and avian invasion. Ecology 31:587-605.

Robbins, C. S., ed. 1970. An international standard for a mapping method in bird census work recommended by the International Bird Census Committee. Audubon Field Notes 24:723-726.

Rosene, W. Jr. 1951. Breeding bird populations of upland field borders. J. Wildl. Mgmt. 15:434-436.

Shugart, H. H., Jr., and D. James. 1973. Ecological succession of breeding bird populations in Northwestern Arkansas. Auk 90:62-77.

Twomey, A. C. 1945. The bird population of an elm-maple forest with special reference to aspection, territorialism, and coactions. Ecol. Monogr. 15:173-305.

Williams, A. B. 1936. The composition and dynamics of a beech-maple climax community. Ecol. Monogr. 6:317-408.

Yahner, R. H. 1973a. Breeding-bird populations on a strip-mined area in a deciduous forest in Campbell County, Tennessee. Master's thesis, Univ. Tennessee. 114 pp.

———. 1973b. Mixed-deciduous forest-strip mine. Amer. Birds 27:971.

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INTERSPECIFIC BEHAVIOR OF THE PRAIRIE VOLE *(MICROTUS OCHROGASTER)* AND THE WHITE-FOOTED MOUSE *(PEROMYSCUS LEUCOPUS)* AS A POSSIBLE FACTOR IN HABITAT SEGREGATION

JAMES MORONI

Austin Peay State University
*Clarksville, Tennessee 37040**

ABSTRACT

Interspecific tests involving individual encounters and nesting habits of the prairie vole (*Microtus ochrogaster* Wagner) and the white-footed mouse (*Peromyscus leucopus* Rafinesque) were conducted to investigate the possibility of dominance as a factor in the habitat segregation of these animals.

Test results indicated the dominance of the prairie

* Present Address: Three Rivers Community College, Poplar Bluff, Missouri 63901

voles. The degree of dominance was greatest during the individual encounter tests conducted during the day and in the nesting study. This introduced the possibility of time and location of encounter as factors in influencing the response of the animals.

It was concluded that the interspecific dominance evidenced by the voles could be a factor in the segregation of these animals in areas of adjoining habitats. The extent this dominance actually manifests itself is questionable since activity periods and probably nest locations would tend to minimize it. Other factors, such as habitat preference, food habits, and activity patterns would probably serve as more effective barriers to the coexistence of these animals in natural situations.

Introduction

The ecological preferences of the white-footed mouse, *Peromyscus leucopus* (Rafinesque), and the prairie vole, *Microtus ochrogaster* (Wagner), vary considerably. The mouse, a nocturnal granivore, is characteristic of woods and woods' edges while the vole is a diurnal herbivore of dry, grassy, upland situations (Barbour, 1963; Brown, 1964; Dice, 1922; Getz, 1962; and Klein, 1960). These preferences usually serve to separate them to such an extent that Whitaker (1967) found them occupying the same habitat only as often as would be expected by chance.

Where preferred habitats of these animals adjoin some overlapping might be expected and more direct mechanisms of separation may operate. Several workers have reported the role varying degrees of interspecific aggression may have in habitat segregation of other small rodents. Grant (1971) reported that the population density of the meadow vole, *M. pennsylvanicus* (Ord), was a factor in the exclusion of the deer mouse, *P. maniculatus* (Wagner). Brown (1964) reported that interspecific aggression helped separate three species of *Peromyscus*, including *P. leucopus*. Wirtz and Pearson (1960) indicated the dominant reactions of the meadow vole may aid in the exclusion of the deer mouse. Getz (1962) discussed the possibility of interspecific reactions as a factor in the separation of the meadow vole and the prairie vole. This paper investigates the possibility of interspecific dominance as a factor in the segregation of the prairie vole and the white-footed mouse in areas of adjoining habitats.

Methods

Five male and two female prairie voles and six male and three female white-footed mice were wild trapped and used in tests involving individual interspecific encounters and nesting segregation. Tests involving individual encounters included males and females since both move about their home ranges and would be expected to have interspecific contacts. All animals were in good health and were sexually mature.

The test cage, used for the interspecific encounter tests, was 18 x 6 x 6 inches in dimensions and contained a solid sliding partition at the midpoint of the cage. The nest cage, used in tests concerning nesting segregation, was 36 x 12 x 10 inches and had two partitions, each with a one inch diameter hole bored at the bottom. These partitions divided the cage into three freely accessible sections, each with dimensions of 12 x 12 x 10 inches.

For individual encounters the animals were placed on either side of the partition of the test cage and left separated long enough for them to calm down, which was signified by the absence of any frantic activity. The partition was then removed and the reaction of the individuals observed and recorded. Five minute encounters were used. All animals were tested with every animal of the other species; at least 30 minutes elapsed between tests involving the same individual.

Behavioral reactions were divided into ten categories. Those of threats, approaches, and attacks were considered to be aggressive reactions. The recessive reactions were those in the categories of avoidance, defensive position, and retaliation. The remaining categories were fighting, fraternizing, sniffing and no conclusive reaction. The descriptions of the categorized reactions were the same as those used by Clarke (1956), Krebs (1970) and Wirtz and Pearson (1960). During all tests the investigator sat quietly alongside the test cage and recorded the data. All data were collected by the same investigator to avoid discrepancies in the interpretation of the reactions. Tests were conducted at night with the aid of a red light, and during the day to investigate the influence of time of encounter.

The second type of testing involved the nesting habits of the animals. Two groups of male-female paired animals were introduced into the nest cage and allowed to reassociate themselves at will in their nesting habits. Nesting material was evenly distributed throughout the nest cage and sources of ample food and water were located near each end of the cage. Notes were taken on the reactions of the animals upon introduction into the nest cage and then activity and nesting position of the animals were periodically noted.

Results

A total of 56 individual interspecific encounter tests were conducted between the white-footed mice and the prairie voles resulting in 1231 contact reactions, an average of 21.9 reactions per trial. Thirty-one of the tests were conducted at night with 564 reactions resulting, and 25 were conducted during the day resulting in 667 reactions, for averages of 18 and 26.4 reactions per trial, respectively (Table 1).

During night testing the mice exhibited a greater number of total reactions (349) than did the voles (215). This, to some extent, was the result of divergence from a one reaction-one response situation between animals; for example, with the approach of a vole (1 reaction/vole) a mouse would often assume a defensive position quickly followed by avoidance (2 reactions/mouse). As a result the mice would accumulate a greater number of reactions than the voles; however, by converting each reaction category to its percentage of the total number of reactions a lucid interpretation of the data was possible. As a result of percentage evaluations it can be seen that the voles recorded twice the percentage of aggressive reactions as did the mice during night testing (Table 1). Although the percentage for approaches was approximately equal (32.4 mice, 37.2 voles) the voles combined threats and attacks with their approaches much more often than did the mice. A great difference was recorded in the recessive behavior of the animals since over one-half of all reactions (57.6%) of the mice were in the recessive categories. The recessive responses of the voles were minimal (8.3%), most being in the category of retaliation. Of the remaining response categories, only the one for no reaction showed any marked difference.

The voles ignored the presence of the mice more than did the mice in the reverse sense.

Day testing further demarcated the aggressive tendencies of the voles which increased their total aggressive activity by increasing the percentage of approaches and attacks. Nearly every approach was followed by an attack. The percentage of threats was reduced by nearly one-half; perhaps indicating the clearly aggressive nature of the reactions. The recessive reactions of the voles, minimal to start with, were also reduced by nearly one-half. Corresponding to the voles' increased aggressive activity, the recessive reactions of the mice increased. The reactions in the avoidance category nearly doubled while the other two recessive categories dropped, perhaps indicating the preference of the mice to take immediate flight rather than any antagonistic action. The percentage of aggressive reactions of the mice declined correspondingly. The remaining categories of reactions were essentially nonexistent.

The greater activity of the voles during the day testing indicates that the normal activity period of these animals may have an influence on the nature of their responses as well as their aggressive behavior (93% of all reactions during the day were aggressive). The role of normal activity period on reactions for the mice could not be determined since the strong aggressive reactions of the voles forced a response by the mice. No sexual difference was apparent during any of the regular testing.

The comparison of the aggressive and recessive figures of the total results (Table 1) indicate the more aggressive tendencies of the prairie voles in interspecific relations with the white-footed mice. Little difference could be ascertained from the remaining reaction categories.

The nesting study showed dramatic results. Almost immediately upon introduction of the animals into the nest cage, the voles attacked and chased the mice around the cage. This activity continued, with only momentary pauses, for an hour. The voles then went to one corner of the cage and started to construct a nest. Periodically the male vole would harass the mice which were usually huddled in a distal corner, then he would return to the female vole and the nest building activity. The female vole tended to remain at the nest site, once its construction had begun, for the duration of the test. Rarely was a mouse observed to approach the voles. Little actual fighting was observed since the mice were usually quick enough to escape the voles, and when fighting did occur, the mice quickly broke off the encounter by fleeing. This pattern of harassment was noted during all observation periods.

During the first night the voles moved all the nesting material into one corner of the cage and constructed their nest. The mice, huddled in a far corner, were denied any nesting material at all.

Two separate groups were tested in this manner and the results were identical in both cases, with the exception of the death of one mouse in the second test group. It is not known if this death was due directly to physical abuse or if it was from exhaustion from the constant harassment. Although none appeared markedly severe,

TABLE 1: *Results of Interspecific Tests.**

	Aggressive				Recessive			Frater-		No	Total
	Threat	Approach	Attack	Fight	Avoid	Defense	Retaliate	nize	Sniff	Reaction	Reactions
Night (31 tests)											
		37.0				57.6					
Mice	2.3	32.4	2.3	0.3	37.0	12.6	8.0	0.3	1.4	3.4	349
		72.6				8.3					
Voles	20.9	37.2	14.4	1.4	2.8	0	6.0	0.5	2.8	14.0	215
Day (25 tests)											
		24.2				74.6					
Mice	0	23.5	0.6	0	61.8	6.4	6.4	0	0.3	0.9	327
		92.9				5.0					
Voles	12.1	41.5	39.4	0	0.3	0.3	4.4	0	0.6	1.5	340
Total (56 tests)											
		30.8				65.8					
Mice	1.2	28.1	1.5	0.1	49.0	9.6	7.2	0.1	0.9	2.2	676
		85.0				6.5					
Voles	15.5	39.8	29.7	0.5	1.3	0.2	5.0	0.2	1.4	6.3	555

* Numbers in the final column are the total number of reactions for the animals concerned. All other numbers are percent expressions (rounded off to one decimal place) of the numbers in the total column.