A COMPARISON OF SMALL MAMMALS OF THE DECIDUOUS FOREST AND OLD FIELD HABITATS OF SWEET BRIAR, VIRGINIA

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Date: April 15, 1979

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A, Highest Honors

A Thesis

Submitted in Partial Fulfillment of the

Requirements for the Degree with Honors

in Biology

Sweet Briar College

Sweet Briar, Virginia

April, 1979

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ABSTRACT

The number and types of small mammals captured in forest and old field habitats may indicate their differing adaptations to vegetation and climate. Live-trapping in a grid arrangement was employed on forest and old field plots in southwest Virginia to determine small mammal species present, their home ranges, and the effect of weather on their activity. Physical characteristics are presented for *Peromyscus leucopus*, *Microtus pennsylvanicus*, and *Reithrodontomys humilis*, and comparisons are made between species and between habitats.

INTRODUCTION

There are many obvious as well as intuitive differences between the forest and the field; the premise that there exists a significant difference in the numbers and species of small mammals found in each habitat is supported by recent studies on this subject. Traditionally, old fields have proved ideal locations for the permanent

homes of a large number of small mammals (Howell, 1954; Gottschang, 1965), while forested habitats generally support reduced small mammal faunas (Dueser & Shugart, 1978). Numerous studies have dealt with the choice of microhabitats by small mammals, and it has been shown that many factors influence the type of habitat in which a particular species of small mammal may be found (Brown, 1962; Dueser & Shugart, 1978; Gottschang, 1965; Orr, 1959). These factors include population density, suitable food, available cover, territoriality, climate, and competition. Harris (1952) suggests that habitat selection in some instances may be basically genetic. The purpose of the present study is to compare the types, relative abundance, and home range sizes of small mammals in forest and old field quadrats, and to suggest possible explanations for the data obtained.

Many factors known to influence habitat selection also affect the size of an individual animal's home range. An animal's home range includes that area of land over which it travels regularly, perhaps following consistent paths, in order to carry out its usual activities. Because they are continually influenced by these factors, home range sizes are not constant for each species, nor are they constant over long periods of time for individual animals. Therefore, the calculation of home ranges will not reveal former or future ranges even for the same

population. Nevertheless, home ranges are valuable indicators of population size and density, spatial relationships between males and females of the same species, and the distribution of different species with regard to each other. Repeated home range studies are valuable in determining preferred and unsuitable conditions for a species' survival, for studying the periodic rise and decline in populations, and for helping to determine differing intensities of usage throughout the area.

There are numerous methods by which home ranges may be traced, including radioisotope tracking, monitoring of marked feces, and live-trapping. Although the validity of the live-trap and mark method is still questioned by some researchers, Stickel (1954) regards it as a valuable and fairly accurate tool with which to monitor small mammals. Blair (1951) also believes that ranges calculated by live-trap capture patterns coincide acceptably with the actual range sizes. Traps may be arranged in concentric circles, in a grid, or on a trap line. By marking, releasing, and later recapturing animals in different traps, home ranges may be roughly determined. The more times an animal is captured, the more accurate will be its calculated range. Blair (1951) considered an animal a resident of an area if it was captured four or more times, and a transient if captured less than four times.

Stickel (1960) also supports this view.

The concept of home range naturally leads the researcher to wonder if all parts of the animal's range are utilized to the same degree. There is still some disagreement among workers concerning the measurement of differing intensities of usage within a range. Although the concept is regarded as yielding worthwhile information, Hayne (1949) asserts that the relative frequency of captures per trap is not a dependable index to normal activity, while Blair (1942) states, "In general, the amount of use of a given part of its home range by a mouse should vary in direct proportion to the number of times it was caught there." Metzgar (1973) also found that the frequency of detection in Peromyscus leucopus decreased normally away from the center of activity, which is determined by plotting the vertical and horizontal means of the capture sites. Neither theory can be accepted confidently until more data are available, but the present study makes use of the center of activity calculation to indicate probable areas of heaviest usage by individual mice.

Still another factor believed to influence small mammal activity, and thus indirectly the patterns of capture, is the weather. Getz (1961) indicates that temperature is the major climatic factor causing variation in

Microtus activity. Gentry and Odum (1957) say more generally that "weather does have a marked effect on catch, with warm, cloudy nights favoring a larger catch than clear, cold nights." Because weather conditions seem to influence the activity levels of small mammals, extended similar weather conditions might then influence actual home range sizes. Conditions of shorter duration could give misleading impressions of home range sizes because of inaccurate capture patterns due to temporarily suppressed activity. Because differing weather conditions may have some bearing on small mammals and their activity, data will be presented in this study concerning weather trends and their possible effects.

The research reported here was conducted in an area of Virginia where little work has been done on the small mammal fauna, and it should provide significant information concerning characteristics of the species present, their relative abundance, and their apparent home ranges.

HABITAT

The two habitats used for this study are located approximately one-half mile apart near Amherst, Virginia,

on Sweet Briar College property, elevation 800 feet, USGS Amherst Quadrangle (1963)(Figures 1 & 2).

The old field plot is rolling terrain which was formerly a cattle pasture (Photos 1 & 2). In 1969, the field became an ecological study area for observation of the progress of successional stages, and for the last ten years has supported no cattle or farming. The field has been invaded by many plant species interspersed among the still abundant fescue (Festuca), these being primarily coralberry (Symphoricarpos orbiculatus), redtop grass (Agrostis sp.), broom sedge (Andropogon virginicus), blackberry (Rubus sp.), thistle (Carduus sp.), wild grape (Vitis sp.), sunflower (Helianthus sp.), and pokeberry (Phytolacca decandra), listed in approximate order of abundance. Several tree species have also invaded the plot, including red cedar (Juniperus virginiana), honey locust (Gleditsia triacanthos), white ash (Fraxinus americana), and wild plum (Prunus sp.). Though thick fescue is still the major plant component of the quadrat, patches of coralberry and blackberry have begun to spread, exposing bare ground in places. Figure 3 shows the larger vegetation areas of the quadrat.

The forested plot is a sloping, dry, mesic climax forest of primarily white oak (Quercus alba), red oak (Quercus rubra), and tulip poplar (Liriodendron tulipifera),

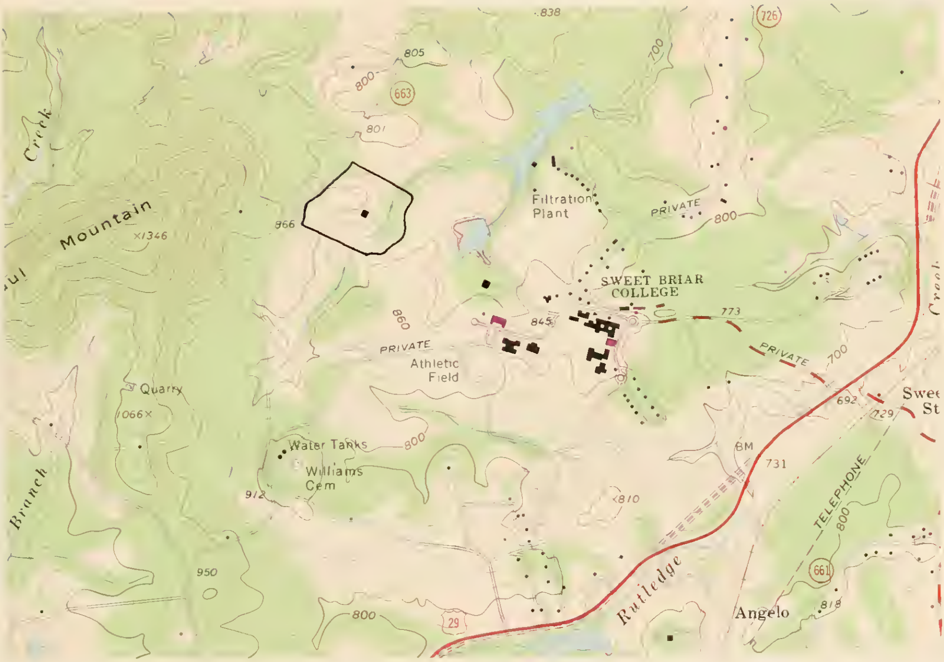


Figure 1. Plot Locations on USGS Map

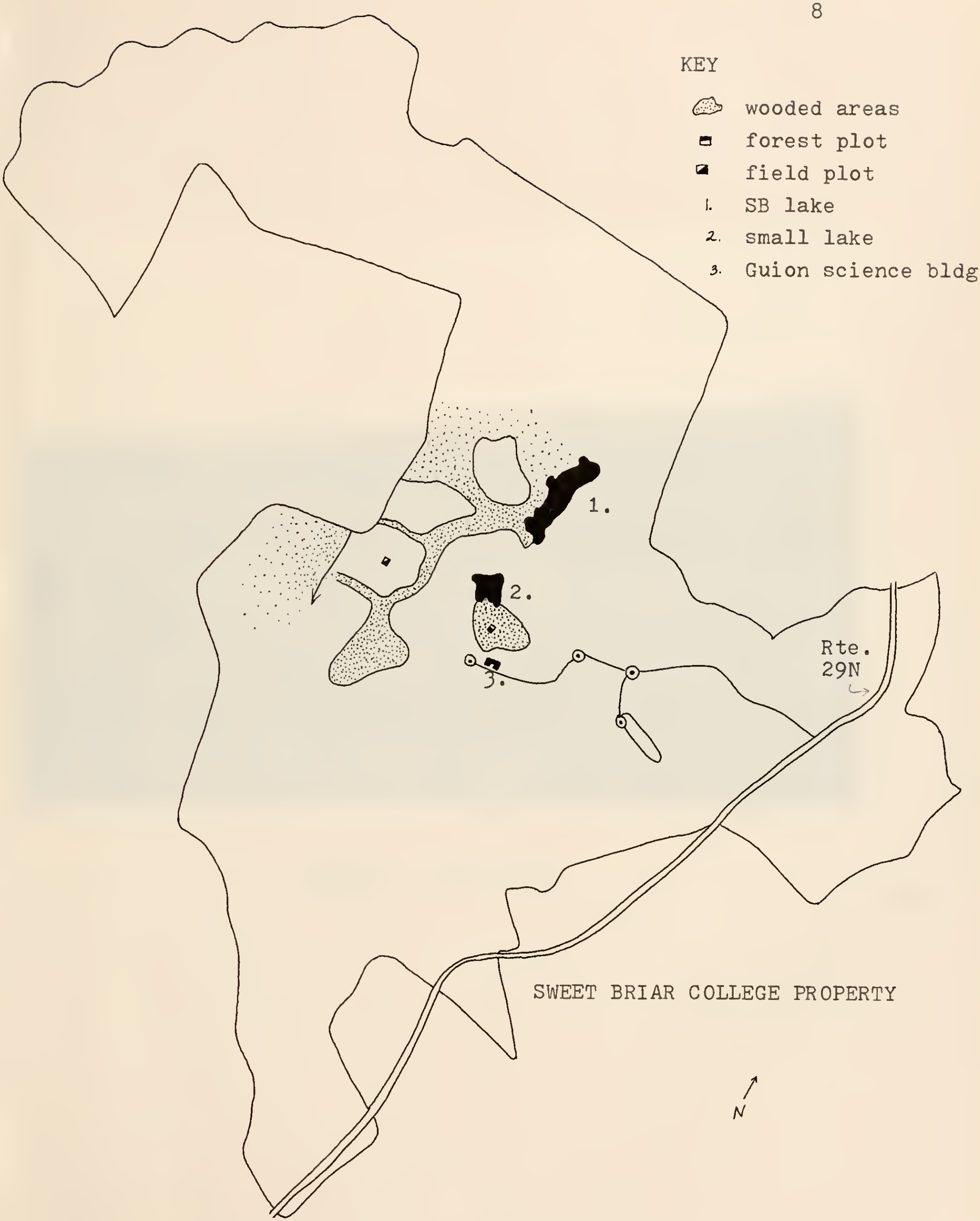


Figure 2. Locations of Study Plots

Photo 1. Field Plot

Photo 2. Field Plot

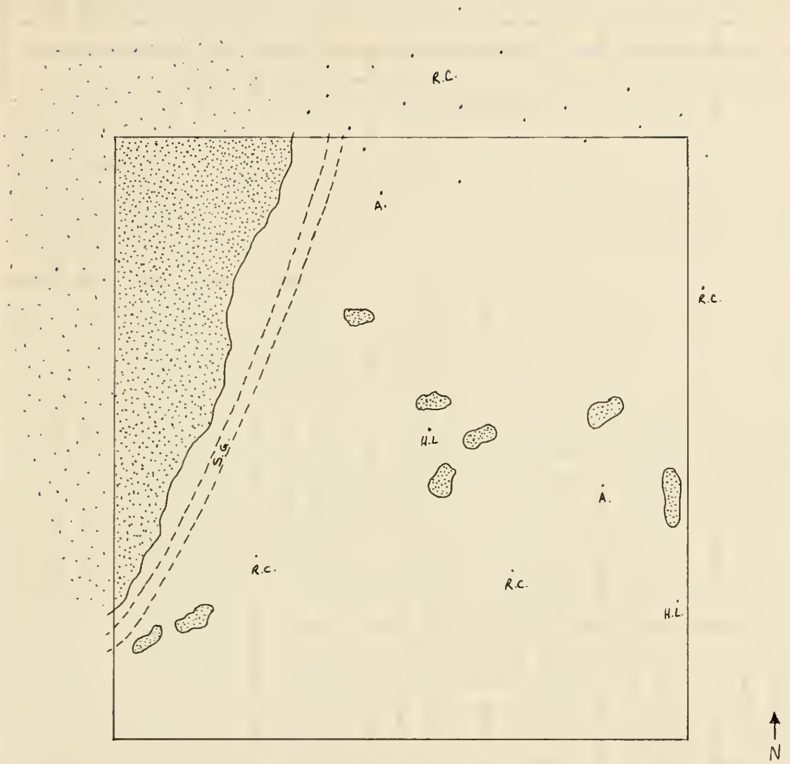


FIGURE 3. APPROXIMATE AREAS OF FIELD VEGETATION OTHER THAN GRASS

- PRIMARILY CORALBERRY & BLACKBERRY; SOME THISTLE, SUNFLOWER, POKE
- 5 METERS
R.C. - RED CEDAR
A. - WHITE ASH
H.L. - HONEY LOCUST
S.G - SHORT GRASS PATH

with a canopy height ranging from 90 to 120 feet (Photo 3). Honeysuckle (Lonicera japonica) introduced into the area has eliminated most other shrubs and herbs in a large portion of the plot, and another introduced area of periwinkle (Vinca minor) has produced a similar effect (Figure 4). Fallen rotting logs and ground holes up to six inches in diameter are present throughout the quadrat.

MATERIALS & METHODS

The eight weeks between 15 October and 9 December were divided into four two-week trapping sessions alternating between the two study plots. Trapping was extended for these relatively long periods of time because the maximum number of captures yields the most accurate home range calculations, and because the length of time involved in moving the traps from one plot to the other precluded four one-week sessions per plot. Trapping was begun on 15 October in the forest, and traps were moved on 29 October to the field. After the next two-week session in the forest, traps were returned to the field for the final session until 9 December.

Traps used were size 0 Havaharts with rolled oats and peanut butter as bait, which was replenished whenever necessary. Because the traps were new and shiny, and

Photo 3. Forest Plot

FIGURE 4. APPROXIMATE LOCATIONS OF LARGE TREES, HOLES, & VEGETATION AREAS IN THE FOREST PLOT

o - WHITE OAK
● - TULIP POPLAR
→ - OPENING OF HOLE 4-6" IN DIAMETER
⁘ - PERIWINKLE
FALLEN TREES
HONEYSUCKLE
├─┤ - 3 METERS

provided no protection from the weather, some camouflage and weather-break were fashioned by removing the flaps from each trap's shipping carton and dipping the resulting tube into hot paraffin wax. After the wax had dried, the trap was baited, set, and slid into the tube. The solid walls of the carton afforded protection from the weather, and the neutral color of the wax helped to camouflage the trap. These boxes were used throughout the eight trapping weeks, and proved to be quite durable.

In a few cases the cartons were disturbed by what is believed to be an opossum, possibly because of the attractiveness of the paraffin coating. Some researchers' use of paraffin as mammal bait adds weight to this theory. Large pieces were sometimes ripped off the sides of boxes, and they were usually thoroughly chewed nearby. Photo 4 shows the result of a mild disturbance, in which the box was upside down with the trap less than a foot away. I do not believe the trapping results were greatly altered by this interference because of the small number of traps which actually captured mammals in the forest, and because of the low disturbance level in the field.

For each initial session, 25 traps were set in a 60-meter grid, with the traps 15 meters apart in five rows. No attempt was made to position them in favorable

Photo 4. Trap Disturbance

locations. Traps were checked each day soon after sunrise and again several hours after sundown. In each second session, trap sites were deliberately adjusted in relation to results obtained in the first session of each plot. Researchers have recognized that traps spaced too far apart will not yield suitable captures to reveal accurate ranges, and traps spaced too close together may interfere with the animals' normal activities by their very presence (Hayne, 1950). Consequently, the forest grid size was decreased in the second session so that traps were set 5 meters apart, and the field grid was expanded to place the traps 25 meters apart (Figure 5).

After capture, each mouse was removed from the trap, weighed, sexed, and measured to determine the length of tail, rear foot, and body (Photos 5-8). It was then marked using the toe-clip method if previously uncaptured, and released at the point of capture.

Along with information concerning the mice captured, data were also collected on temperature, precipitation, average wind speed, and percent cloud cover per day. All weather information was obtained from the National Weather Service in Lynchburg, Virginia.

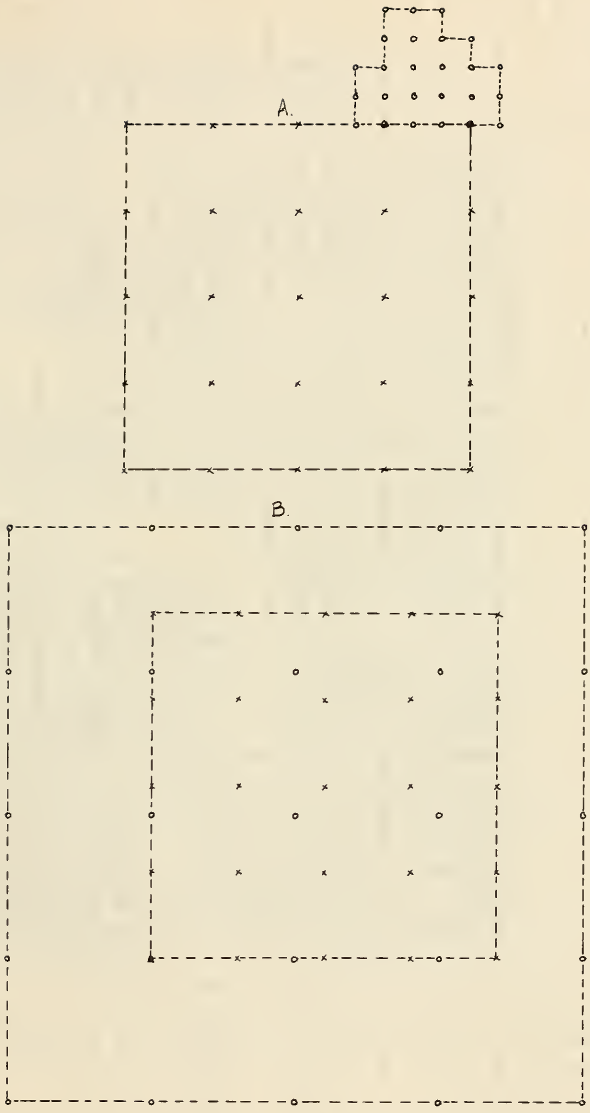


FIGURE 5. INITIAL AND ADJUSTED GRID LOCATIONS OF FOREST (A) AND FIELD (B)

X - INITIAL GRID
O - ADJUSTED GRID
- 5 METERS

Photo 5. Mouse Removed From Trap

Photo 6. Mouse Weighed

Photo 7. Rear Foot Measured

Photo 8. Tail Measured

RESULTS

Four species of small mammal were captured in the two study plots. Table 1 shows a compilation of characteristics of these species in each habitat. It can thus be seen that only one species, *Peromyscus leucopus*, was captured in the wooded plot, while four species, *Microtus pennsylvanicus*, *Peromyscus leucopus*, *Reithrodontomys humilis*, and *Blarina brevicauda* were trapped in the field. A single *Blarina brevicauda* was also caught in the forest quadrat before initiation of the formal trapping program, but none were caught during the two reported sessions. It can be seen from the table that *M. pennsylvanicus* was by far the nost numerous species, with *B. brevicauda* the least abundant. The ratio of males to females was approximately 1:1 in both populations of *P. leucopus*, while there were many more female *M. pennsylvanicus* and many more male *R. humilis*. Nevertheless, the one female *R. humilis* encountered was captured ten times in the first two-week session. In all species, the females showed a greater average weight than the males, along with a greater variation in weight, which may be due to pregnancies. The *P. leucopus* of the forest and field showed similar total lengths, but those

SPECIES	TOTAL CAPTURES		# INDIVIDUALS		# CAPTURES		% CAPTURED		AVER. WEIGHT (GRAMS)		AVER. LENGTH (CM)				% CAUGHT	
	# IND.	# TIMES	♂	♀	♂	♀	♂	♀	♂	♀	BODY	TAIL	TOTAL	FOOT	AM	PM
	FOREST															
P. leucopus	12	49	6	6	13	36	27	73	23.1 ± .81	23.5 ± 1.6	7.6	7.2	14.8	2.0	61	39
	FIELD															
P. leucopus	7	24	3	4	5	19	21	79	25.5 ± .6	27.4 ± 1.3	7.8	6.7	14.5	2.0	64	36
M. penn.	16	45	3	13	4	39	9	91	54.8 ± .8	55.9 ± 4.2	10.5	4.0	14.5	2.0	32	68
R. humilis	5	33	4	1	23	10	70	30	9.5 ± .5	10.3 ± .6	6.2	5.6	11.8	1.5	69	31
B. brevi.	1	1	0	1?	0	1	0	100	—	16.5	7.5	2.1	9.6	1.1	100	0

Table 1. Characteristics of Species Caught

captured in the field showed somewhat shorter mean tail length. Figure 6 shows average body, tail, and total lengths of the four species. M. pennsylvanicus was the only species which was very active during the daylight and early evening hours; the other three species showed the most activity throughout the night and early morning hours. Physical characteristics of the three mouse species are shown in Photos 9-11.

The Lincoln Index was used to calculate the approximate number of animals per hectare and acre (Delaney, 1974). In the forest plot there were approximately 43 P. leucopus per hectare (17/acre). The field plot supported 10 P. leucopus per hectare (4/acre), 23 M. pennsylvanicus per hectare (9/acre), and 5 R. humilis per hectare (2/acre). Because of the adjustments made to each grid, the figures are approximate, but provide some indication of relative abundance in the two plots.

Home ranges have been calculated only for those mice captured four or more times during the two trapping sessions (Blair, 1951; Stickel, 1960). This allows calculations for three female P. leucopus from the forest quadrat, and two female P. leucopus, five female M. pennsylvanicus, and three male and one female R. humilis from the field. Ranges have been calculated using the exclusive boundary strip method, because Stickel (1954)

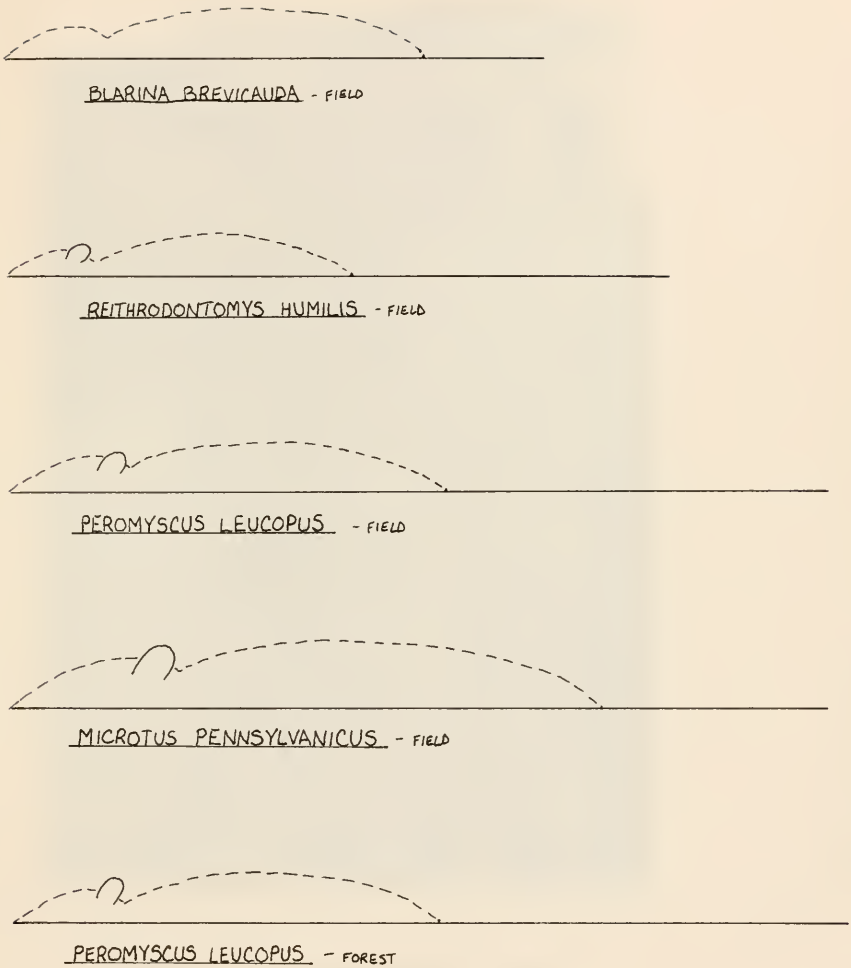


FIGURE 6. COMPARISON OF AVERAGE LENGTHS, FOREST AND FIELD SPECIES

Photo 9. *Microtus pennsylvanicus*

Photo 10. Peromyscus leucopus

Photo 11. Reithrodontomys humilis

has found that this method most closely approximates actual home ranges. Figure 7 shows plotted home ranges for the three female P. leucopus of the forest quadrat. Ranges vary from 125 m^2 to 375 m^2, with a mean of 225 m^2. There is a great deal of overlap among the three ranges and the two smaller ranges are completely enclosed by the largest one. The total area covered by the ranges of these three mice is 375 m^2. Figures 8, 9, and 10 show plotted field ranges for M. pennsylvanicus, P. leucopus, and R. humilis, respectively. Figure 11 illustrates that only 900 m^2(16 %) of the 5560 m^2 covered in the field support overlapping ranges of all three species. Overlap of two species occurs on 1050 m^2(19 %) of the 5560 m^2, and only one species occurs on 3610 m^2(65 %) of that covered. The mean range size for M. pennsylvanicus is 690 m^2, with the largest plotted range 1070 m^2 and the smallest 450 m^2. The ranges of the two P. leucopus show no overlap and are quite different in size. The smaller of the two ranges is 670 m^2, and the larger is 1320 m^2, making the mean 1000 m^2. R. humilis shows by far the largest ranges in this plot, and has overlap of two or more individuals in 2010 m^2(49 %) of the 4110 m^2 covered by this species. The mean range size is 1590 m^2, with the largest being 2700 m^2 and the smallest being the 450 m^2 of an immature male. Though a meaningful comparison

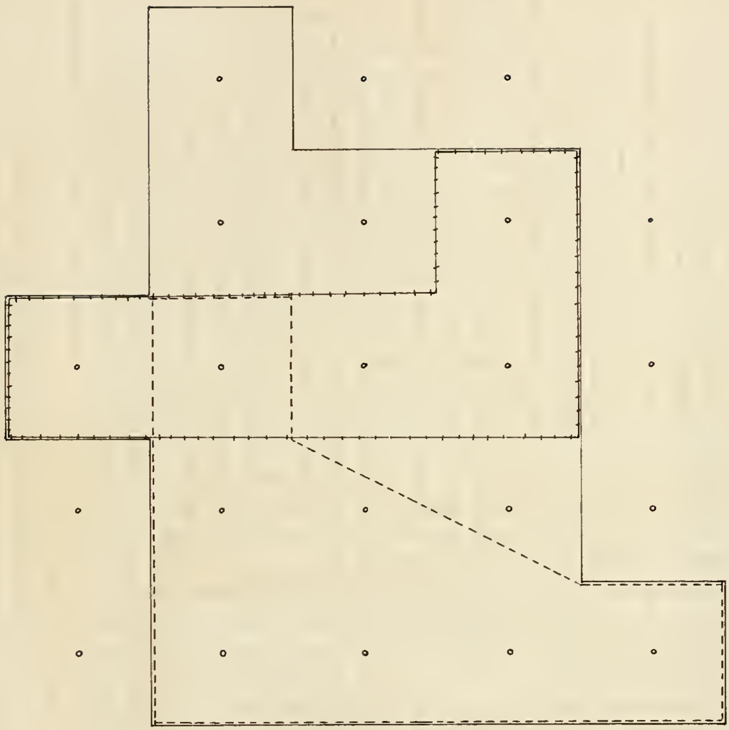


FIGURE 7. PEROMYSCUS RANGES IN THE FOREST PLOT

→ #1 (♀)
→ #2 (♀)
→ #3 (♀)
→ 1 METER

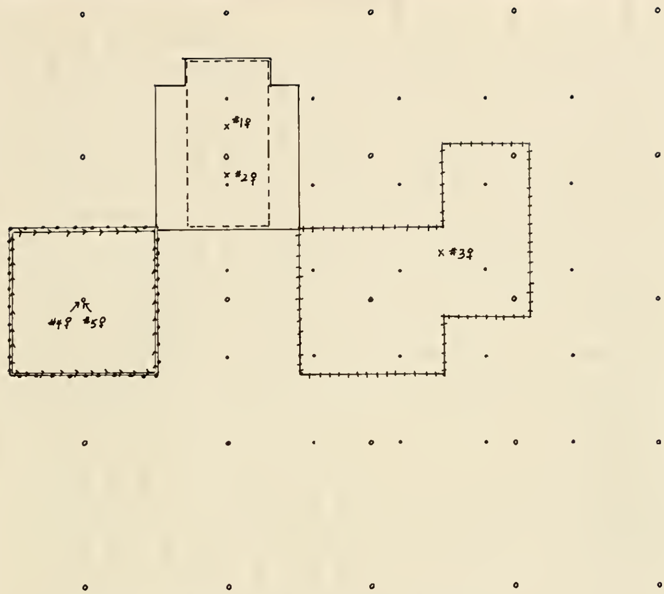
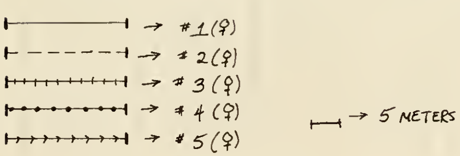


FIGURE 8. MICROTUS RANGES IN THE FIELD PLOT



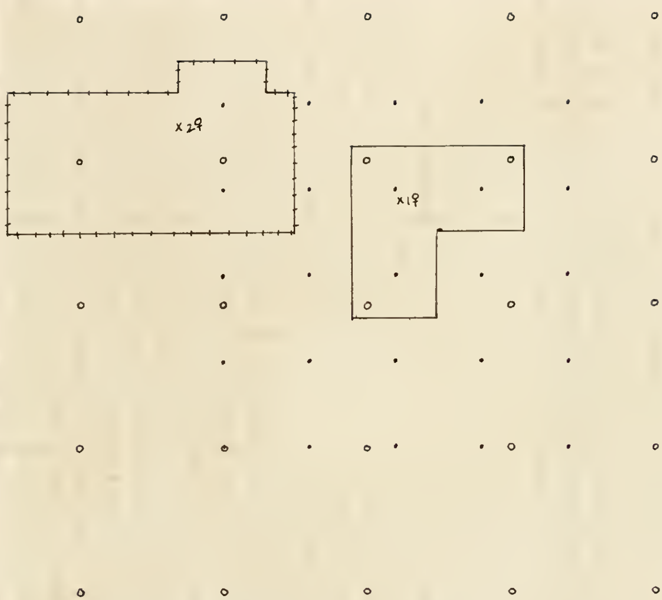


FIGURE 9. *PEROMYSCUS* RANGES OF THE FIELD PLOT

→ #1 (♀)
→ #2 (♀)
– 5 METERS

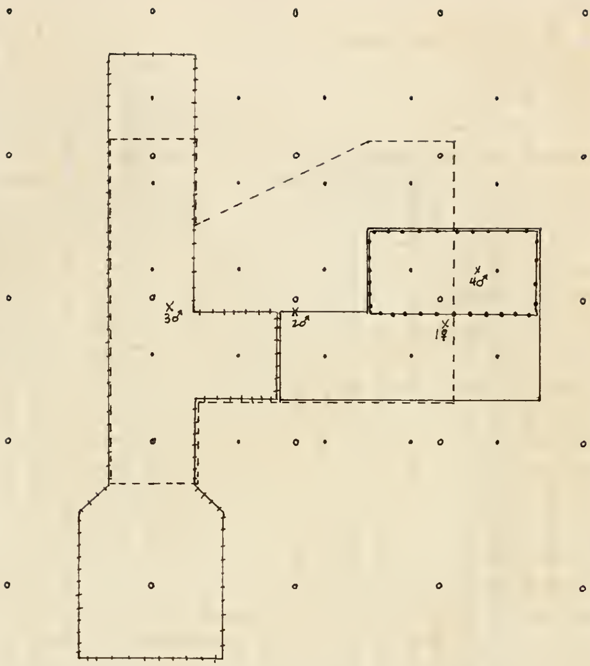


FIGURE 10. REITHRODONTOMYS RANGES IN THE FIELD PLOT

→ #1 (♀)
→ #2 (♂)
→ #3 (♂)
→ #4 (♂)

→ 5 METERS

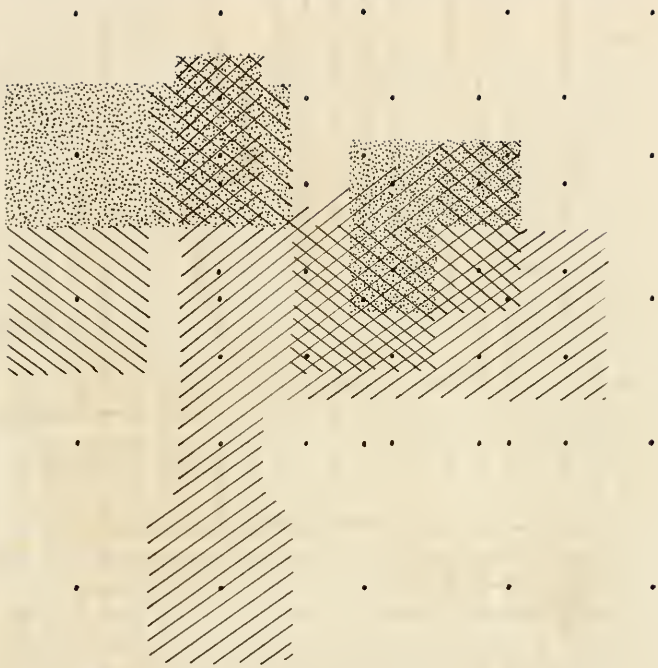


FIGURE 11. OVERLAPPING OF FIELD RANGES

→ PEROMYSCUS
→ MICROTUS
→ REITHRODONTOMYS

— 5 METERS

cannot be made with only one female specimen, of the mature individuals the males seem to have significantly larger ranges than the female.

In addition to home ranges, centers of activity have been plotted in Figures 7,8,9, and 10. The mean distance between centers of activity in P. leucopus of the forest is 7.6 meters, with a minimum distance of 5 meters and a maximum distance of 10 meters. Figures 8, 9, and 10 show centers of activity in the field to be a mean distance of 37 meters for M. pennsylvanicus, 42 meters for P. leucopus, and 32 meters for R. humilis. M. pennsylvanicus was the only species which had two centers of activity located at the same point.

Several parameters have been plotted in Figure 12 to compare small mammal activity with weather conditions during the study. In order to show more obvious transitions, minimum temperature and percent cloud cover were averaged in seven day increments and then plotted. From the figure, it appears that the hatched line indicating activity most closely follows that of percent cloud cover, but it may also be affected to some degree by the minimum temperature.

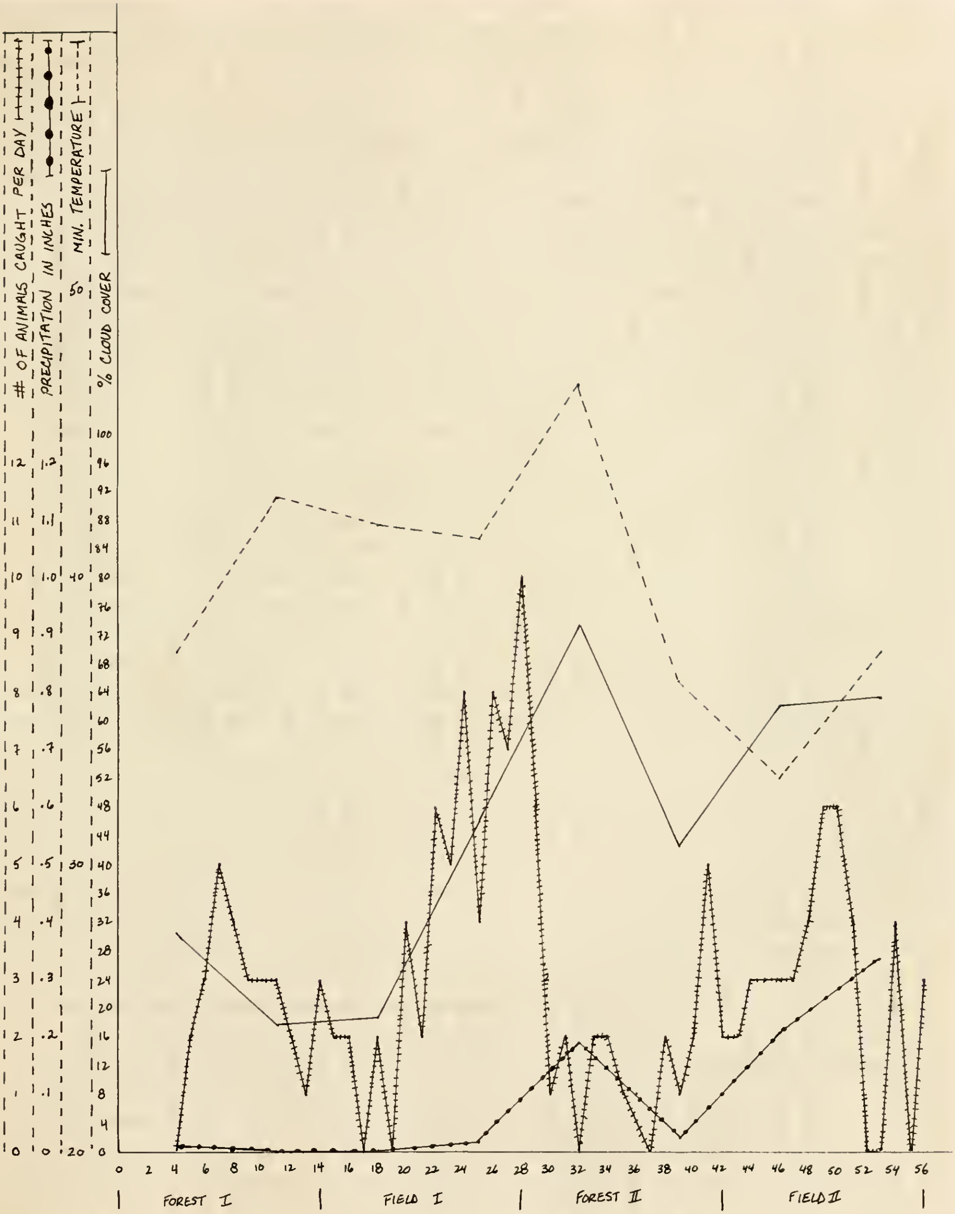


FIGURE 12. COMPARISON OF SMALL MAMMAL ACTIVITY AND CHOSEN WEATHER CONDITIONS.

DISCUSSION

It can be seen from the results of this study that there does indeed exist a significant difference in the species encountered in the two plots presented. Physical requirements and adaptations of the species present preclude their invasion of drastically different areas, thus favoring the continuation of features well adapted to each habitat. Patterns of distribution and range size are also specific for each habitat and the environmental factors present at the time of the study. Because of the variable nature of these factors, range sizes, species abundance, distribution, and perhaps even species occurrence may fluctuate in different seasons and circumstances, making this study completely applicable only to a specific habitat at a specific time of year. Nevertheless, knowledge of species characteristics in various habitats and conditions can be helpful in predicting the occurrence of small mammals in differing conditions.

Diversity and abundance are both concepts used to measure differences in selected habitats. It has been shown that as an ecosystem develops it becomes more diverse. One would therefore expect to find a greater diversity of small mammals in the forest than in the field, the

latter being a "younger" ecosystem. On the contrary, the results of this study seem to refute that statement. One explanation for this apparent contradiction may relate to the types of animals filling the available niches in each situation. While there is only one mouse species in the forest, there may be several other ecologically similar types of mammals inhabiting the area, perhaps of a more arboreal nature. There is much evidence of squirrel activity in the forest plot, and several chipmunks have been heard and seen. In the field plot the vegetation is not suitable for squirrels or chipmunks; different types of small rodent are better suited to this habitat. Consequently, small mammal diversity and biomass in the forest may be far higher than this study indicates, perhaps because most forest rodents are too large to be caught in the traps used. Even though the traps were too small to capture them, it did not take many days before the squirrels of the area became adept at flipping the traps over and scraping out the peanut butter. The absence of trees and fallen logs in the field forces small mammals to remain at or below ground level, and it may aid their survival to remain small and relatively inconspicuous. The forest may more easily support larger mammals of a more diurnal and arboreal nature because of the large

number of trees. Thus, though the diversity of mice is greater in the field than in the forest, the forest may still support an equal or greater diversity and biomass of rodents.

Competition can be seen to influence the occurrence of species in many types of habitats; the species competing more successfully in an area will appear more frequently than that competing less successfully. These competitive interactions may be inferred in the species inhabiting the field plot. Maximum use of the available habitat has been achieved through an adaptation toward different peaks of use by each species. While *M. pennsylvanicus*, the most numerous species, is quite active during the daylight and early evening hours, the smaller populations of *P. leucopus* and *R. humilis* are more active at night and during the early morning hours. Kaye (1961) also found *R. humilis* to be constantly on the move at night, and more or less sedentary during the day. This reduces competition between the most numerous species and the two less abundant species, allowing both to exist in higher numbers in the same area.

Characteristics allowing different species to inhabit the same area may also permit the existence of one species in several areas. In this study, *P. leucopus* was found in both the forest and the field. Jameson (1955)

also found that *Peromyscus* could exist in a variety of habitats, often feeding on the fruiting parts of plants. Mc'Closkey (1975) found that *Peromyscus* eats a large amount of insect matter. These two researchers found *Microtus* to exist almost exclusively in grassy areas, feeding mainly on the vegetative parts of monocots. Thus, while *Peromyscus* can find suitable food in forest or field, *Microtus* can find its preferred food only in grassy fields.

While this study seems to indicate that *P. leucopus* was far more numerous in the forest than in the field, this may not be true to such a great extent. While the field habitat is relatively uniform, the forest habitat has what seem to be islands of optimum *P. leucopus* habitat adjacent to unsuitable areas. Thus, the calculation determining that there are 43 *P. leucopus* per hectare in the forest is based on a fairly small section of productive habitat. Animals were trapped in very few places in the forest plot, but those favorable areas seem to support a great number of individuals. In an overall view of the forest *P. leucopus* population, it seems to be larger than that of the field, thus supporting the Lincoln Index calculation, but because the habitat is so variable in the forest the number of *P. leucopus* is probably not as large as the calculation indicates.

Three other factors affecting the validity of the Lincoln Index are its three assumptions. The first assumption is that there is no birth, death, immigration, or emigration in the area, which cannot hold for an eight-week trapping session. The second assumption is that all animals are equally catchable. Gottschang (1965) found Reithrodontomys reluctant to enter his traps, thus invalidating the second assumption. In contrast to Gottschang's results, my findings indicate a higher return rate for R. humilis than any other species (Table 2).

TABLE 2. Return Capture Rate in the Field

#	species	# Caught > 4X	%
16	M. pennsylvanicus	5	31%
5	R. humilis	4	80%
7	P. leucopus	2	29%

These conflicting results also cast some doubt on the second assumption. The third assumption is that the marking process in no way affects the animals, and that they move freely through the area. Getz's (1961) finding that marked Microtus were more easily captured than unmarked individuals makes this assumption questionable. Depsite doubts concerning the accuracy of the Lincoln Index, it is useful in determining relative abundances,

and therefore has been employed in this study. It must be recognized, however, that exact numbers are questionable, especially in study areas where vegetation distribution is not uniform.

One result of fluctuating density and abundance of animals is a differing degree of range overlap among individuals of the same species. Brown (1962) states that the female vole or mouse usually exhibits territorial behavior to a higher degree than the male, and concludes that "overlapping of ranges is not uncommon except in the case of breeding females." It then follows that, especially for breeding females, centers of activity should be widely spaced despite range overlap. The centers of activity plotted in this study, while based on a technique some researchers question, support this prediction. Many of the ranges overlap with one or more others of the same species, but centers of activity remain separated. Only in two female *M. pennsylvanicus* does the center occur at the same place, and that point is located at a trap on the outer edge of the grid. An evaluation of the other *M. pennsylvanicus* ranges and centers of activity indicates that, had the grid been extended toward the west, more accurate capture data would show these centers of activity to be separated.

Population size and resulting intraspecific

competition affect patterns of distribution and the spacing of centers of activity. When the distribution of suitable food and cover is uniform, such as in the field, centers of activity remain separated by large distances. Where preferred habitat is concentrated in islands, such as in the forest, ranges are forced to overlap to a greater extent. Nevertheless, the centers of activity of the three female P. leucopus in the forest plot are clearly separated despite extensive range overlap. Thus it seems that, while habitat distribution greatly affects the actual distance between activity centers, there is usually a tendency, at least among females, toward separation of those parts of the range which are most heavily used.

The effect of specific weather conditions on small mammal activity is not clear in this study, but data presented indicate that activity is affected by changes in the weather. Pearson (1960) found Reithrodontomys activity on runways slightly higher on rainy and moonless nights. As has been mentioned earlier, Getz (1961) and Gentry and Odum (1957) also found variation in small mammal activity as a result of changes in weather conditions. The changes in total catch throughout this study seem to be correlated with fluctuations in cloud cover and perhaps also with changes in minimum temperatures. More specific data are needed to support either view with

confidence. The sudden drop in catch on Day #28, however, is probably not a result of weather. On that day traps were transferred from the field to the forest, and seldom were many animals caught on the first night in an area. Because of differences in absolute numbers of animals caught in the two plots, the trends in numbers of animals caught must be the only correlate with weather conditions; to compare actual numbers of animals caught per day would be misleading. Using a more subjective viewpoint, it did seem to me that, as Gentry and Odum (1957) noted, more mice, especially Microtus, were captured on warm, cloudy nights than on cold, clear nights. Though more detailed experimentation is necessary to determine more accurately the effects of weather on activity, the graph presented with this study does show correlations between small mammal activity and certain weather conditions.

This study of small mammals in the forest and old field, while completely applicable only in certain circumstances, has helped to make obvious the differences between these two habitats. It has been shown that, because of adaptations present in each species, the occurrence, abundance, and home range sizes of small mammals in each habitat are markedly different. While it seems that centers of activity are usually separated in both

habitats, the actual distances between them vary depending upon the distribution of vegetation. To further elucidate this theory, perhaps additional research could focus on intermediate or very different habitats, along with an evaluation of factors affecting the habits and activity of small mammals.

ACKNOWLEDGEMENTS

I would like to thank Lee A. Applegate for taking the photographs appearing on pages 19, 20, 21, 22, 28, and 29, and, along with Carol Robinson, for accompanying me during field work. I also appreciate the advice and guidance of Dr. Ernest P. Edwards, Duberg Professor of Ecology, Sweet Briar College.

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