

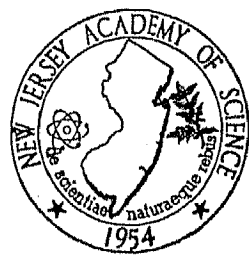
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Small Mammals in the Early Stages of Old Field Succession on the New Jersey Piedmont

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Abstract: Live trapping was done in four adjoining cover types in central New Jersey: a mature oak forest, a sorghum field, and fields in the first and third years of abandonment. Peromyscus leucopus was found in the forest and the first year field. Mus musculus occupied the sorghum field during the summer. Microtus pennsylvanicus was found occasionally in the successional fields and Blarina brevicauda was found in all four cover types.

Studies of small mammals have often been used to illustrate the changes which occur during succession. Previous work has been done in Michigan by Beckwith (1954), in Illinois by Wetzel (1958), and in central New Jersey by Pearson (1959). The purpose of this study was to examine the small mammal populations in fields in the early stages of succession. Populations in a cultivated field and a mature forest were also observed to determine which species were available to occupy fields at the time of abandonment. The amount of movement of animals between cover types and any seasonal variation in the species using the different cover types were also noted.

Secondary succession in the Piedmont of New Jersey has been described by Bard (1952). In the first year after abandonment fields are dominated by several species of annual herbs. Perennial herbs

such as goldenrods and asters become dominant after the first year and continue to be important until about the fifteenth year. *Andropogon scoparius*, a perennial grass, begins dominance at about the seventh year and largely replaces the goldenrods and asters by the fifteenth year. Trees and shrubs enter the fields soon after abandonment but are not visible above the herbaceous cover until between five and ten years after abandonment. While the trees and shrubs extend their cover there is also a disintegration of the dense *Andropogon* cover. By the sixtieth year after abandonment a forest is developed which contains most of the species found in the mature oak forests of the region.

The William L. Hutcheson Memorial Forest in East Millstone, New Jersey, provided a suitable location for this study because it contained not only a mature forest but cultivated fields and fields abandoned at intervals to provide examples of the pattern of succession. In addition to the study of secondary succession in the area by Bard (1952), the plant communities of the Hutcheson Memorial Forest have been described by Monk (1957).

A diagram of the vegetation types in the study area is shown in Fig. 1. They included a sorghum field, a field in the first year of abandonment, a field in the third year of abandonment, and a mature oak forest. The sorghum field was ploughed in May 1960 and young sorghum and soybean plants were showing when trapping began in June. Yellow

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rocket (*Barbarea vulgaris*) soon became the most conspicuous plant in the field, developing into a uniform cover that lasted until July when the sorghum and soybeans grew over it. Ragweed (*Ambrosia artemisiifolia*) was common in this field in July and August and formed a dense cover where the cover of sorghum was sparse. During the entire summer this field had a dense and homogeneous plant cover with practically no space not shaded by plants. There was, however, open space between the rows of sorghum at ground level. In September the field was mowed and raked leaving it bare except for the remnants of sorghum, soybeans, and associated plants.

The field in the first year of abandonment was ploughed in the spring of 1959 and planted with sorghum and soybeans. When trapping began in November 1959 this field contained remnants of the sorghum and a few rosettes of plants which had grown with it. In May this field was dominated by radish (*Raphanus* sp.) and yellow rocket. Fleabane (*Erigeron annuus*) became conspicuous in June, developing its best growth in a 20 foot wide strip along the forest edge. Ragweed reached its maximum in August and September and filled up much of the space that had previously been vacant. The cover of this field developed from bare ground with scattered crop remnants and rosettes in the autumn and winter to a continuous cover of rosettes and other low herbs with scattered taller herbs by late summer.

The field in the third year of abandonment was last ploughed in the spring of 1957 when it was planted with sorghum. Through the winter of 1959-1960 it was covered by a continuous growth of grasses and other low herbs with the dead stems of many taller herbs still standing. In May yellow rocket was the most conspicuous plant in this area followed by fleabane in June. Common plantain (*Plantago rugelii*) was more abundant in this field than it was in the first year field and in some places formed an extensive, continuous cover. In late summer and autumn asters and scattered plants of goldenrod dominated this cover type. This field differed from the first year field in having a continuous cover during the winter and a denser vegetation during the following summer. The cover developed during the summer of 1960 was definitely two-layered with an almost continuous layer of low herbs growing under the taller herbs.

The forest area used in this study was a mature oak forest. In most of the area where trapping was done the larger trees formed a closed canopy. *Cornus florida* was the dominant subcanopy tree species. The most abundant shrub was *Viburnum acerifolium* which occurred in scattered thickets. This shrub and poison ivy (*Rhus radicans*) reached their best development at the forest edge and in areas where the canopy had been disturbed by

falling trees. From May through July much of the forest floor was covered by May apple (*Podophyllum peltatum*). Several other herbs occurred in the area but were not important as cover. During most of the year the cover for small mammals in the forest consisted of deep leaf litter with scattered shrub thickets and fallen logs. The forest presented the most varied habitat available to small mammals in the study area with cover ranging from open leaf litter to dense shrubs and herbs and fallen trees providing many places of concealment.

Methods

Methods included live trapping, dyed bait stations, and general observations. Small Sherman live traps were placed on a grid with seven lines of ten traps each. Six of these lines were placed fifty feet apart. The seventh line was placed inside the forest one hundred feet from the line at the forest edge. From November 1959 through May 1960 there were in addition to the two lines in the forest three lines which ran across both successional field types. From June through October two additional lines were placed in the sorghum field. Traps were generally placed within five feet of the grid stations. Logs and runways were used as trap locations whenever possible. The usual trapping period was two or three days. Peanut butter was used as bait from November through May, being replaced by oatmeal from June through October. Cotton was placed in the traps as nesting material. The traps were checked each morning and bait and cotton were replaced when necessary. The captured animals were marked by toe clipping and released. Data on species, sex, reproductive condition, age class, location of capture, and behavior when released were also noted. These data were recorded on McBee Keysort cards.

New (1958) described a method for observing the activity of small mammals which consisted of placing dyed food in bait stations and observing the distribution of dyed feces. A modification of this method was attempted in this study. Three lines of five milk carton bait stations were used. One line was inside the forest, one ran through both successional field plots, and one was in the sorghum field. Oatmeal was dyed with Uranine, Fast Green FCF, and Rhodamine B and was placed in the bait stations with a different dye used in each line. Thirty-five four inch ceramic tiles were placed at alternate trap locations. Bait stations and tiles were checked for dyed feces for a week after dyed bait was put out.

Results and Discussion

In 4,210 trap nights during the months of November 1959 through October 1960 there were a total of 327 captures of small mammals in the forest and the adjoining fields. The species captured

were *Peromyscus leucopus*, *Mus musculus*, *Microtus pennsylvanicus*, *Blarina brevicauda*, and *Napaeozapus insignis*.

Peromyscus Leucopus

The white-footed mouse was the most abundant small mammal observed in this study. There were a total of 215 captures which included 200 captures of 64 marked mice, 11 of mice which escaped before they could be examined, and four captures of dead, unmarked mice. The number of *Peromyscus* captures in the different cover types is summarized in Table 1.

Table 1. Total captures of *Mus* and *Peromyscus* in four cover types.

Cover Type	Sorghum Field		First Yr. Field		Third Yr. Field		Mature Forest	
	M.m.	P.I.	M.m.	P.I.	M.m.	P.I.	M.m.	P.I.
Month								
Nov.	—	—	4	2	7	4	0	21
Dec.	—	—	3	1	2	0	0	13
Jan.	—	—	0	7	0	0	0	15
Feb.	—	—	0	6	0	1	0	11
March	—	—	0	1	0	0	0	5
April	—	—	0	0	0	1	0	4
May	—	—	0	0	0	0	0	3
June	3	0	1	2	0	0	0	15
July	27	0	0	12	0	1	0	36
Aug.	12	0	0	7	1	0	0	31
Sept.	5	0	2	1	1	0	0	6
Oct.	2	0	1	1	0	0	0	6
Total	49	0	11	40	11	7	0	166
Trap Nights	660		1065		1065		1420	

Repeats are included. 0 indicates traps set but no captures, — indicates no traps set.

In the forest the location of traps had an effect on their success. The nine traps set on or near logs or brush piles had a total of 113 captures while the eleven traps which were not located on or near logs or brush piles had a total of 53 captures. Often when mice were released they would walk along logs and fallen branches before disappearing under the leaf litter. The fact that the majority of captures were associated with logs or branches on the ground indicates that these objects serve as pathways for the mice in their movements in the forest.

Although both the first- and third-year successional field plots were equally accessible from the forest, the majority of captures occurred in the first-year field. During the months of June, July, and August when trapping was most frequent there were 21 captures of *Peromyscus* in the first year field and one in the third year field. Apparently, the more open cover in the first year field was a more suitable habitat for this species than was the dense mat of cover which had begun to develop in the third year field. There were no captures of *Peromyscus* in the sorghum field during the period of trapping in that habitat.

Because of the unequal spacing of the trap lines used in this study the capture data are not suitable for the calculation of home ranges. The capture data do indicate the amount of use of the successional fields by this species. Twenty-three marked *Peromyscus* were captured in the fields during the entire study period. Most of these mice were captured in the fields only once and were apparently transients from other habitats. Seven mice were captured more than once in both the forest and the successional fields.

Maximum use of the successional fields occurred in January and July. The January movement of mice from the forest occurred at a time of probable food scarcity which would require the mice to range over larger areas. The summer movement into the fields coincided with high population density in the forest which would lead to conflict causing some of the mice to move to a less crowded habitat.

Peromyscus leucopus is primarily a forest species but is also able to occupy fields in certain stages of succession. The distribution of *Peromyscus* and the other species in the successional fields will be discussed in a separate section.

Mus Musculus

There was a total of 82 captures of house mice in this study. All of these occurred in the field cover types. In November and December of 1959 there were eight captures of this species in each of the successional fields. There were no captures of house mice during the months of January through May, 1960. From June through October, 1960, this species was found principally in the sorghum field with only three captures in each of the successional fields.

The first summer captures of house mice were made when the sorghum was about six inches tall. As the sorghum developed a dense cover the number of mice in the field increased. Because of the reduced number of trap nights in September and October, it is not possible to determine the effect of the mowing of the sorghum on the distribution of these mice. The three captures in the first year field occurred after the mowing, but captures of both new and previously marked animals continued in the sorghum field at this time. None of the mice captured in 1959 was recaptured in 1960.

Other Species

The other species captured in this study were the meadow vole (*Microtus pennsylvanicus*), the short-tailed shrew (*Blarina brevicauda*), and the woodland jumping mouse (*Napaeozapus insignis*).

The meadow vole was captured only in the successional fields. There was a total of 17 captures of this species. Thirteen of these occurred in the third year field. The captures in the first year

field were made late in the season in locations where the cover was especially dense. This association of *Microtus* and dense cover will be discussed more fully in a later section on small mammals and succession.

The short-tailed shrew was captured in all the cover types during the summer and autumn months. There were 19 captures of this species. Most of these animals were marked but only one was re-taken alive. There was one capture of this species in the sorghum field, eight in each of the successional fields, and two in the forest. The fact that there were only two captures of shrews in the forest does not indicate that they did not use this habitat. The soil beneath the deep leaf litter of the forest contained a system of runways which were probably much used by shrews. Had the traps in the forest been placed in the runways beneath the litter, they probably would have revealed a population of shrews which served as a source of animals moving into the successional fields.

One woodland jumping mouse was captured in the third year field in July. This mouse was marked but not captured again. Jumping mice were seen in the forest twice during the summer.

Small Mammals and Succession

If it is assumed that each species is equally liable to capture in each habitat it uses, the rate of capture of a species in a cover type can be used as an index of habitat utilization. The use of the different cover types by small mammals is

summarized in Table 2. The discrepancy between the number of *Blarina* captures in the forest and the probable abundance of that species there has already been noted. For the other species, however, there was probably no difference in liability to capture in the different cover types.

Table 2. Captures of small mammals in four cover types, June-October 1960.

	Sorghum Field	First Yr. Field	Third Yr. Field	Mature Forest
Mus	7.42	0.60	0.60	0
Peromyscus	0	4.64	0.20	14.24
Blarina	0.15	1.61	1.61	0.30
Microtus	0	0.80	2.63	0

Figures indicate captures per 100 trap nights in a cover type.

The sorghum field was first trapped in the beginning of June, but captures of house mice did not begin until the middle of that month when the sorghum was approximately six inches high. House mice continued to use this field as long as trapping was continued. The only evidence of use by any other species was one capture of a short-tailed shrew.

Pearson (1959) observed house mice in fields which had a dense cover of *Andropogon*. Beckwith (1954) found this species in fields at the time of abandonment and in successional fields with both open and dense cover. Wetzel (1958) found occa-

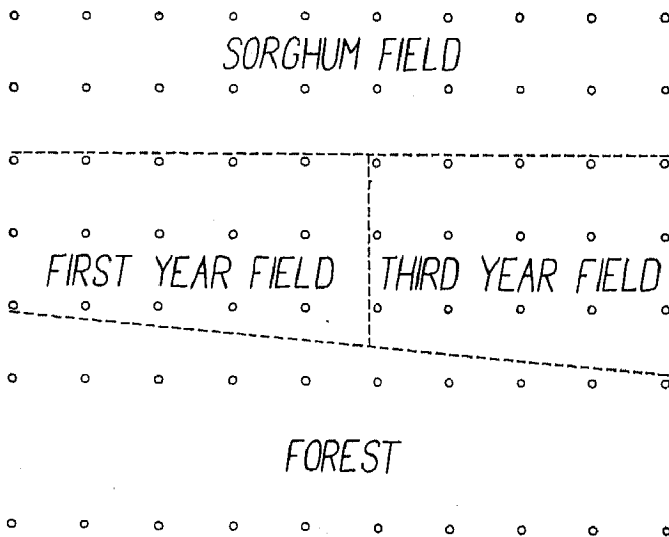


Fig. 1. Vegetation types in the study area. Circles indicate trap locations.

sional populations of house mice in the early stages of succession on strip-mined land and observed that these populations were apparently not permanent. The lack of winter captures in our study indicates that this population left the fields during the winter and apparently was renewed in the summer by the movement of mice from nearby buildings. The proximity of buildings appears to be more important than the cover type in determining the distribution of this species.

The vegetation of the first year and the third year fields was quite similar in plant species but different in structure. In the first year field there was much open space near the ground. The third year field had a well developed two layered vegetation with an almost continuous layer of tall herbs over a dense layer of low herbs and matted stems from previous years. Structurally, the cover of the first year field was similar to the open herb cover found in the forest while the cover in the third year field resembled the dense mat produced by *Andropogon* in older fields.

The meadow vole (*Microtus pennsylvanicus*) was captured most often in the third year field. These captures of this species which occurred in the first year field were in a wet area where the cover was more dense than that of the rest of the field. All trap locations where *Microtus* was captured were in areas with a dense cover of low herbs.

Eadie (1953) found a significant association between *Microtus* activity and dense cover by weighing samples of vegetation from areas of high and low activity. Mossman (1955) used dropping boards as an indication of the activity of small mammals in prairie vegetation in Wisconsin and measured light intensity at these stations. A significant relationship was found between low light intensity and high activity of small mammals including *Microtus*. The association between *Microtus* and dense cover has also been observed in an artificial habitat by Wirtz and Pearson (1960). In this study *Microtus* captures occurred irregularly during the summer. They often occurred during wet weather, perhaps because of flooding of dense sedge and grass cover east and west of the study area.

The use of New's dyed bait method in this study produced no satisfactory results. In the first trial the bait was eaten but no feces were recovered from the bait stations or tiles. In the second trial when larger quantities of bait were used some feces were recovered from the bait stations, but none of these contained any dye. One mouse was captured which had stained fur indicating that it had eaten dyed bait. The only times when feces were found on tiles were during periods when *Microtus* were being captured in nearby traps. Many of the bait stations were in habitat used by *Peromyscus*. New (1958) reported a very low rate of recovery of the dyed feces of this species at bait stations.

Peromyscus leucopus was abundant in the forest

and this habitat served as a source of mice moving into the successional fields. Although both the first and third year fields were equally accessible to mice moving from the forest, there were 21 captures of this species in the first year field and only one capture in the third year field during the summer months. This distribution of captures suggests an avoidance of the dense cover of the third year field by *Peromyscus*. There were no captures of *Peromyscus* in the sorghum field during the period of trapping in that habitat.

Beckwith (1954) noted that in Michigan the prairie deer mouse (*Peromyscus maniculatus bairdi*) was the most abundant small mammal in fields at the time of abandonment and in the early stages of succession. As the cover in the fields became more dense the number of *Peromyscus* declined and *Microtus* became dominant.

With the beginning of the tree and shrub stages *Peromyscus leucopus* became the dominant species and maintained its dominance after the development of a mature forest. Wetzel (1958) recorded a similar temporal distribution of these two species of *Peromyscus* and observed that the increase of *P. leucopus* in the late stages of succession did not compensate for the decrease in grassland forms but was probably associated with the development of a closed canopy and densites for the mice.

Pearson (1959) found that in New Jersey *P. leucopus* was found in both the early and late stages of succession. The youngest field observed by Pearson was seven years old and contained both goldenrod-aster and *Andropogon* cover. Captures of *Peromyscus* were associated with the goldenrod-aster cover while *Microtus* dominated the *Andropogon*. Pearson concluded that the *Microtus* excluded the *Peromyscus* from the *Andropogon* cover by aggressive behavior. The aggressiveness of *Microtus* toward *Peromyscus* has also been noted in cage studies by Wirtz and Pearson (1960).

Aggressive behavior of house mice may explain the lack of *Peromyscus* captures in the sorghum field. King (1957) observed caged house mice and deer mice and found that the deer mice were recessive in most encounters. The presence of house mice in the sorghum field together with the dense cover found there may have been the factors excluding *Peromyscus* from this habitat. The distance from the forest to the field which was less than 150 feet in most places was not sufficient to limit accessibility of the field to *Peromyscus* moving from the forest. Stickel and Warbach (1960) recorded movements of *Peromyscus* from a woodlot into surrounding farm land as far as half a mile away.

The non-occurrence of *Peromyscus* in the goldenrod-aster cover of the third year field observed in this study at first seems to contrast with the abundance of this species in the goldenrod-aster cover in the seven year old field observed by Pear-

son (1959). Actually, the cover in these two stages differed in structure. In the third year field there was a dense layer of low herbs creating conditions similar to those found in *Andropogon* cover. By the seventh year the goldenrod and asters had excluded the low herbs beneath them leaving open space near the ground.

It is difficult to attribute the non-occurrence of *Peromyscus* to conflict with *Microtus*. Voles were present in this field only at irregular intervals during the summer and autumn. It is likely that there is some orientation of *Peromyscus* that leads this species to avoid dense cover even when it is not occupied by *Microtus*. Comparison of the results of this study with those of Pearson (1959) indicates that *P. leucopus* is abundant in the open cover of fields in the first year after abandonment but declines as a dense cover develops by the third year. With the elimination of the low herbs beneath the goldenrods and asters, *Peromyscus* again increases and occupies the fields until the development of *Andropogon* cover between the seventh and fifteenth years. *Peromyscus* does not again become dominant until the development of tree and shrub cover late in succession.

The short-tailed shrew (*Blarina brevicauda*) was found with equal frequency in both of the successional fields. This species probably moved from the forest into the fields although the placement of traps in the forest was such that shrews were seldom captured there.

Pearson (1959) found this species in all habitats sampled and concluded that there was no significant association of *Blarina* with any particular cover type.

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