EFFECTS OF A CORNFIELD UPON THE MOVEMENT OF *PEROMYSCUS LEUCOPUS*

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ABSTRACT. — Movement of *Peromyscus leucopus* between areas of abundant natural food and an unharvested crop of corn is discussed. Information from data of 100,480 trap-nights is presented. Records of 298 movements of 183 white-footed mice averaged 151 feet. Maximum recorded movement in one day was 450 feet. Males averaged greater distances per movements, greater time intervals between capture, and greater number of captures than females. *P. leucopus* moved from areas of abundant natural food into a cornfield and became established therein. The population within the cornfield was due to initial migration, and subsequent reproduction, rather than continual immigration. Possible effects of inundation are noted.

Investigators have found food supply to be a factor limiting the abundance (Linderborg, 1941; Brown, 1953; Pearson, 1953; Bendell, 1959) as well as the local distribution (Hamilton, 1941; Getz, 1961) of small mammals.

In the present study, approximately one acre (43,290 square feet) of Pioneer-312A field corn was planted in an area of abundant natural food. Movements of small mammals between the areas of abundant natural food and the cultivated crop then were studied (Turner, 1966a). Effects of the cornfield upon movements were measured through capture-success per traplines as well as movement patterns in relation to the cornfield.

Although this study is concerned primarily with *Peromyscus leucopus*, a brief mention will be made of the other species captured.

DESCRIPTION OF AREA

The area of study was located in a moist bottomland located in the W½, NE¼, SE¼, SW¼, of Section 32 situated in T9S, R1W, 3rd P. M., Jackson County, Illinois. The research area (FIG. 1) was two-tenths mile southwest of the Carbondale City Reservoir.

Vegetation. — The introduced cornfield was bordered on the northern, southern, and eastern sides by a wooded area. The western border of trees extended only 50 yards beyond the plot and was succeeded by an open field. A steep, wooded hillside was located 50 yards south of the cornfield, and numerous intermittent streams drained the bottomland woods (FIG. 1).

The vegetation of the four borders was fairly uniform in species composition. In general, the area seemed to be in a transitional stage. A climax was not discernible due to the mixed nature of the components.

The area adjacent to the streams was dominated by large box elder (*Acer negundo*), sycamore (*Platanus occidentalis*), honey locust (*Gleditsia triacanthos*), and cottonwood (*Populus deltoides*). Other trees found in the area were winged elm (*Ulmus alata*), slippery elm (*Ulmus rubra*), white ash (*Fraxinus americana*), green ash (*Fraxinus lanceolata*), red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), sassafras (*Sassafras albidum*), hackberry (*Celtis occidentalis*), flowering dogwood (*Cornus florida*), wild black cherry (*Prlnus serotina*), persimmon (*Diospyros virginiana*), and hazelnut (*Corylus americana*).

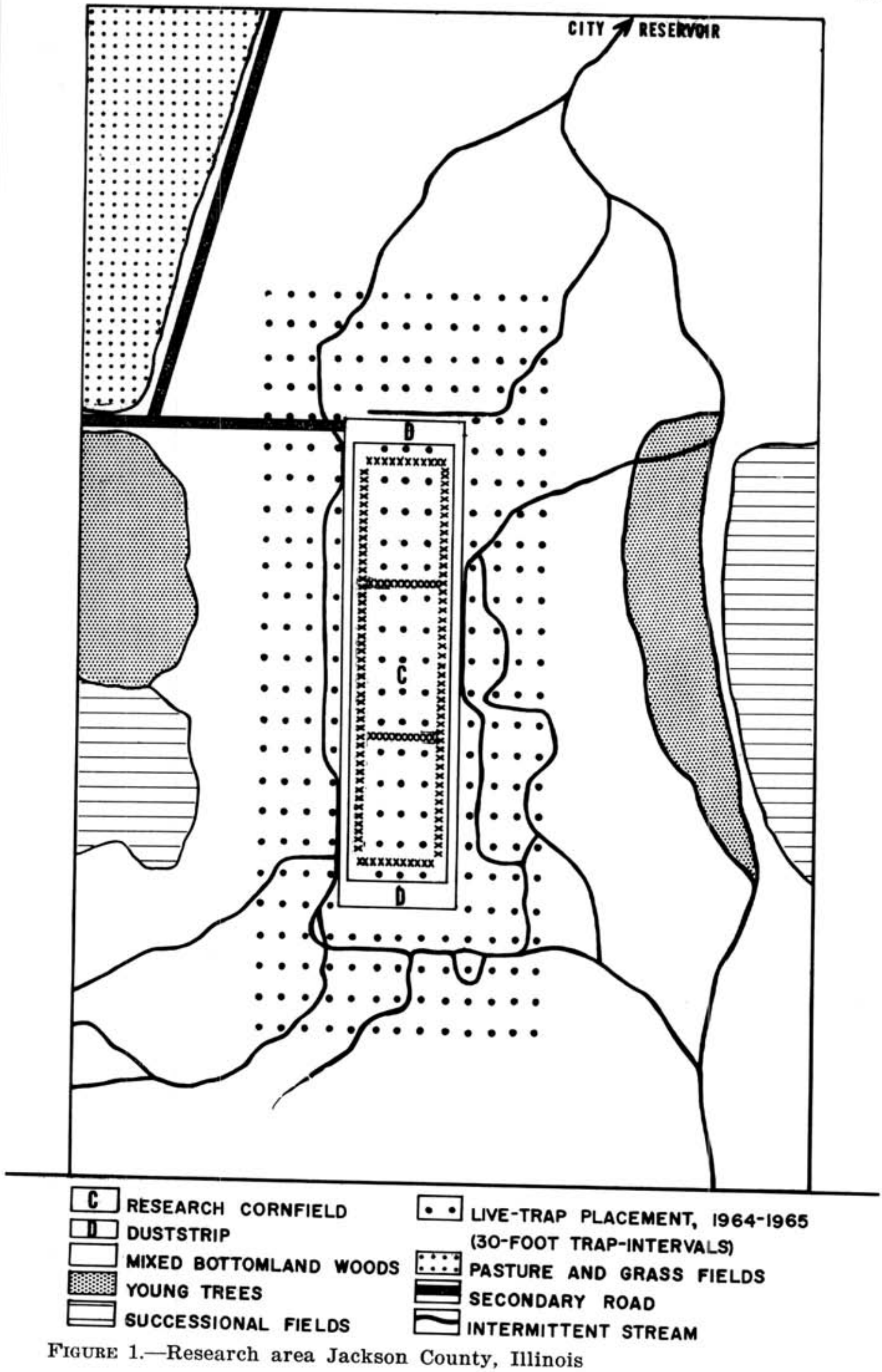

FIGURE 1.—Research area Jackson County, Illinois

Of scattered distribution were shingle oak (*Quercus imbricaria*), swamp white oak (*Quercus bicolor*), shagbark hickory (*Carya ovata*), bitternut hickory (*Carya cordiformis*), pignut hickory (*Carya glabra*), river birch (*Betula nigra*), and red cedar (*Juniperus virginiana*).

The most abundant trees adjacent to the streams were cottonwood, sycamore, and box elder. Red cedar and river birch were scarce; swamp white oak was rare. The peripheral woody vegetation of the northwestern and eastern borders contained large stands of young box elder, ash, cottonwood, and slippery elm. Fallen logs were abundant throughout the area and leaf-litter was evident in most seasons.

The woods contained a rich understory. Suffruticose and viny vegetation often were encountered in dense thickets. Blackberry (*Rubus ostryifolius*), dewberry (*Rubus flagellaris*), trumpet creeper (*Campsis radicans*), and honeysuckle (*Lonicera japonica*) were extensive in some areas. Cat-brier (*Smilax rotundifolia*), wild yam (*Dioscorea villosa*), buttonbush (*Cephalanthus occidentalis*), and winter grape (*Vitis cinerea*) were scattered throughout the understory. Grape lianas were suspended from many of the larger trees.

Commonly, the herbaceous understory was composed of touch-me-not (*Impatiens biflora*), poison ivy (*Rhus radicans*), wood nettle (*Leportea canadensis*), goosegrass (*Galium aparine*), and panic grasses (*Panicum anceps, P. latifolium, P. agrostoides*, and *P. oligosanthes*). Other herbs were virginia creeper (*Parthenocissus quinquefolia*), buttercup (*Ranunculus abortivus*), plantain (*Plantago major*), white avens (*Geum canadense*), wild rye (*Elymus* sp.), clearweed (*Pilea pumila*), fesque (*Festuca rubra*), fleabane (*Erigeron annuus*), wild garlic (*Allium canadense*), *false nettle* (*Boehmeria cylindrica*), ragweed (*Ambrosia artemisiifolia* and *A. trifida*), beggar's ticks (*Desmodium pauciflorum, D. paniculatum*, and *D. cuspidatum*), mayapple (*Podophyllum peltatum*), dogbane (*Apocynum cannabinum*), cup plant (*Silphium perfoliatum*), violets (*Viola striata and V. sororia*), snakeroot (*Sanicula canadensis*), wild petunia (*Ruellia strepens*), bluets (*Housonia* sp.), green dragon (*Arisaema dracontium*), dock (*Rumex acetosella*), false pimpernel (*Lindernia dubia*), thistle (*Cirsium* sp.), Venus' looking-glass (*Triodanis perfoliata*), milkweed (*Asclepias syriaca*), Carolina cranesbill (*Geranium carolinianum*), cinquefoil (*Potentilla simplex*), agrimonies (*Agrimonia parviflora* and *A. rostellata*), mountain mint (*Pycnanthemum flexuosum*), spring beauty (*Claytonia virginica*), meadow rue (*Thalictrum revolutum*), water hemlock (*Cicuta maculata*), aster (*Aster* sp.), groundnut (*Apios americana*), honewort (*Cryptotaenia canadensis*), passion flower (*Passiflora lutea*), garden phlox (*Phlox paniculata*), spanish-needle (*Bidens vulgata*), and elderberry (*Sambucus canadensis*).

A dust strip, averaging 16 feet wide, was constructed between the cornfield and the surrounding woods. The vegetation between the dust strip and the woods was distinct from the understory. Plants from this two to three foot wide strip were constantly invading the dust strip. Touch-me-nots again were numerous and fleabane present. Most of the plants, however, were different: indian tobacco (*Lobelia inflata*), dwarf St. John's wort (*Hypericum mutilum*), wood sorrel (*Oxalis stricta*), boneset (*Eupatorium serotinum* and *E. perfoliatum*), mercury (*Acalypha rhomboidea*), cuscuta (*Cuscuta* sp.), sedge (*Cyperus strigosus*), sundrop (*Oenothera pilosella*), red clover (*Trifolium pratense*), vervains (*Verbena hastata* and *V. urticifolia*), and smartweeds (*Polygonum hydropiperoides, P. lapathifolium*, and *P. pennsylvanicum*).

Pokeweed (*Phytolacca americana*), hog peanut (*Amphicarpa bracteata*), knotweed (*Polygonum virginianum*), and beggar's lice (*Hackelia virginiana*) were present at the base of the hill south of the cornfield. The northern slope of the hill supported slippery elm, bitternut hickory, shagbark hickory, red maple, sugar maple, redbud (*Cercis canadensis*), black haw (*Viburnum rifidulum*), hop hornbeam (*Ostrya virginiana*), spice bush (*Lindera benzoin*), Solomon seal (*Polygonatum biflorum*), wild ginger (*Asarum reflexum*), and Christmas fern (*Polystichum acrostichoides*). White oak (*Quercus alba*), black oak (*Quercus velutina*), red mulberry (*Morus rubra*), white ash, pignut hickory, and hop hornbeam were situated on the hillside.

Although traps were not placed in the open field west of the cornfield, close proximity of the field to the traplines warranted a vegetational survey. The field was entering a stage of shrub succession. Partridge pea (*Cassia fasciculata*), golden rod (*Solidago* sp.), and panic grasses formed the most abundant herbaceous cover. Of more general distribution were selfheal (*Prunella vulgaris*), wild carrot (*Daucus carota*), timothy (*Phleum pratense*), sweet potato vine (*Ipomoea pandurata*), wild lettuce (*Lactuca canadensis*), rush (*Juncus biflorus*), beggar's tick, fleabane, milkweed, thistle, boneset, and sedge. The suffruticose and woody invaders were blackberry, dewberry, winter grape, honeysuckle, poison ivy, honey locust, winged elm, slippery elm, wild black cherry, persimmon, shining sumac (*Rhus copallina*), sycamore, and shingle oak.

The nomenclature utilized in this vegetational resume follows Mohlenbrock and Voight (1959). Vegetative quadrats were not attempted. The traplines in the woods were arranged in concentric rectangles with each line transecting most of the vegetational types (FIG. 1). This arrangement lessened the need for quantitative vegetational measurements.

Fifty-one per cent of the enumerated species previously have been cited as possible foods of *Peromyscus leucopus* and other small mammals (Cogshall, 1928; Hamilton, 1941; Martin, Zim, and Nelson, 1951; Whitaker, 1963).

Precipitation. — Southern Illinois averages 38 to 46 inches of annual precipitation (Layne, 1958). Recorded precipitation during the eleven-month trapping period of 1964-65 was 41.1 inches, and the mean for this period was 3.7 inches per month (TABLE 1). December (6.2 inches) and January (5.1 inches) were the months of greatest precipitation. No rainfall was recorded during October.

Two rain guages within the research area, placed only 518 feet apart in similar conditions, recorded different amounts of rainfall. The two gauges differed by 1.3 inches in total precipitation during the 1964-65 trapping period. The rainfall of August 28 as well as the total rainfall for August, differed by 0.9 inch between gauges.

Flooding was a common occurrence in the bottomland woods and may have been a factor in small mammal survival in the area. The entire area trapped in 1964-65 was under water during early spring of 1964. Currents cleared the

TABLE 1.—Weather Data Collected at Study Area, 1964-65.

Month	Precipitation (in.)			Mean Temp. (F°)	
	Gauge 1	Gauge 2	Mean	Max.	Min.
June	2.4	2.4	2.4	86.6	65.0
July	4.1	4.4	4.2	86.3	66.4
August	3.7	4.6	4.2	86.8	64.0
September	4.4	4.7	4.6	79.9	56.8
October	0.0	0.0	0.0	72.5	39.1
November	3.2	3.3	3.3	62.6	36.4
December	6.2	6.0	6.2	44.9	27.1
January	5.2	5.0	5.1	47.6	24.5
February	4.9	5.1	5.0	48.6	24.8
March	3.1	3.1	3.1	48.1	28.5
April	3.2	3.2	3.2	73.7	50.0
Year Average	3.7	3.8	3.7	66.6	43.3

area of leaf-litter. Less extensive flooding occurred in January, February, and April of 1965. Enders (1930) says *Peromyscus leucopus* can tolerate a greater range of moisture conditions than any other rodent in Ohio, and Nicholson (1941) says that *Peromyscus leucopus* escapes excessive moisture or standing water by living and nesting in trees.

Temperatures. — Southern Illinois has 185 to 213 frost-free days annually (Layne, 1958). Winters are cool and mild; below zero temperatures were recorded on only two days during the winter of 1964-65. The lowest monthly mean of minimum daily temperatures (24.5°F) occurred in January, but the lowest monthly mean of maximum daily temperatures (44.9°F) as well as the lowest mean for daily range of temperatures (19.1°F) occurred in December.

Summers are hot and usually dry. In the summer of 1964, only one day above 100°F was recorded but 21 days were above 90°F. The highest monthly mean of maximum temperatures was in August (86.8°F), but July (66.4°F) had the highest mean of minimum temperatures. The highest mean for daily range of temperatures (33.5°F) was recorded in October, during absence of rainfall. Averages for the eleven-month trapping period are given in TABLE 1. Daily temperature readings were taken on a maximum-minimum thermometer.

Temperatures may not be limiting, for *Peromyscus leucopus* can acclimatize to low temperatures (Getz, 1961). Behavioral patterns of huddling, burrowing, and nest building further offset the adverse effects of cold weather (Sealander, 1953), and nocturnal, small mammals avoid exposure to high temperatures by day (Behney, 1936; Getz, 1959).

METHODS AND MATERIALS

The quadrat method of live-trapping was utilized, and the live-traps were modified after those of Burt (1927). Traps were baited with rolled oats and were checked daily. Captured mammals were toe-clipped for individual identification (Stains, 1962) and released at point of capture. Cotton material was placed in each trap during the winter. Stickel (1946a) recommends 50-foot trap-intervals when applying quadrat trapping methods. Mohr (1947) states that a system of small grids would be most accurate. In this study, ten-yard intervals were maintained between traps and between traplines.

During 1963, two lines of 104 small mammal live-traps were placed within the border of woods surrounding the cornfield. The cornfield proper was encircled with Museum Special snap-traps and two additional lines of snap-traps divided the cornfield into thirds; a total of 139 snap-traps was used (FIG. 1). Snap-trap intervals were ten feet along the length of the cornfield and snap-traps were placed between alternate rows of corn.

During 1964, three rows of live-traps replaced the snap-traps and ten-yard trap-intervals were maintained within the cornfield. Two rows of live-traps, additional to the two rows of 1963, were established in the surrounding woodlands in order to examine any influence of the cornfield upon more distant small mammal movement. A total of 285 live-traps were used.

Plant growth was eradicated within the dust strip between the cornfield and the surrounding woods. Vegetation, other than corn, was held in check within the cornfield. These disturbances may have lessened chance movements of small mammals into the cornfield.

Traplines were maintained for 19,858 trap-nights in 1963 and 80,622 trap-nights in 1964-65. A total of 100,480 trap-nights constituted the investigation of small mammal movement (TABLE 2). Actual number of trap-nights was less than the stated total due to malfunction of traps caused by inclement weather, animal disturbance, and miscellaneous causes. A pattern of sprung traps was not evident and random placement of malfunctioning traps was assumed.

Traplines varied in number of traps; therefore, numbers of rodents captured in each line were not comparable. Use of the unit "mice per 100 trap nights" enable comparisons of capture-success between traplines, months, and trapping periods. Likewise, comparison of movements within the cornfield (45 traps) to movements within the woodland (240 traps) were facilitated through use of this unit.

Each recorded movement was placed in one of four categories depending on the relation of that movement to the cornfield:

1. POSITIVE MOVEMENTS — Those movements oriented toward the cornfield; i.e., movements within the woodland from an outer trapline to an inner trapline, or movements from any trapline within the woodland to the trapline within the cornfield.

TABLE 2.—Trap-nights of 1963-65 in Jackson County, Illinois; Traplines C, 1, 2, 3, and 4.

Month	C	1	2	3	4	Total Catch
1963						
May	0	960	0	0	0	960
June	0	1,440	0	0	0	1,440
July	1,112	1,488	1,736	0	0	4,336
August	4,309	1,488	1,736	0	0	7,533
September	3,197	1,104	1,288	0	0	5,589
Total	8,618	6,480	4,760	0	0	19,858
1964-65						
June	810	0	0	0	0	810
July	1,395	1,440	1,680	1,920	0	6,435
August	1,395	1,488	1,736	1,984	1,224	7,827
September	1,350	1,440	1,680	1,920	2,160	8,550
October	1,260	1,344	1,568	1,792	2,016	7,980
November	1,080	1,152	1,344	1,536	1,728	6,840
December	1,260	1,344	1,568	1,792	2,016	7,980
January	1,395	1,488	1,736	1,984	2,232	8,835
February	1,260	1,344	1,568	1,792	2,016	7,980
March	1,395	1,488	1,736	1,984	2,232	8,835
April	1,350	1,440	1,680	1,920	2,160	8,550
Total	13,950	13,968	16,296	18,624	17,784	80,622

2. NEGATIVE MOVEMENTS—Those movements oriented away from the cornfield; i.e., movements from the trapline within the cornfield to any trapline within the woodland, or movements within the woodland from an inner trapline to an outer trapline.

3. NEUTRAL MOVEMENTS — Those movements oriented neither toward or away from the cornfield; i.e., movements from a trap of any trapline within the woodland to another trap within the same trapline, or movements from any trap within the cornfield to any other trap within the cornfield.

4. NON-MOVEMENT — Successive recaptures in the same trap.

Some movements indicated passage through the cornfield into the wooded border of the opposite side. These were treated as a movement toward the cornfield (positive movement) and a movement away from the cornfield (negative movement); half the distance of the total movement being accredited to each.

STRUCTURE OF THE POPULATION

In 1963, 116 small mammals were captured of which 39 were caught in snap-traps and eight died in live-traps, leaving a possible population of 69 marked mammals at the start of the 1964-65 trapping period. Although 110 mammals were captured in 1964-65, no recaptures were made of the small mammals marked during the 1963 trapping period. In the two years (1963-65), *Peromyscus leucopus* accounted for 81.0 per cent of the individuals captured, *Mus musculus* 9.7 per cent, *Blarina brevicauda* 4.0 per cent, and *Tamias striatus* 3.1 per cent. Incidental captures accounted for the remaining 2.2 per cent; three *Glaucomys volans*, and one each of *Zapus hudsonius* and *Rattus norvegicus*.

The population of 1964-65 was much reduced over that of 1963 as there were 60,764 more trap-nights in 1964-65 than in 1963 and only six additional animals taken. Extensive flooding in the spring of 1964 was the probable agent of reduction. Possible elimination of breeding stock through trap mortality in 1963 as well as the normal longevity of a species like *Peromyscus* also may have been factors in the reduction of the population size.

Effects of flooding were observed during the last three weeks of February,

1965. Though the flood was not as extensive as in the spring of 1964, standing water and cold temperatures probably were adverse conditions for small mammals. Rain in excess of four inches fell during a 5-day period (Feb. 8-12). Only three animals marked previously were captured following the flood (Turner, 1966b). The survivors were captured in the middle row of traps in the cornfield. This part of the cornfield was wet and muddy but was not under water as was the woodland. Unmarked mice first appeared in the outer lines of traps on February 27. Of the first ten unmarked mice captured after the flood, four were juveniles and six adults. Perhaps the new inhabitants resulted from dispersal of young (Stickel, 1954) and through increased activity of the breeding season.

The sex ratio of white-footed mice in the two years was 116 males and 67 females (TABLE 3, original captures). The age ratio was 39:144 in favor of adults. Layne (1958) reports white-footed mice breeding throughout the winter months in Southern Illinois, with a period of reduced or discontinued reproductive activity during late summer. In the present study, immature individuals were captured from July through April. Only one juvenile, a male, was captured in July. In the two years, 36 per cent of the original juvenile captures were made in December, 17.9 per cent in April, 12.8 per cent in August, and 10.2 per cent in September (TABLES 4 and 5 list these captures in terms of mice per 100 trap-nights). No juvenile was captured in May or June but trap data were meager for May. Aging was based on criteria used by Bendell (1959).

Although a greater percentage of the female *Peromyscus* population was recaptured, the total number of male recaptures was more than double that of the females. Researchers have found males often outnumber females in captures and movements (Townsend, 1935; Stickel, 1946b). Average number of captures per male (3.54) remained constant in both trapping periods (Table 3), and the maximum recaptures for a male was 12. Average number of captures per female in 1964-65 (2.91) fluctuated slightly from that of 1963 (3.17), and eight recaptures were maximal for a female. The overall average number of captures per individual mouse was 3.36.

Higher frequency of trap-encounter

TABLE 3.—Summary of *Peromyscus leucopus* Trap-data, 1963-65.

Year and Sex	Number of original captures: Taken once	Number of original captures: Taken two or more times	Average number of times captured	Number of recapture movements: None	Number of recapture movements: Some	Average trap-record longevity (days)
1963						
Males	13	42	3.55	47	93	24.0
Females	10	25	3.17	33	43	15.0
Total	23	67	3.40	80	136	20.6
1964-65						
Males	21	40	3.54	33	122	23.9
Females	5	27	2.91	21	40	26.3
Total	26	67	3.32	54	162	24.7
1963-65						
Males	34	82	3.54	80	215	23.9
Females	15	52	3.04	54	83	20.4
Total	49	134	3.36	134	298	22.7

TABLE 4.—Capture-success (*Peromyscus leucopus* per 100 trap-nights) in 1963.

Month	Trapline C				Trapline 1				Trapline 2			
	Male		Female		Male		Female		Male		Female	
	Yg.	Ad.	Yg.	Ad.	Yg.	Ad.	Yg.	Ad.	Yg.	Ad.	Yg.	Ad.
Original Captures												
May	....	....	....	....	.00	.63	.00	.00	....	....	....	....
June	....	....	....	....	.00	.97	.00	.69	....	....	....	....
July	.00	.09	.00	.09	.00	.40	.00	.20	.00	.81	.00	.40
August	.00	.02	.02	.00	.13	.20	.07	.13	.06	.06	.00	.06
September	.03	.03	.03	.06	.09	.09	.00	.09	.00	.16	.08	.31
Total (age)	.01	.04	.02	.04	.05	.46	.02	.25	.02	.36	.02	.25
Total (sex)	.05		.06		.51		.27		.38		.27	
Total (line)	.11				.78				.65			
Recaptures												
May	....	....	....	....	.00	.00	.00	.00	....	....	....	....
June	....	....	....	....	.00	.83	.00	.97	....	....	....	....
July	.00	.09	.00	.00	.00	1.34	.00	.20	.00	2.19	.00	.75
August	.02	.09	.00	.05	.54	.64	.20	1.01	.17	1.10	.00	.58
September	.00	.25	.00	.06	.00	1.09	.00	.18	.00	.31	.08	.85
Total (age)	.01	.15	.00	.05	.12	.83	.05	.53	.06	1.29	.02	.71
Total (sex)	.16		.05		.95		.58		1.35		.73	
Total (line)	.21				1.53				2.08			

by males has been attributed to greater wandering tendency (Townsend, 1935), larger range (Verts, 1957), or increased activity during breeding season (Hirth, 1959). Since it has been postulated that females travel shorter distances, traps were maintained at 30-foot intervals in an effort to equate the trap encounters of females with those of males. Although males averaged traveling greater distances than females in 1963, in 1964-65 females traveled greater distances per movement (TABLE 6). Greater activity rather than longer movements probably account for the higher frequency of males captured during this study.

Male *Peromyscus* had greater average trap-record longevity (23.9 days) than did females (20.4 days) as judged by lapsed recapture times; i.e., from the date of the first capture to the date of the last capture of a given individual.

TABLE 5.—Capture-success (*Peromyscus leucopus* per 100 trap-nights) per Month by Trapline, Sex, and Age, in 1964-65.

Month	Trapline C				Trapline 1				Trapline 2				Trapline 3				Trapline 4			
	Male		Female		Male		Female		Male		Female		Male		Female		Male		Female	
	Yg.	Ad.	Yg.	Ad.	Yg.	Ad.	Yg.	Ad.	Yg.	Ad.	Yg.	Ad.	Yg.	Ad.	Yg.	Ad.	Yg.	Ad.	Yg.	Ad.
Original Captures																				
June	.00	.00	.00	.25	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
July	.00	.07	.00	.07	.00	.49	.00	.14	.06	.24	.00	.19	.00	.31	.00	.10	...	...	...	...
August	.00	.14	.00	.00	.00	.00	.00	.00	.00	.06	.00	.06	.00	.05	.00	.05	.00	.00	.00	.08
September	.00	.07	.00	.00	.07	.07	.00	.00	.00	.00	.00	.00	.00	.05	.00	.00	.00	.00	.00	.00
October	.08	.08	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
November	.09	.00	.00	.00	.00	.09	.09	.00	.00	.00	.00	.07	.00	.00	.00	.00	.00	.00	.00	.00
December	.48	.32	.00	.08	.30	.22	.07	.00	.00	.06	.13	.06	.00	.00	.00	.00	.00	.00	.00	.00
January	.00	.00	.00	.00	.00	.07	.07	.07	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
February	.00	.00	.00	.00	.00	.07	.07	.07	.00	.00	.00	.00	.00	.00	.00	.06	.05	.00	.00	.00
March	.00	.07	.00	.07	.00	.07	.00	.07	.06	.00	.00	.00	.00	.05	.00	.00	.00	.00	.05	.00
April	.15	.00	.15	.00	.07	.00	.07	.00	.06	.00	.00	.06	.00	.00	.00	.00	.00	.05	.00	.00
Total (age)	.07	.07	.01	.04	.04	.11	.04	.04	.02	.04	.01	.04	.00	.05	.00	.02	.01	.01	.01	.01
Total (sex)	.14		.05		.15		.07		.06		.06		.05		.02		.01		.01	
Total (line)	.19				.22				.12				.07				.02			

Month	Trapline C				Trapline 1				Trapline 2				Trapline 3				Trapline 4			
	Male		Female		Male		Female		Male		Female		Male		Female		Male		Female	
	Yg.	Ad.	Yg.	Ad.	Yg.	Ad.	Yg.	Ad.	Yg.	Ad.	Yg.	Ad.	Yg.	Ad.	Yg.	Ad.	Yg.	Ad.	Yg.	Ad.
Recaptures																				
June	.00	.00	.00	.00	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
July	.00	.72	.00	.14	.00	.21	.00	.35	.00	.42	.00	.24	.00	.52	.00	.10	...	...	...	...
August	.00	.86	.00	.36	.00	.13	.00	.07	.00	.52	.00	.06	.00	.10	.00	.05	.00	.08	.00	.00
September	.00	.67	.00	.00	.07	.35	.00	.00	.00	.42	.00	.06	.00	.00	.00	.00	.00	.05	.00	.00
October	.08	.00	.00	.00	.07	.00	.00	.00	.00	.06	.00	.00	.06	.00	.00	.00	.00	.00	.00	.00
November	.00	.37	.00	.00	.00	.17	.17	.00	.07	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.06
December	.48	.24	.00	.08	.22	.00	.00	.00	.00	.06	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
January	.14	.43	.29	.36	.27	.40	.00	.13	.06	.06	.06	.00	.00	.00	.00	.00	.00	.00	.00	.00
February	.00	.56	.08	.24	.00	.15	.00	.07	.00	.00	.00	.00	.00	.00	.00	.00	.05	.00	.00	.00
March	.07	.14	.00	.14	.07	.07	.07	.07	.00	.06	.00	.06	.00	.00	.00	.00	.00	.00	.00	.00
April	.22	.37	.30	.22	.00	.00	.07	.07	.00	.18	.00	.00	.05	.21	.05	.00	.00	.05	.05	.00
Total (age)	.09	.42	.07	.15	.07	.15	.03	.08	.01	.18	.01	.04	.01	.09	.01	.02	.01	.02	.01	.01
Total (sex)	.51		.22		.22		.11		.20		.05		.10		.03		.02		.01	
Total (line)	.73				.33				.25				.13				.03			

TABLE 6.—Distances Moved by Recaptured *Peromyscus leucopus*, 1963-65.

Month	Males		Females		Total	
	No. moved	Avg. feet	No. moved	Avg. feet	No. moved	Avg. feet
1963						
June	7	216	9	103	16	152
July	46	212	13	164	59	201
August	22	115	14	130	36	121
September	18	174	7	109	25	156
Total	93	182	43	131	136	166
1964-65						
June	0	....	0	....	0	....
July	24	105	7	92	31	102
August	22	123	6	216	28	143
September	18	158	1	180	19	159
October	4	155	0	....	4	155
November	5	124	1	124	6	124
December	10	100	1	75	11	98
January	14	92	10	172	24	125
February	6	138	4	146	10	141
March	6	173	4	217	10	190
April	13	206	6	120	19	179
Total	122	132	40	155	162	138
1963-65 Total	215	154	83	143	298	151

Longevity of males was constant for both trapping periods (23.9 days), while that of the females (15.0 and 26.3 days) fluctuated (TABLE 3). Maximum longevity was 137 days for the males and 105 days for the females. White-footed mice in the 1964-65 trapping period established longer trap-records (24.7 days) than those of 1963 (20.6 days), probably due to partial removal by snap-traps in 1963. The average interval between recapture for all *Peromyscus leucopus* was 22.7 days.

INFLUENCE OF CORNFIELD ON *Peromyscus*

Capture-success per Trapline. — Comparison of traplines failed to reveal substantial capture-success in the cornfield during 1963 (Table 4). However, captures in traplines 1 and 2 decreased from June to September as the captures in Trapline C (cornfield) increased, even though mice caught in line C were being removed from the population.

During 1964-65, total capture-success per trapline decreased with increased distance from the cornfield (TABLE 5). Capture-success of Trapline C was 1.7 times greater than that of trapline 1 (innermost trapline of the woodland border), 2.6 times greater than trapline 2, 4.8 times greater than trapline 3, and 16.4 times greater than trapline 4 (outermost line). The monthly distribution of capture-success for each trapline is illustrated in FIGURE 2.

Only trapline C was operative in June, and captures were few for the corn was still immature at this time and the ground lacking cover. Ears of corn formed on the stalks in the second week of July, and the capture-success of the inner traplines (C and 1) was equivalent to that of the outer traplines (2 and 3) at this time. Mice released within the cornfield often ran into the forest border near trapline 1. High capture-

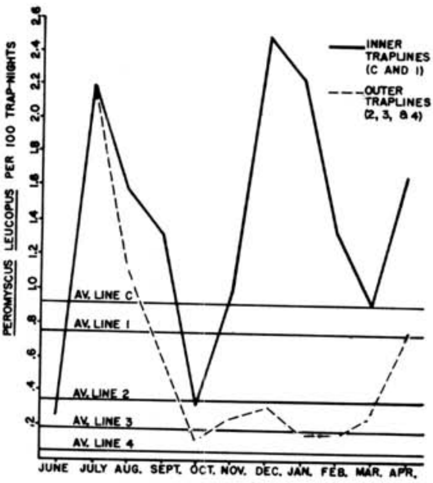

FIGURE 2. Monthly distribution of capture-success in 1964-65.

success of line 1 may indicate reciprocal movement between the cornfield and the woodland border, thus lines C and 1 are treated together in FIGURE 2. Trapline 4 was as yet inoperative. Line C achieved much greater success in July than in June.

In August, capture-success of lines 1, 2, and 3 dropped while that of line C rose sharply (TABLE 5), correlated with fruiting of the corn. Trapline 4 was established in August but maintained a low capture-success. Establishment after initial ear formation may explain the failure of line 4 to achieve moderate success.

A pronounced decline of capture-success was apparent during August, September, and October. Burt (1940) and Blair (1940 and 1948) indicate the seasonal peak should occur during the autumn. The decline in the present study might be attributed to decreased trapability of the population, since small mammals may be present in an area and yet escape capture (Nicholson, 1941; Evans, 1942; Hayne, 1949). Recovery during November was not due to new individuals, but to recapture of individuals marked previous to the decline. The nadir occurred in October and was correlated with lack of precipitation and wide temperature fluctuation (TABLE 1). The two seasonal peaks of capture-success during this study, July and December, were accompanied by abundant precipitation and minimal temperature fluctuation. The mice may have been attracted to the ripened corn instead of the baited traps during October. However, if this was the reason for decreased captures, similar patterns of low capture-success should have occurred during the following months when corn was still available to the rodent population.

Increased capture-success in the inner traplines during December reflect an increase in the *Peromyscus leucopus* population. Forty-five per cent of the 1964-65-juveniles were captured in December, and nine unmarked adults also were captured. Traplines C, 1, and 2 accounted for 50 per cent, 35 per cent, and 15 per cent of the captures, respectively. New individuals were not captured in lines 3 and 4.

Maximum utilization of the cornfield and adjacent area was in the winter months. Previous to the flood in February, captures were concentrated in the inner traplines. Survivors of the flood remained within the cornfield, while new individuals were trapped in the outer lines. Proportionately higher capture-success was recorded in the outer traplines in March and April. Increased capture-success in both inner and outer traplines during April reflect an increase in the size of the population.

Movement in Relation to the Cornfield. — Brevity of the 1963 trapping period hindered detection of movement patterns. Snap-traps biased the data on movements through elimination of movements within the cornfield and movements exiting the cornfield. Lengthening the trapping period and replacing snap-traps with live-traps allowed more comprehensive data on movements in 1964-65.

Although extensive movements have been recorded, white-footed mice seldom range more than 200 or 300 feet (Fitch, 1958; Nicholson, 1941). Maximum distance moved during this investigation was 541 feet by both sexes and the average distance was 151 feet. Burt (1940) mentions the average cruising range to be about 159 feet. Although males averaged a greater distance per movement in 1963-65, the females averaged greater distances in the 1964-65 trapping period (TABLE 6). Movements of the males were represented by a larger sample and may be more reliable than those of females, which fluctuated greatly. Nicholson (1941) and Burt (1940) note males often travel greater distances than do females. A male made the greatest movement in one day, 450 feet, while the greatest movement of a female in one day was 212 feet. The average distance for all *Peromyscus* in 1963 was greater than in 1964-65 but may have been due to the removal of mice from the vicinity of the cornfield.

Hatfield (1940) and Hirth (1959) note that activity of small mammals decreases during the winter months. Distance per movement decreased below average (151 feet) from November through February (124, 98, 125, and 141 feet) of 1964-65 (TABLE 6). Distance per movement in July (102 feet), 1964, also was below average, but rose in August (143 feet) and September (159 feet) as the ears of corn became edible.

During 1963, recaptures representing non-movement accounted for 32.1 percent of total recaptures. Positive movement, neutral movement, and negative movement accounted for 24.4, 22.2, and 21.3 per cent of total recaptures, respectively.

Neutral movement accounted for 29.1 per cent of total recaptures in 1964-65. Positive movement, non-movement, and negative movement accounted for 26.0, 25.1, and 19.8 per cent of total recaptures, respectively. Replacement of snap-traps with live-traps probably accounts for the relative changes of neutral movement and non-movement between the 1963 and 1964-65 trapping periods.

Data on movements discussed herein are for 1964-65 (FIG. 3). In general, males accounted for greater percentages in all categories of movement; however, this phenomenon is the function of the larger number of males recaptured.

Total positive movements exceeded total negative movements by a small margin (TABLE 7 and FIG. 3). Both categories of movement were equal and maximal in July. Correlated with the fruiting of the corn, negative movements decreased in August while positive movements remained high. The greatest differences between positive and negative movements occurred during August, January, and April. Reasons for these differences were not readily discernible; availability of food, sexual activity, and

TABLE 7.—Positive and Negative Movements of Recaptured *Peromyscus leucopus* in 1964-65.

Month	Males/ 100 trap-nights	Females/ 100 trap-nights	Total catch/ 100 trap-nights
POSITIVE			
July	.11	.03	.14
August	.09	.05	.14
September	.06	.00	.06
October	.01	.00	.01
November	.03	.00	.03
December	.04	.01	.05
January	.08	.06	.14
February	.00	.00	.00
March	.02	.02	.04
April	.07	.05	.12
Average	.05	.02	.07
NEGATIVE			
July	.08	.06	.14
August	.05	.01	.06
September	.07	.00	.07
October	.04	.00	.04
November	.03	.02	.05
December	.03	.00	.03
January	.03	.03	.06
February	.03	.00	.03
March	.02	.02	.04
April	.05	.00	.05
Average	.04	.01	.05

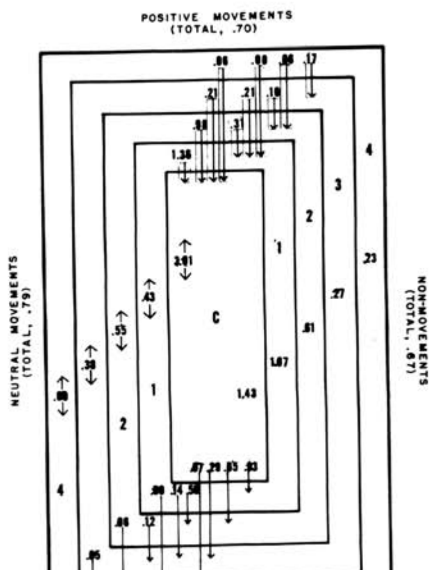

FIGURE 3. Movements of *Peromyscus leucopus* in 1964-65 (mice/1000 trap-nights).

immigration probably are the most logical factors.

Total neutral movement within the cornfield greatly exceeded total neutral movements within the woodland during all months (TABLE 8, FIG. 3). The zenith of neutral movement within the cornfield was reached in August, correlated with the fruiting of the corn, with a second peak being reached in February when the flooded woodland restricted movement to the cornfield. The nadir of neutral movement within the cornfield occurred in March when new individuals were being trapped in the outer lines rather than the inner lines.

TABLE 8.—Neutral Movements of Recaptured *Peromyscus leucopus* in 1964-65.

Month	Males/ 100 trap-nights	Females/ 100 trap-nights	Total catch/ 100 trap-nights
IN CORNFIELD			
July	.29	.00	.29
August	.57	.14	.71
September	.52	.00	.52
October	.00	.00	.00
November	.28	.00	.28
December	.16	.00	.16
January	.22	.14	.36
February	.24	.32	.56
March	.14	.00	.14
April	.15	.15	.30
Average	.24	.07	.31
IN WOODLAND			
July	.16	.02	.18
August	.05	.00	.05
September	.04	.01	.05
October	.00	.00	.00
November	.00	.00	.00
December	.01	.00	.01
January	.01	.00	.01
February	.00	.00	.00
March	.00	.00	.00
April	.01	.00	.01
Average	.03	.00	.03

Total non-movement within the cornfield exceeded total non-movement within the woodland (TABLE 9, FIG. 3). Previous to fruiting of the corn, non-movement within the woodland was maximal and was greater than non-movement within the cornfield; thereafter, non-movement within the cornfield was greater, and non-movement within the woodland dropped sharply. Increased non-movement during the winter months may have been due to decreased activity, or to establishment of breeding territories (Burt, 1943). The increase in April reflects an increase in the population size and probable establishment of breeding territories.

In general, *Peromyscus leucopus* shows a tendency to move to the cornfield and become established therein. Since differences in positive movement and negative movement are not great, the concentration within the cornfield must have been due to reproduction and recapture of individuals living within the cornfield rather than to immigration. Institution of territorality may have hindered immigration of mice into the cornfield. During the 1964-65 trapping period, total juvenile captures within

TABLE 9.—Non-movements of Recaptured *Peromyscus leucopus* in 1964-65.

Month	Males/ 100 trap-nights	Females/ 100 trap-nights	Total catch/ 100 trap-nights
IN CORNFIELD			
July	.07	.00	.07
August	.14	.07	.21
September	.07	.00	.07
October	.00	.00	.00
November	.09	.00	.09
December	.24	.00	.24
January	.07	.14	.21
February	.16	.00	.16
March	.00	.07	.07
April	.07	.22	.29
Average	.08	.05	.13
IN WOODLAND			
July	.10	.14	.24
August	.03	.02	.05
September	.04	.00	.04
October	.00	.00	.00
November	.02	.05	.07
December	.02	.00	.02
January	.08	.00	.08
February	.02	.02	.04
March	.00	.01	.01
April	.04	.03	.07
Average	.03	.02	.05

the cornfield were .32 per 100 trap-nights, as compared to .06 per 100 trap-nights in the woodland. Predominance of neutral movement and non-movement within the cornfield substantiates the establishment of white-footed mice within the cornfield.

Summary and Conclusions

Movements of small mammals between areas of abundant natural food and an area of cultivated crop were studied. Effects of a cornfield upon the movements of *Peromyscus leucopus* were measured through capture-success per trapline (mice per 100 trap-nights), and movement patterns in relation to the cornfield (movements per 100 trap-nights). Four live-trap traplines were placed within the woodland and were arranged in concentric rectangles, surrounding the cornfield. An additional live-trap line was placed within the cornfield. Trap intervals of 30 feet were maintained. A total of 100,480 trap-nights constituted the investigation of small mammal movement.

In 1963, 116 small mammals were captured 352 times in four months. Of the 116 mammals, 39 were caught in snap-traps and eight died in live-traps, leaving 69 marked small mammals at the termination of the 1963 trapping period. In 1964-65, 110 small mammals were captured 334 times in 11 months. No recaptures were made of small mammals marked during the 1963 trapping period.

The nadir of capture-success in October was correlated with lack of precipitation and wide daily temperature fluctuation. The two capture-success maxima during the present study, in July and December, were accompanied by abundant precipitation and minimal daily temperature fluctuation.

White-footed mice, 116 males and 67 females, totaled 81 per cent of all species captured. Two hundred and ninety-eight movements averaged 151 feet and maximum movement was 541 feet. Maximum movement in one day was 450 feet by a male and 212 feet by a female. Males averaged greater distance per movement, greater time intervals between capture, and were captured more often than females. Greater activity rather than longer movement may account for larger number of male captures. Average recapture-time and average number of captures per male remained constant in both trapping periods, while average recapture-time and average number of captures per female differed between trapping periods. Average distance moved by both sexes also varied between trapping periods. Distance per movement was below average during the winter months and in July, but increased in August (1964) as the ears of corn became edible.

Effects of flooding upon a population of *Peromyscus leucopus* were observed in February of 1965. Only three previously marked animals were recaptured following the flood. These were in an area above water. New individuals appeared in peripheral traplines about two weeks after the flood. The white-footed mice apparently did not escape the flood by climbing, but either left the area or were drowned.

Brevity of the 1963 trapping period hindered detection of movement patterns. Snap-traps in the cornfield biased the data on movements by eliminating movements within the cornfield and movements exiting the cornfield. Lengthening the trapping period and replacing snap-traps with live-traps allowed more comprehensive movement data in 1964-65.

Although captures in the woodland decreased in 1963, the captures within the cornfield increased, even though mice were removed from the cornfield. During 1964-65, total capture-success per trapline decreased with increased distance from the cornfield. Coinciding with the fruiting of the corn, capture-success in the woodland dropped while that in the cornfield rose sharply.

Maximum capture-success within the cornfield and adjacent area occurred in the winter months. Periods of high capture-success in the inner trapline of the woodland may reflect reciprocal movement between the cornfield and the woods edge. Proportionally higher capture-success was recorded in the peripheral traplines during the spring than in any other season.

Correlated with the fruiting of the corn, negative movements (oriented away from the cornfield) decreased while positive movements (oriented toward the cornfield) remained maximal, allowing for the greatest difference between positive and negative movement. Degree of movement was generally similar for both movement categories during other seasons.

Neutral movements (oriented neither toward or away from the cornfield) within the cornfield greatly exceeded those within the woodland. The zenith of neutral movement within the cornfield was correlated with the fruiting of the corn.

Previous to fruiting of the corn, non-movement (representing no movement between two successive recaptures) within the woodland was maximal and was greater than non-movement within the cornfield; thereafter, non-movement within the cornfield was greater, and non-movement within the woodland dropped sharply.

Peromyscus leucopus moved from areas of abundant natural food into a cornfield and became established therein. Since differences in positive and negative movement are not great, the concentration within the cornfield must have been due to reproduction there, and recapture of established individuals, rather than immigration. Institution of territoriality may hinder immigration of mice into the cornfield. During the 1964-65 trapping period, total juvenile captures within the cornfield were 0.32 per 100 trap-nights, as compared to 0.06 per 100 trap-nights in the woodland. Maintenance of high capture-success of the inner traplines and predominance of neutral movement and non-movement within the cornfield substantiates the establishment of white-footed mice within the cornfield and vicinity.

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