

SOME ASPECTS OF GOLDEN MOUSE ECOLOGY IN SOUTHERN ILLINOIS

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ABSTRACT.— A 1-year study of the ecology of the southern golden mouse, *Ochrotomys nuttalli aureolus*, in southern Illinois revealed that honeysuckle thickets, canebrakes, and cat-brier thickets provided suitable habitat. The average home range of five adults was 1.2 acres, and the greatest linear distance traveled by nine individuals averaged 240 feet. Utilization of arboreal nests seemed to lack a definite pattern; this indefiniteness was further complicated by the undetermined degree of usage of ground nests. Main food items identified were small acorns and seeds of poison ivy, bedstraw, and blackberry.

The golden mouse, *Ochrotomys nuttalli* (Harlan), is a rodent of the southeastern United States which reaches one of the most northerly points of its distribution in southern Illinois. The subspecies occurring in Illinois is the Southern Golden Mouse, *O. n. aureolus* (Audubon and Bachman), which has been recorded from six counties, namely, Alexander, Jackson, Johnson, Marion, Pope, and Union. Many aspects of the life history of the golden mouse have received little attention primarily because it is limited in distribution and population and because it is of little economic value. Thus, the purpose of this study is to bring to light some additional considerations of the life history of this rodent and to augment some aspects which have been studied previously.

METHODS

The Union County Wildlife Refuge, which lies in the floodplain of the Mississippi River less than one mile south of Ware, Illinois, was selected as a study area. Residence was established on the Refuge where field work was carried out from June, 1960 through July, 1961. Of 6200 acres at the Refuge, lakes and borrow pits constitute 460; agricultural land accounts for 2700; and timber, roads, and barnlots constitute 3050. Some field work was conducted at several other sites in Union County and at one area in Jackson County.

Five study areas for live-trapping were established and coded at the Refuge after arboreal nests were found. On Plot 1, 96 traps were placed at intervals of 66 feet in a grid pattern of six rows with 16 traps in each row. On plots 2 through 5, 20 to 30 traps were placed at random near cover apparently suitable for small mammals. Trappings were carried out on one or more of these plots every month except October. A mixture of peanut butter and rolled oats was used as bait. When each small mammal was live-trapped initially, a numbered, monel metal tag was attached to its ear. After tagging, measuring, and recording the sex, age, reproductive condition, weight, molt, and other information, the animal was released at the point of capture. Because Plot 1 seemed to contain the best population of golden mice and afforded certain conveniences, it was considered the primary study area and received most attention.

When nests were located, information concerning occupancy, height from ground, supporting vegetation, diameter, distance to nearest nest, and other data were recorded. Each nest was marked and inspected periodically to check condition and utilization. A total of 34 non-active nests were collected; these

and 14 others collected in 1955 at the Refuge were examined and information concerning food remains, nest materials, and other aspects were recorded. Nests of golden mice were identified on the basis of hair found in the lining; the bright golden mid-portion of each hair was thought to be a reliable criterion for identification. The seed collection of the Cooperative Wildlife Research Laboratory at Southern Illinois University was utilized in identifying food materials.

A total of 14 0.1-acre quadrats were laid out around nests at various areas in Jackson and Union counties. The diameter breast high (d.b.h.) of trees 3.5 inches or more in diameter were measured and the number of each species was recorded. In addition, general notes were taken on species of shrubs, vines, and small trees in or near each quadrat.

HABITAT

The golden mouse has been reported in several types of wooded habitat in Illinois. Layne (1958) recorded it in a sumac thicket with a ground cover of broomsedge and in moist woodlots in or near canebrakes or other brushy situations. This rodent has been said to prefer the thick timber bordering cypress swamps (Hoffmeister and Mohr, 1957; Cory, 1912). It has been captured in canebrakes and honeysuckle thickets at Pine Hills in Union County (John Crim, 1960, Personal Communication). Andrews (1963) collected this species from a drainage way in an old field in Pope County; honeysuckle and green brier (cat-brier) were recorded at this site.

During this study, golden mice were usually found in mesic wooded habitats where 36 species of trees were recorded (Table 1). There was a lack of uniformity in size, occurrence, and abundance of the various species of trees in areas sampled. Shrubs commonly observed in or near quadrats were swamp holly, *Ilex decidua*, dogwood, *Cornus* spp., giant cane, *Arundinaria gigantea*, spice bush, *Lindera benzoin*, pawpaw, *Asimina triloba*, and poison ivy, *Rhus radicans* (plant nomenclature after Mohlenbrock and Voigt, 1959). Vines noted often in these areas were grape, *Vitis* spp., cat-brier, *Smilax* spp., Japanese honeysuckle, *Lonicera japonica*, Virginia creeper, *Parthenocissus quinquefolia*, and trumpet creeper, *Campsis radicans*.

Important plants.— In general, golden mouse habitat in southern Illinois may be separated into three categories depending upon the presence of a particular plant species or genus; these are Japanese honeysuckle thickets, canebrakes, and cat-brier thickets. The former two categories are usually distinct entities in which cane or honeysuckle plants are numerous and dominate that particular type of vegetation of which each is a member. Cat-brier often lacked this dominance and abundance in regions where golden mice were found; that is, mice or nests were noted in local areas where cat-brier was rare or absent, but large mats of this vine were always observed in the immediate vicinity. These three plants were rarely found together in any combination. Of the five live-trapping areas, all were located in bottomland hardwood forests with the important understory species being cat-brier on plots 1 through 4 and cane on Plot 5.

The restriction of *O. n. aureolus* to areas containing one of the three plant categories previously described was due in some part to suitable nesting facilities provided by these groups. This is not a complete explanation as some nests were built in other species of vines and shrubs and a few were constructed on the ground. Goodpaster and Hoffmeister (1951) suggested that availability of suitable avenues of escape by climbing might be an important factor in the selection of a nest site; but during this study, this factor did not seem of importance as mice jumped to the ground as frequently as they escaped by climbing when nests were disturbed. Packard and Garner (1961) also noted a mouse jumping to the ground from a disturbed nest.

The importance of these plants in golden mouse habitat has been noted in other studies. Barbour (1951) noted that greenbrier was always one of the dominant plants, whereas Goodpaster and Hoffmeister (1951) concluded that honeysuckle was the preferred vine at any elevation with greenbrier and certain other shrubs also being of importance. Handley (1948) found the golden mouse wholly confined to honeysuckle thickets when found on mountains. Occasionally they were recorded in greenbrier and blackberry, while at lower elevations, cane was used extensively. Ivey (1949) mentioned Spanish moss and greenbrier as important plants. In contrast to the above findings, Redman

and Sealander (1958) found this mouse inhabiting a pine-oak forest with little understory.

Hill and lowland forests.—The somewhat xeric hill forests in southern Illinois generally support sparse underbrush. On higher hills, honeysuckle was the only plant noted which provided suitable habitat, but this vine was seemingly restricted in distribution in these areas. The majority of forests at the Union County Refuge are of a swampy nature, and as such, do not support golden mice due to the absence of the three important understory plants which are found primarily in mesic forests. The golden mouse has been noted to pre-

fer lowland areas to upland areas (Goodpaster and Hoffmeister, 1954; Barbour, 1942); however, it has been reported from an altitude of 4120 feet in North Carolina (Odum, 1949).

Disturbances.—In most areas where golden mice were noted, disturbances from lumbering and road construction had occurred. In certain areas, such activities permitted the invasion and establishment of the important understory species, particularly honeysuckle. Although exact times were unknown, disturbances probably occurred at least 15 years prior to this study.

Most of the forests at the Refuge are undergoing succession resulting from ex-

TABLE 1. Species and Occurrence of Trees over 3.5 Inches in d.b.h. Noted in 14 0.1-acre Quadrats.

Species	Representation in quadrats	Frequency index
Slippery elm (<i>Ulmus rubra</i>)	8	57.1
White mulberry (<i>Morus alba</i>)	8	57.1
Sweet gum (<i>Liquidambar styraciflua</i>)	7	50.0
Box elder (<i>Acer negundo</i>)	6	42.9
American elm (<i>Ulmus americana</i>)	6	42.9
Persimmon (<i>Diospyros virginiana</i>)	5	35.7
Bitternut hickory (<i>Carya cordiformis</i>)	5	35.7
Southern hackberry (<i>Celtis laevigata</i>)	4	28.6
Chinquapin oak (<i>Quercus muhlenbergii</i>)	4	28.6
Black walnut (<i>Juglans nigra</i>)	4	28.6
Green ash (<i>Fraxinus lanceolata</i>)	3	21.4
Red oak (<i>Quercus rubra</i>)	3	21.4
Wild black cherry (<i>Prunus serotina</i>)	3	21.4
Redbud (<i>Cercis canadensis</i>)	3	21.4
Cottonwood (<i>Populus deltoides</i>)	3	21.4
White oak (<i>Quercus alba</i>)	3	21.4
Honey locust (<i>Gleditsia triacanthos</i>)	2	14.3
Sycamore (<i>Platanus occidentalis</i>)	2	14.3
Pignut hickory (<i>Carya glabra</i>)	2	14.3
Shagbark hickory (<i>Carya ovata</i>)	2	14.3
Pecan (<i>Carya illinoensis</i>)	2	14.3
Red mulberry (<i>Morus rubra</i>)	2	14.3
Pin oak (<i>Quercus palustris</i>)	1	7.1
Sassafras (<i>Sassafras albidum</i>)	1	7.1
Pawpaw (<i>Asimina triloba</i>)	1	7.1
Kentucky coffee tree (<i>Gymnocladus dioica</i>)	1	7.1
Red maple (<i>Acer rubrum</i>)	1	7.1
Blue beech (<i>Carpinus caroliniana</i>)	1	7.1
Red haw (<i>Crataegus mollis</i>)	1	7.1
Silver maple (<i>Acer saccharinum</i>)	1	7.1
Black willow (<i>Salix nigra</i>)	1	7.1
Tulip tree (<i>Liriodendron tulipifera</i>)	1	7.1
Black locust (<i>Robinia pseudoacacia</i>)	1	7.1
Shellbark hickory (<i>Carya laciniosa</i>)	1	7.1
American ash (<i>Fraxinus americana</i>)	1	7.1
Hard Maple (<i>Acer saccharum</i>)	1	7.1

tensive timber harvest prior to 1947 when the State of Illinois purchased this tract. It is thought that as succession from cut-over areas to mature mesic forests proceeds, the golden mouse progressively loses portions of suitable habitat as tall trees tend to deter profuse growth of important shrubs and vines. This seems to have occurred at the Refuge where there are now only a few acres of optimal habitat. McCarley (1958) concluded that lumbering may benefit the golden mouse as this practice tends to open the canopy and permit lush growth of the understory. However, it was indicated that a dense canopy may be formed again in less than 30 to 40 years.

Distribution in Illinois.—The dissimilarity of vegetation occurring in southern Illinois and that of other regions of the State must be understood when the distribution of the golden mouse is considered. The three plants which seem to be required in the habitat of this animal are greatly or wholly restricted to southern Illinois. Cane is found only in the extreme southern region; Japanese honeysuckle is restricted primarily to the south; and all seven species of cat-brier recorded for the State are found in southern Illinois with four restricted primarily to this area (Winlerringer and Evers, 1960).

Average annual precipitation is higher and temperatures generally warmer in southern Illinois than in other regions of the State. Such climatological factors determine plant communities present in these areas. The eastern deciduous forest occurs in most of southern Illinois. Much of central Illinois and part of the northern region is an ecotone between forest and prairie with the forests being restricted mainly to floodplains and dry areas in which the oak-hickory type supports less well developed understory than forests in which golden mice are found.

NESTS

Nests were globular in form, usually hollow, and composed of an inner lining and an outer covering. The lining usually made up the bulk; finely shredded parts of sedges, grasses, or bark were commonly used in constructing this section, while bits of cloth, bird feathers, or "cotton" from cottonwood trees, *Populus* spp., were used less frequently. The covering was composed of whole leaves

of trees, sedges, grasses, or coarsely shredded stem materials. Leaves identified were those of cat-brier, cane, box elder, *Acer negundo*, grass, sedge, elm (*Ulmus* spp.), honeysuckle, red haw, *Crataegus mollis*, maple, *Acer* spp., hackberry, *Celtis* spp., pin oak, *Quercus palustris*, grape, ash, *Fraxinus* spp., and spice bush. Silver maple samaras and stem materials from grape and honeysuckle were also noted in the covering. In regard to nest measurements, diameters ranged from 4.0 to 8.5 inches with the average being 5.3 inches. The height above ground varied from 8 inches to 20 feet 10 inches with an average measurement of 7 feet 2 inches (excluding ground nests). Packard and Garner (1964) found nests at heights of 1.5 to 25 feet in eastern Texas.

The average distance between nests was 43 feet. In two instances, an inhabited nest was found in close proximity of another occupied structure within the same day; a distance of 140 feet separated one pair and 180 feet the other. Eight solitary nests were found; all were noted in widely separated regions except two which were approximately 200 yards apart. As the immediate vicinity around each solitary nest was examined cursorily, intensive searches might have revealed additional nests.

Sites.—Arboreal nests were sometimes constructed in shrubs or forks of trees. In one instance, a cluster of thorns on the trunk of a honey locust, *Gleditsia triacanthos*, was utilized; but in most cases (55.6 percent), nests were supported entirely or partially by cane, honeysuckle, cat-brier, or grape. Most of the remaining nests were found near one or more of the four plants.

Of 87 nests located, 6 were found at ground level. Four of the ground nests were constructed at the bases of spice bush clumps; one was noted under a log, and one was situated on several shoots of cane about 1 inch above ground level. Other than location, ground nests were similar in all respects to arboreal nests. Most studies of the golden mouse describe use of arboreal nests with only a few reporting nests at ground level (Cory, 1912; Barbour, 1942; Eads and Brown, 1953).

Occupancy.—During the year, two inhabited nests were recorded on Plot 1 during July and November while one was noted in June, August, September, and October. Two occupied nests were recorded in other areas in April and one

in June, July, and August. A nest on Plot 1 contained a female with subadults in November, while two nests in a honey-suckle thicket outside the Refuge each yielded a female with suckling young on April 6. Layne (1958) also listed an occupied nest in December in southern Illinois. Packard and Garner (1964) recorded two inhabited nests in December and one in March in eastern Texas. Goodpaster and Hoffmeister (1954) found occupied nests from January through April and in November in Kentucky. From these studies, it is apparent that golden mice are capable of occupying arboreal nests at all times of the year.

In one instance a mouse was found to take over a nest after it was deserted; an individual of unknown sex was routed from a nest in June which had previously contained a litter of young and a female that were taken into captivity in April. Of the ten inhabited nests which contained only adults, a single individual was found except in one instance when two were observed. This is in contrast to the findings of Goodpaster and Hoffmeister (1954) and Barbour (1942) who commonly found several adults per nest. Of three inhabited nests found by Packard and Garner (1964), two contained single adults and the other a female with suckling young. Layne (1958) reported a nest containing two adults. During this study, mice were sensitive to disturbances of nests and would usually permanently desert a nest once caused to leave. On one occasion, several subadults were found in a nest from which they had been routed several days before.

NESTING HABITS

The nesting habits of *O. n. aureolus* seemed to lack a definite pattern. Forty-one nests were found on Plot 1 during the first 9 months of study; new nests were lacking the last 4 months. The last inhabited nest was noted in November and the last newly constructed nest was recorded in March, yet mice were captured throughout the study including the winter period when arboreal nests were relatively easy to locate. A lack of new nests during the spring and summer was also noted on all other live-trapped areas; only one new nest was located on the Refuge during April through July. On three trapped areas, nests were never found to be inhabited. A majority of those nests found outside

the Refuge were in ill-repair when found, and few were occupied.

The apparent lack of a pattern in nesting habits on trapped areas could have been due to increased utilization of less conspicuous nests such as those on the ground or in hollow trunks of trees due to disturbance of arboreal structures by the investigator. There was no evidence to suggest a greater degree of use of ground nests at a particular period of the year; however, this possibility existed.

FOOD

Seeds of poison ivy, blackberry, and bedstraw and small acorns were principal food items identified in 48 nests examined (Table 2). Cat-brier was conspicuously absent from food items identified, although it was present in many areas where nests were collected. These limited data suggest that the three plants most important in golden mouse habitat were unimportant in food habits. Goodpaster and Hoffmeister (1954), in a study of the golden mouse in Kentucky, listed greenbrier, sumac, wild cherry, and dogwood as main food items. Unopened seeds were sometimes found in nests. These may have represented a cache for future consumption, but the small quantity indicated that these were inedible or that they were left when nests were deserted. Food storage was indicated in one instance where five, entire, small acorns were found in a nest collected during November.

Goodpaster and Hoffmeister (1954) described two types of nests; these were the home and the feeding platform. The platform was used for feeding; as a result, the lining contained many seed hulls. The home, used as a residence by one or more animals, was usually devoid of food remains. During this study, most nests contained a few hulls. However, two nests were found which contained 2000 and 100 seed hulls. These nests could be termed feeding platforms, but most nests did not fit conveniently into either category as described by the above authors. Packard and Garner (1964) failed to find feeding platforms among 11 nests examined.

HOME RANGE AND MOVEMENTS

The method used to calculate home ranges of mice captured on Plot 1 was the inclusive boundary method described

by Stickel (1954); ranges of animals captured on the edges of the grid were not included. The average home range of 1.2 acres obtained during this study (Table 3) was similar to that reported by McCarley (1958) who listed the average home range for a number of individuals captured 10 or more times as near 1.3 acres. Redman and Sealander (1958) calculated the average range of five individuals, apparently captured less than 10 times, as 0.13 acre. Dunaaway (1955) reported the average range of three females, each captured 15 or more times each, as 0.26 acre.

Distances traveled by trapped golden mice were relatively small even over an

extended period of time. On Plot 1, the greatest linear distance traveled by an individual during one day was 297 feet, while the greatest distance covered over an extended period of time was 483 feet (Table 4). The average distance traveled by nine individuals captured three or more times on Plot 1 was 240 feet.

The golden mouse seemed restricted to mesic wooded habitats. On Plot 1, eight traps were permanently set a few feet from wheat fields. Three individuals, including an adult and two subadults, were captured once in these traps. Eleven traps were set in lowland woodlots that bordered Plot 1. On only one occasion was an animal captured;

TABLE 2. Food Items Contained in 31 of 48 Golden Mouse Nests.

Food items	Representation in nests	Frequency index
Oak (<i>Quercus</i> sp.)	9	18.8
Poison ivy (<i>Rhus radicans</i>)	7	14.6
Bedstraw (<i>Galium</i> spp.)	5	10.4
Blackberry (<i>Rubus</i> spp.)	5	10.4
Grape (<i>Vitis</i> spp.)	4	8.3
Sassafras (<i>Sassafras albidum</i>)	3	6.3
Polygonum (<i>Polygonum scandens</i>)	3	6.3
Pokeberry (<i>Phytolacca americana</i>)	2	4.2
Hackberry (<i>Celtis</i> sp.)	1	2.1
Dogwood (<i>Cornus</i> sp.)	1	2.1
Black locust (<i>Robinia pseudacacia</i>)	1	2.1
Holly (<i>Ilex</i> sp.)	1	2.1
Pawpaw (<i>Asimina triloba</i>)	1	2.1
Unidentified	12	25.0

TABLE 3. Home Range Size of Five Adult Golden Mice.

Sex	Number of captures by months						Total captures	Home range in acres
	Aug.	Sept.	Nov.	Dec.	Feb.	Mar.		
Female		1	1	1	1	14	15	1.5
Male				1		9	10	0.6
Female		5					5	0.5
Male					1	5	6	1.9
Male						5	5	1.6

it was taken 20 feet from a mesic forested habitat. This apparent avoidance of open fields and low woodlots indicated a limited pattern of movement. Komarek (1939) found that the golden mouse ranged least of several species of small mammals studied and indicated that populations of the former tended to be sedentary. As Plot 1 was an island of golden mouse habitat surrounded by

cultivated fields and connected to other woodlots by two narrow strips of lowland forests, the population in this area was essentially isolated.

POPULATION DENSITIES

The greatest concentration of *O. n. aureolus* was noted on Plot 5 during the period January through March when

TABLE 4. Greatest Linear Distances Traveled by Nine Golden Mice.

Sex	Age	Number of captures	Period of movement	Distance in feet
Male.....	adult.....	5	March.....	483
	adult.....	5	August to December.	413
	adult.....	6	March.....	297 (1 day)
	subadult....	4	August.....	198
	adult.....	10	March.....	139
Female.....	adult.....	15	March.....	264
	subadult....	3	August.....	198
	adult.....	4	August.....	94
	adult.....	3	March.....	78

TABLE 5. Comparison of Greatest Population Densities of Golden Mice per Acre on Five Areas.

Plot number	Size in acres	Months	Individuals captured	Density
1.....	7.5 ¹	March, August...	6	0.8
2.....	0.8	December.....	2	1.3
3.....	1.5	January, April...	1	0.7
4.....	0.5	April.....	1	2.0
5.....	0.2	January.....	6	30.0

¹ Suitable golden mouse habitat constituted approximately 5 acres.

ten individuals were captured. As determined from trapping, a population density of 30 mice per acre was present during January (Table 5). It is of interest to note that only 17 individuals were taken on the larger Plot 1 during the year. The greatest monthly density occurred on Plot 1 during March and August when six animals were captured; this represented a density of 0.8 mice per acre. During the year, only single captures of individuals were noted on Plot 2 (4), Plot 3 (2), and Plot 4 (1). The densities on plots 2 through 4 approximated that on Plot 1. On all plots, there were months of intensive trapping when no mice were taken. McCarley (1958) reported densities of 2.2 to 0.0 mice per acre in eastern Texas, while Shadowen (1963) recorded densities of from 2.79 to 0.08 mice per acre in Louisiana.

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