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STATUS OF THE GRAY AND FOX SQUIRRELS IN TENNESSEE

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This paper is one of a series on the distribution of Tennessee mammals which have been appearing in the *Journal of the Tennessee Academy of Science* and is concerned with the status of the gray squirrel (*Sciurus carolinensis*) and the fox squirrel (*Sciurus niger*). The nomenclature in this report is after Miller and Kellogg (1955). They list the following subspecies as occurring in Tennessee or directly adjacent to the State:

Sciurus carolinensis carolinensis Gmelin,
Sciurus carolinensis pennsylvanicus Ord,
Sciurus niger bachmani Lowry and Davis,
Sciurus niger subauratus Bachman,
Sciurus niger rufiventer E. Geoffroy-Saint-Hilaire, and
Sciurus niger vicinus Bangs.

They remark or imply that *Sciurus c. carolinensis* is found throughout Tennessee; *Sciurus c. pennsylvanicus*, ". . . in Appalachian Mountains to Great Smoky Mountains in eastern Tennessee . . ."; *Sciurus n. bachmani*, ". . . eastern Tennessee . . ."; *Sciurus n. subauratus*, ". . . southeastern Arkansas and Yazoo River Delta of northwestern Mississippi . . ."; *Sciurus n. rufiventer*, "Mississippi Valley from western Tennessee, northern Arkansas . . ."; *Sciurus n vicinus*, ". . . in Appalachian Mountains to western North Carolina."

The most recent literature on the distribution of Tennessee squirrels, primarily that of Hamilton (1943) and Burt and Grossenheider (1952), relies chiefly upon the reports of Rhoads (1896) and Kellogg (1939) for information on Tennessee mammals. Rhoads' report, which is based on limited field work in Tennessee, contains the statement in regard to the "western fox squirrel, *Sciurus n. ludovicianus* Curtis," that, "We do not find this species numerous except in the heavily timbered bottoms of West Tennessee, more especially west of the Tennessee River in the direct drainage of the Mississippi." He did not know for sure whether or not the northern fox squirrel, which he called "*Sciurus n. cinereus*," was present in Tennessee. He reported typical examples of *Sciurus c. pennsylvanicus* in the "high mountains of the east which integrated with another form in the west."

Kellogg's report contains the most complete information regarding the mammals of Tennessee to date. He remarks that

Sciurus c. carolinensis frequents not only the moist bottomlands and swamps of the State but is also found on wooded hills and lower mountain slopes [Specimens he inspected by county: Benton, 18; Campbell, 4; Fayette, 1; Grainger, 2; Hamilton, 3; Lincoln, 2; Shelby, 7]. In regard to *Sciurus c. pennsylvanicus* he stated, "Although not typical, the specimens from the southern Alleghenies and the Great Smoky Mountains in eastern Tennessee are referred to *leucotis*, since they resemble those taken in the north in the mountainous sections of eastern West Virginia in the predominance of whitish-tipped hairs in the tail as well as large hind feet [Specimens he inspected by county: Cocke, 1; Johnson, 1; Polk, 2]." The northern fox squirrel, *Sciurus n. vicinus*, was reported, ". . . to occur in the deciduous woods on the lower levels (altitude 1,500 to 2,000 feet) of Denny Mountains near Cosby, Cocke County. These are most likely referable to the northern race but can be only tentatively placed here until actual specimens are available for examination." The Mississippi Valley fox squirrel, *Sciurus n. rufiventer*, was thought by Kellogg to be most numerous in the northwestern corner of the State. He also remarked that, "Along the southern border of the State, a few fox squirrels were reported to occur in the woods south of Fayetteville, Lincoln County.

"The upper parts of the skins from Obion and Lincoln Counties appear much darker than those from Campbell County. This condition appear attributable in part to wear . . . [Specimens he inspected by county: Campbell, 7; Lincoln, 1; Obion, 3].

Since neither Rhoads nor Kellogg presents distribution maps of the gray and fox squirrels in Tennessee, it is necessary that we rely upon maps and conclusions of Hamilton (1943) and Burt and Grossenheider (1952) for the latest material available. Burt and Grossenheider (1952) are not concerned with subspecies but do present maps showing the range of *Sciurus carolinensis* and *Sciurus niger* as being throughout Tennessee. On the basis of the critical examination of museum specimens, correspondence with members of game commissions and other persons, Hamilton (1943), reporting on the mammals of eastern United States, has presented maps outlining the range of a species, its subspecies and related forms with the comment that he has used his own judgment in drawing boundaries. He treats zones of intergradation as blank areas on his map which are common on his map of Tennessee as a result of the number of subspecies of squirrels supposedly present in the State. He shows the southern gray squirrel, *Sciurus c. carolinensis*, as occurring in Tennessee from the Mississippi River to the eastern edge of the Cumberland Plateau, intergrading with the northern gray squirrel, *Sciurus c. pennsylvanicus*, in the Valley of East Tennessee and the southern half of the Unaka Range. The northern gray squirrel is shown as occurring in the Unaka Range from the Great Smoky Moun-

tains northeastward to the Virginia state line, with a zone of intergradation with the southern gray squirrel as mentioned above.

The distribution of the fox squirrels is more difficult to delineate on a map as a result of the reported existence of four subspecies within the State. Hamilton shows the primary range of the Bachman fox squirrel, *Sciurus n. bachnani,* to be in an area encompassed by a curved line extending north eastward across Tennessee from the junction of the Alabama, Mississippi and Tennessee state lines almost to the Kentucky state line and then turning southeastward to the great Smoky Mountains. It appears to include primarily the southern and eastern Highland Rim, Central Basin, Cumberland Plateau, and the central and southern portions of the Valley of East Tennessee and Unaka Range.

The primary range of the golden-bellied fox squirrel, *Sciurus n. subauratus,* is shown as extending from the lower Mississippi Valley northward to the vicinity of Memphis, Tennessee. The Mississippi Valley fox squirrel, which Hamilton calls the "western fox squirrel," *Sciurus n. rufiventer,* has its primary range delineated as north of central Kentucky with apparently a zone of intergradation in Tennessee with *subauratus* in the Mississippi Valley and with *bachmani* in the Plateau Slope of West Tennessee, western and northern Highland Rim, and the northwestern portion of the Central Basin. The northern fox squirrel, *Sciurus n. vicinus,* is shown as having its primary range in the extreme northeast corner of Tennessee with a zone of intergradation with *bachmani* in the remainder of the northeast Tennessee.

It should be realized that these boundaries are proposed on a basis of very limited data and detailed studies on the classification and distribution of the gray and fox squirrels in Tennessee would undoubtedly result in major revisions.

Other than the reports of Kellogg (1939) and Rhoads (1896) the literature contains only limited information on the status of the gray and fox squirrels in Tennessee. Howell (1909) remarked that the fox squirrel was fairly numerous throughout the Cumberland Plateau and that they ". . . are becoming scarce in many parts of the South, and specimens are often difficult to obtain." He referred a small series of specimens from Campbell County to what is now known as *Sciurus n. bachmani.* Wing (1940), reporting on the game survey encompassing an area roughly between the Holston River and the Tennessee-Kentucky state line, remarked that fox and gray squirrels occurred in the area and, "A few fox squirrels are said to be found but I have seen none other than Gray Squirrels." Lowery and Davis (1942) present a map showing the distribution of the races of fox squirrels in Mississippi, Alabama and a portion of Arkansas which is similar to that of Hamilton (1943) for these states. Their report, "*A*

revision of the fox squirrels of the lower Mississippi Valley and Texas," should be consulted by taxonomists studying the races of fox squirrels in Tennessee. Caldwell *et al.* (1947), in a publication for school children, have listed *Sciurus c. carolinensis* and *Sciurus n. rufiventer* as occurring in Tennessee. In regard to *carolinensis* they state, "There is a black phase, rare in Tennessee and also a white phase (albino) common only in Obion County," also that, "The fox squirrel is much rarer in most parts of the State. They appear to be most numerous in the northwestern corner of Tennessee." Goodpaster and Hoffmeister (1952) reporting on the mammals in the vicinity of Reelfoot Lake stated, "Gray squirrels [*Sciurus c. carolinensis*] were common all along the bluffs although very few were noted along the lake," and that, "In 1940, fox squirrels [*Sciurus n. rufiventer*] were common on the northwest side of Reelfoot Lake near Phillipy." No specimens of the gray squirrel were collected but ten specimens of the fox squirrel were collected in 1940 and are currently in the collection of the senior author. Conaway and Howell (1953), working in Johnson and Carter Counties, as determined from comments of residents of these counties, reported the fox squirrel, *Sciurus niger,* as uncommon and local in distribution. They made personal observation of the gray squirrel, *Sciurus carolinensis,* and remarked that, "This species appeared to be generally distributed and common throughout most of the area." In regard to the Cumberland Plateau (Howell and Conaway, 1952) they made no reference to the gray squirrel and believed that the fox squirrel, *Sciurus niger,* was generally distributed. The observations of gray squirrels mentioned above were the only personal observations of squirrels reported by these writers in either region.

It is of interest to note that the distribution of the subspecies of fox and gray squirrels in Tennessee is based on the inspection of only a very limited number of specimens and other information. The majority of the museum specimens of the above subspecies collected in Tennessee are either in the collection of the United States National Museum or the United States Fish and Wildlife Service, both of which are housed in the United States National Museum, Washington, D. C. Kellogg (1939) has listed the number and collection locality of all Tennessee specimens of gray and fox squirrels in these collection at the time of his study. Since there have been no new additions since 1937, we can consider his list as current for the year 1956. It should be remarked that the writer was unable to locate all the specimens inspected by Kellogg.

The University of Tennessee's mammal collection contains the following squirrels identified only to species:

Fox squirrels — 1 collected in Clay County.

Gray squirrels — 6 collected in Knox County; 2 in Anderson County; 3 in Sevier County; 2 in Hardeman County; 1 in Dickson County.

There is no need to emphasize the need for an adequate series of all subspecies of the gray and fox squirrel in Tennesesee as the paucity of data makes this obvious.

Lack of specific information concerning the distribution of the squirrels and other fauna of Tennessee resulted in the Tennessee Game and Fish Commission conducting a statewide wildlife survey. Primary field work on this project was begun in September, 1950, and was completed approximately thirteen months later. The survey procedure (Schultz, 1952; 1954) included a method of sampling known as "area sampling" which permitted computation of sampling errors. In brief, the sampling scheme consisted of a proportionate stratified random sample of 1,000 "sampling areas" in Tennessee which averaged five dwellings per area as indicated on state highway maps. This was a sampling rate of 1 in 51. Heads of farm households dwelling upon these areas were interviewed concerning gray and fox squirrels utilizing their farms and the "sampling areas." Data collected on the squirrels are presented in this paper and Schultz *et al.* (1954). The relative sampling errors (R.S.E.) indicate the adequacy of sampling for all interviewees and also all respondents reporting the two squirrels on their farms. Ninety-five per cent confidence limits on an estimated total (obtained by multiplying the number of respondents by the sampling rate) of either all heads of farm households or all such persons with the squirrels utilizing their farm in a farming-type are obtained as follows:

$$\pm \text{(Estimated Total) (R.S.E.) (2).}$$

Farmer hunters were requested to furnish information on animals hunted, with the intent that such information would assist in delineation of the range of game species and possibly population densities.

Data obtained by personal interview have been tabulated on a farming-type basis (Tables 1, 2 and 3; Figure 1). The farming-types (revised from Luebke *et al.*, 1947) or strata in Figure 1 represent physiographic regions as follows: Mississippi Bottoms, 1; Plateau Slope of West Tennessee, 2, 3, 4, 5, 6; Highland Rim, 7, 8, 9, 11; Central Basin, 10; Cumberland Plateau, 12; Valley of East Tennessee, 13, 14; Sequatchie Valley, 14A; Unaka Range, 15.

A questionnaire was sent to conservation officers located in counties east of the Cumberland Plateau requesting information on the status of the fox squirrel in their assigned county. Each officer was requested to indicate the fox squirrel as being common, rare, or absent in his county. An additional request for specific localities of occurrence was sent to those officers who listed the fox squirrel as rare. In general, the reports agree with

TABLE 1

Status of the gray squirrel in Tennessee as determined by personal interview of heads of farm households.

	Farming - Type															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
FARM:																
Number of Respondents	27	97	489	69	131	261	200	139	116	538	306	137	57	862	131	3560
Number reporting gray squirrel on farm	10	57	305	62	85	229	186	134	92	462	261	107	41	629	93	2753
Per cent reporting gray squirrel on farm	37	59	62	90	65	88	93	96	79	86	85	78	72	73	71	77
R.S.E.[1] for estimated total of:																
All heads of farm households	16.4	7.6	5.0	6.7	6.8	4.6	5.9	6.7	8.8	3.2	5.7	7.7	10.2	3.0	6.5	1.5
Heads of farm households with gray squirrel on farms	26.7	12.6	7.0	9.7	9.4	5.5	6.4	7.3	10.7	3.9	6.5	11.2	16.4	3.7	9.5	1.8
SAMPLING AREA:																
Number of Respondents[2]	16	78	341	58	94	184	158	120	95	417	239	116	45	724	122	2807
Number reporting gray squirrel on sampling area	11	61	292	57	88	184	158	120	86	402	234	114	42	686	118	2653
Per cent reporting gray squirrel on sampling area	69	78	86	98	94	100	100	100	91	96	98	98	93	95	97	95

[1] Relative sampling errors (R.S.E.) computed by use of analysis of variance, with computations by the Iowa State College Statistical Laboratory.

[2] Includes only respondents who have lived on area, or not over 2 miles from area, during the last five years.

TABLE 2

Status of the fox squirrel in Tennessee as determined by personal interview of heads of farm households.

	Farming - Type															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
FARM: Number of Respondents	27	97	489	69	131	261	200	139	116	538	306	137	57	862	131	3560
Number reporting fox squirrel on farm	12	57	240	41	50	163	52	94	74	344	82	60	7	79	11	1336
Per cent reporting fox squirrel on farm	44	59	49	59	38	62	26	68	38	64	27	44	12	9	8	38
R.S.E.[1] for estimated total of: All heads of farm households	16.4	7.6	5.0	6.7	6.8	4.6	5.9	6.7	8.8	3.2	5.7	7.7	10.2	3.0	6.5	1.5
Heads of farm households with fox squirrel on farm	24.9	11.4	8.6	16.7	16.7	7.6	15.9	9.0	17.6	9.8	12.5	16.1	30.6	13.6	34.0	3.0
SAMPLING AREA: Number of Respondents[2]	16	78	341	58	94	184	158	120	95	417	239	116	45	724	122	2807
Number reporting fox squirrel on sampling area	12	63	250	42	54	151	53	97	46	347	90	92	8	108	27	1440
Per cent reporting fox squirrel on sampling area	75	81	73	72	57	82	34	81	48	83	38	79	18	15	22	51

[1] Relative sampling errors (R.S.E.) computed by use of analysis of variance, with computations by the Iowa State College Statistical Laboratory.

[2] Includes only respondents who have lived on area, or not over 2 miles from area, during the last five years.

TABLE 3. *Farmer squirrel hunter statistics, Tennessee* 1950-51 *hunting season.*

	Farming - Type															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Number of farmer hunters	14	40	170	28	39	58	89	55	22	154	117	43	12	169	32	1042
Per cent squirrel hunters	64	68	51	68	49	71	65	82	73	66	76	79	33	56	80	64
Percent of squirrel hunters hunting:																
Only gray squirrels	0	0	8	22	68	38	80	65	88	70	82	62	100	96	100	62
Only fox squirrels	33	22	3	6	0	0	0	2	0	0	1	0	0	1	0	2
Both squirrels	67	28	89	72	32	62	20	33	12	30	17	38	0	3	0	36
Per cent fox squirrels of total squirrel kill	61	55	48	24	18	24	9	19	9	14	11	31	0	3	0	21

those obtained by personal interview. Use of the relative terms, *common, rare* and *absent,* is hazardous as the terms may connote different meanings to different officers.

Although the data collected do not permit delineation of ranges of subspecies, it is believed they do establish the present range and relative density of the gray and fox squirrel in Tennessee.

Gray squirrel. The range of the gray squirrel *(Sciurus carolinensis)* is throughout the entire state of Tennessee with the heaviest populations apparently being in the region east of the western boundary of farming-type 6 and west of the eastern edge of the Cumberland Plateau (Table 1). As indicated by the per cent of farmer respondents having woodland, it is quite possible that the relatively small percentages of respondents in farming-types 1, 2, 3, and 5 reporting gray squirrels may be due to the absence of woodland. Only 22, 45, 47 and 50 per cent of the respondents in these farming-types respectively reported woodland on their farms as contrasted to 9 of the remaining farming-types having over 74 per cent reporting woodland (Schultz *et al.,* 1954).

The gray squirrel was reported as occurring on farms of 2,753 of the 3,560 respondents (Table 1). An inspection of the percentage of farmers reporting the gray squirrel on the sampling area shows the lowest percentages in farming types 1, 2, and 3 with the remaining percentages being over 90 per cent (Table 1). It is difficult to draw any specific conclusions from these relationships other than that the gray squirrel is common throughout the State. As the gray squirrel was reported by 77 per cent of the respondents and was universally reported throughout the State the distribution of these respondents is not presented. Interested readers will find this information in the final report of this project (Schultz *et al.,* 1954).

Gray squirrel population trends on the sampling areas during the five year perior preceding the survey were reported as up, 11 percent; down, 35 per cent; fluctuating, 10 per cent; no change, 28 per cent; unknown, 16 per cent.

In all farming-types the largest per cent of respondents reporting a change reported gray squirrel populations as down. The reported decline was probably a result of a major mast failure over most of the state during the study period.

Fox squirrel. The primary range of the fox squirrel in Tennesee apparently encompasses all of the state west of the eastern edge of the Cumberland Plateau. Within this region our data indicate that the smaller populations are in farming-types 5, 7, 9, and 11. In general, these conclusions are substantiated by data collected on farms and sampling areas (Table 2).

The fox squirrel was reported as occurring on farms of 1,336 of the 3,560 respondents (Table 2). The distribution of the

3,560 respondents, 1,336 of whom reported the fox squirrel on their farms and 2,224 who reported the animal not on their farms, is presented in Figure 1.

Fox squirrel population trends on the sampling areas during the five year period prior to study were reported as: up, 8 per cent; down, 31 per cent; fluctuating, 6 per cent; no change, 34 per cent; unknown, 21 per cent. In all farming-types the largest per cent of respondents reporting a change reported fox squirrel populations as down, possibly the result of the previously reported mast failure.

Squirrel Hunting. Data collected from hunters substantiate some of the above conclusions. Sixty-four per cent of the 1,042 farmer hunters from whom detailed hunting information was obtained hunted squirrels, with the percentages ranging from 33 to 82 per cent in the farming-types (Table 3). There is little doubt, based on these data and other observations by the writer, that the squirrel is the most sought after game animal in Tennessee. Probably the most interesting portion of the hunting data

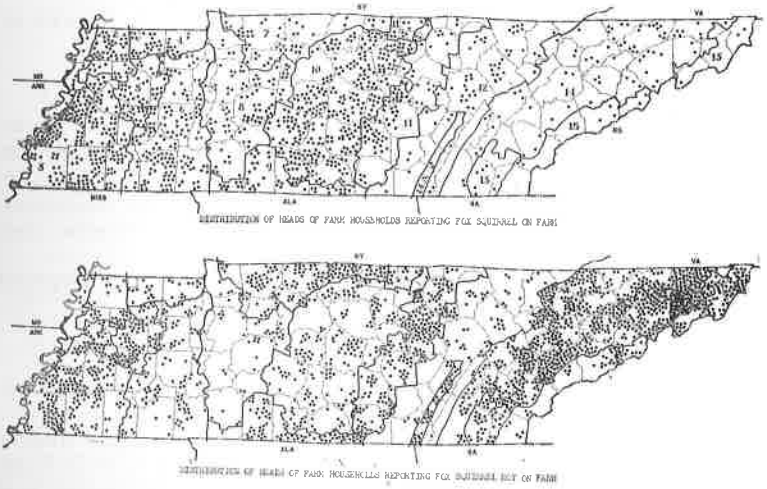

Fig. 1. Distribution of heads of farm households reporting the fox squirrel either utilizing or not utilizing farms.

is that on the kind of squirrels hunted and the proportion of fox squirrels in the hunters bag (Table 3). These data leave little doubt that the primary range of the fox squirrel is west of the Valley of East Tennessee and that the fox squirrel populations probably exceed that of the gray squirrel in farming-types 1, 2 and possibly 3. Of the 668 farmer squirrel hunters contacted 60 per cent possessed a hunting license, with the percentages

ranging from 89 to 27 per cent in the farming-types (Schultz *et al.*, 1954). These were in farming-types 1 and 14, respectively. As farmers are not required to obtain a hunting license to hunt on their own farm and farms in farming-type 14 are more apt to have woodland (75 per cent) than those in farming-type 1 (22 per cent), these percentages may be indicative of the need for off-farm hunting in the Mississippi Bottoms rather than an indication of greater interest and more extensive squirrel hunting in this region.

Of farmer hunters hunting more than one game animal and reporting preference, the squirrel was the first choice of white hunters (45 per cent) while for colored hunters (50 per cent) the rabbit was the first choice. Disregarding race the squirrel was the first choice of the largest percentage of eligible respondents.

Farmer gray squirrel hunters averaged 6.3 trips with an average take of 11.8 gray squirrels per hunter while fox squirrel hunters average 7.6 trips with an average take of 3.7 fox squirrels per hunter. It is estimated that farmer hunters killed 594,672 gray squirrels and 73,071 fox squirrels during the study period.

Detailed data on hunting success are available in Schultz *et al.*, (1954).

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Figure 1. Distribution of heads of farm households reporting the fox squirrel either utilizing or not utilizing farms.

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colleges and universities throughout the United States, Dr. Keenan is a former industrial chemist and has been active in laboratory research at U-T. For some years, however, he has been interested in the philosophy of science —what makes a great scientist "tick," how personal feelings influence his work, and what he expects from life. With his wife teen-age daughter, and seven-year-old son, Dr. Keenan will live near Cambridge University where he will do his research. In its extensive library he will study the writings and observations of some of the greatest physical scientists of the past 200 years.

A continuing scholarship program that will pay tuition, fees, and book costs of eight engineering students each year has been established at the University of Tennessee by the Union Carbide Nuclear Co., Oak Ridge. Four students in chemical engineering and four in mechanical engineering will benefit from the scholarships each year when the program is in full operation. The award plan was announced by C. E. Center, vice president of the Oak Ridge company, a division of Union Carbide Corporation, in a letter to U-T President C. E. Brehm. Beginning with the fall of 1958, four-year scholarships will be awarded to two entering freshmen, on in mechanical and one in chemical engineering. The next year, two more freshmen will receive four-year awards, and so on until there will be eight scholarship holders on the campus at all times. For the fall of 1957, the company will sponsor one-year scholarships for two seniors and two-year scholarships for two juniors. In 1958, when the first four-year freshman awards are made, two sophomores also will receive three-year scholarships. Dean of Students Ralph E. Dunford estimated the four-year scholarships will be worth more than $1,000 to each student.

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