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Factors of the Microclimate Affecting the Activity of Fox Squirrels in Southwestern Michigan

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FACTORS OF THE MICROCLIMATE AFFECTING THE ACTIVITY OF FOX SQUIRRELS IN SOUTHWESTERN MICHIGAN

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by

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INTRODUCTION

The fox squirrel, Sciurus niger rufiventer, is an important small game animal throughout much of the Midwest. Within the last thirty years several scientific investigations have been focused on this animal, the result being that its life history and ecology are fairly well known.

Concerning the range of the fox squirrel, D. L. Allen (1943:33) states that, in Michigan, the range began to increase with the advent of the pioneers. Baumgartner (1940) and J. M. Allen (1952) noted similar occurrences in their respective states, Ohio and Indiana. In Kansas, the fox squirrel, aided by agricultural land-use, has spread westward throughout nearly the entire state (Packard, 1956:61). Hoover and Yeager (1953) indicated that the fox squirrel had increased its range in Colorado. See Fig. 1, for the geographic distribution of Sciurus niger rufiventer in the United States.

Except where it occurred in the few prairie island remnants and oak-openings in the southwest corner of Michigan, the fox squirrel was non-existent in the state before the coming of the pioneers (D. L. Allen, 1943:31). These individuals, farmers and lumbermen, found the southern part

of the state covered with a dense hardwood forest. North of a line drawn across the state westward from the Southern most point of Saginaw Bay, the hardwood forest graded into a transition zone of mixed hardwoods and conifers. This dense, mature forest cover constituted an ideal habitat for the gray squirrel Sciurus carolinensis and the black squirrel, a melanistic variation of the gray squirrel. In the process of lumbering or clearing the land for farming, the pioneer began to change and destroy the environment of the gray squirrel and unknowingly created habitat suitable for the fox squirrel. As a consequence the fox squirrel has spread throughout the lower peninsula of Michigan.

The microclimatological factors which influence the daily activity of the fox squirrel need further study. Hicks (1949) and Packard (1956) both investigated various factors of the environment affecting squirrel activity, however they made no attempt to gather data in the immediate vicinity (microclimate) of the squirrel itself.

The purpose of this investigation was to determine the effect of certain factors of the microclimate (temperature, relative humidity, light intensity and wind velocity) on the activity of a population of fox squirrels. The behavior of individuals in this population was observed as a consequence of studying their activity. Special attention was given to activity possibly associated with territoriality.

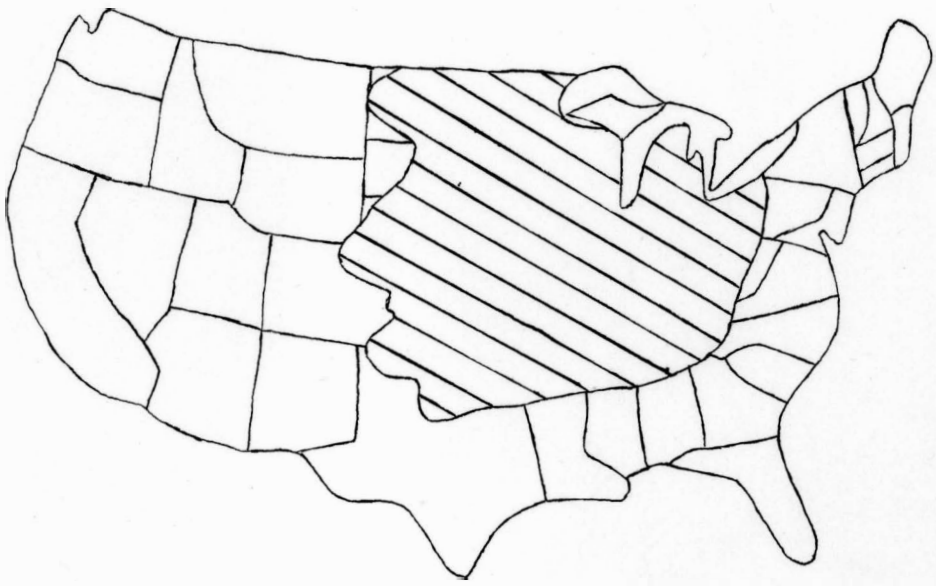

Fig. 1. The distribution of the fox squirrel Sciurus niger rufiventer in the United States.

METHODS

In this study, four factors of the microclimate were investigated in order to determine their possible effect on the activity of fox squirrels. Temperature was measured by three standard Centigrade thermometers placed at ground level. The temperature was then converted to degrees Fahrenheit by an appropriate mathematical equation. Relative humidity was determined by using a sling psychrometer. Wind velocity was measured by a "Florite" anemometer, model 3035 A; Velocities were recorded in miles per hour. Values for light intensity were obtained by using a Weston "Master II," universal exposure meter, Model 735. Conversion factors were used to obtain intensity, in foot-candles, from the meter reading; When measuring incident light the meter readings were multiplied by 25. Meter readings for reflected light were multiplied by 4.

The Mountain Home Cemetery, which lies within the city limits of Kalamazoo, was chosen as the site for this study. This location had two distinct advantages over other areas in or near Kalamazoo. Understory vegetation was practically non-existent, and with the exception of grave markers, there was very little to interfere with the observation of squirrels on the ground. Secondly, the site supported a relatively dense population of squirrels.

A plot approximately 200 yards in width by 400 yards in length was laid out in the cemetery. Within this strip

eighty-two data gathering trips were made, each for a period of one hour. (see Table 1).

Table 1. Number of observations made at various hours of the day (Eastern Standard Time) from October 1, 1959 to March 31, 1960.

Time of day at which observations were made											
A.M. 8	9	10	11	12	1	2	3	4	5	6 P.M.	
7	5	7	8	9	11	13	10	8	3	1	

During each one-hour period activity of fox squirrels was recorded whether it occurred on the ground or in the trees. Because of the difficulty involved in working in trees, only data gathered at ground level were used in this study. Microclimatological data were secured by placing the instruments directly on or over the spot where a squirrel had been seen. Light intensity was measured at a height of six inches above the ground, temperature and wind velocity at ground level. Relative humidity, was measured approximately one foot above the ground. All measurements were made within five minutes after sighting a squirrel.

Mature maples, oaks and hickories form the major portion of the open canopy in the study area. (see Table 2, for a list of the species present). A few elms constitute the remainder of the canopy.

Figure 2 shows the position of the various species of trees within the study area.

Table 2. Species of canopy trees present in the study area.

Silver maple	*Acer saccharinum*
Black maple	*Acer nigrum*
Sugar maple	*Acer saccharum*
Small fruited hickory	*Carya ovalis*
Shagbark hickory	*Carya ovata*
White oak	*Quercus alba*
Black oak	*Quercus velutina*
American elm	*Ulmus americana*

Midstory vegetation is almost entirely absent, an exception being the occasional presence of evergreen shrubs around tombstones. The ground is covered by a mixture of Kentucky blue grass *Poa* sp., creeping red fescue *Festuca* sp., rye grass *Lolium* sp. and white Dutch clover *Trifolium* sp. In places the grass cover is interrupted by patches of mosses and lichens.

RESULTS

Activity of fox squirrels was at a peak during the latter part of September, October and the first part of November, when the year's production of mast was being gathered.

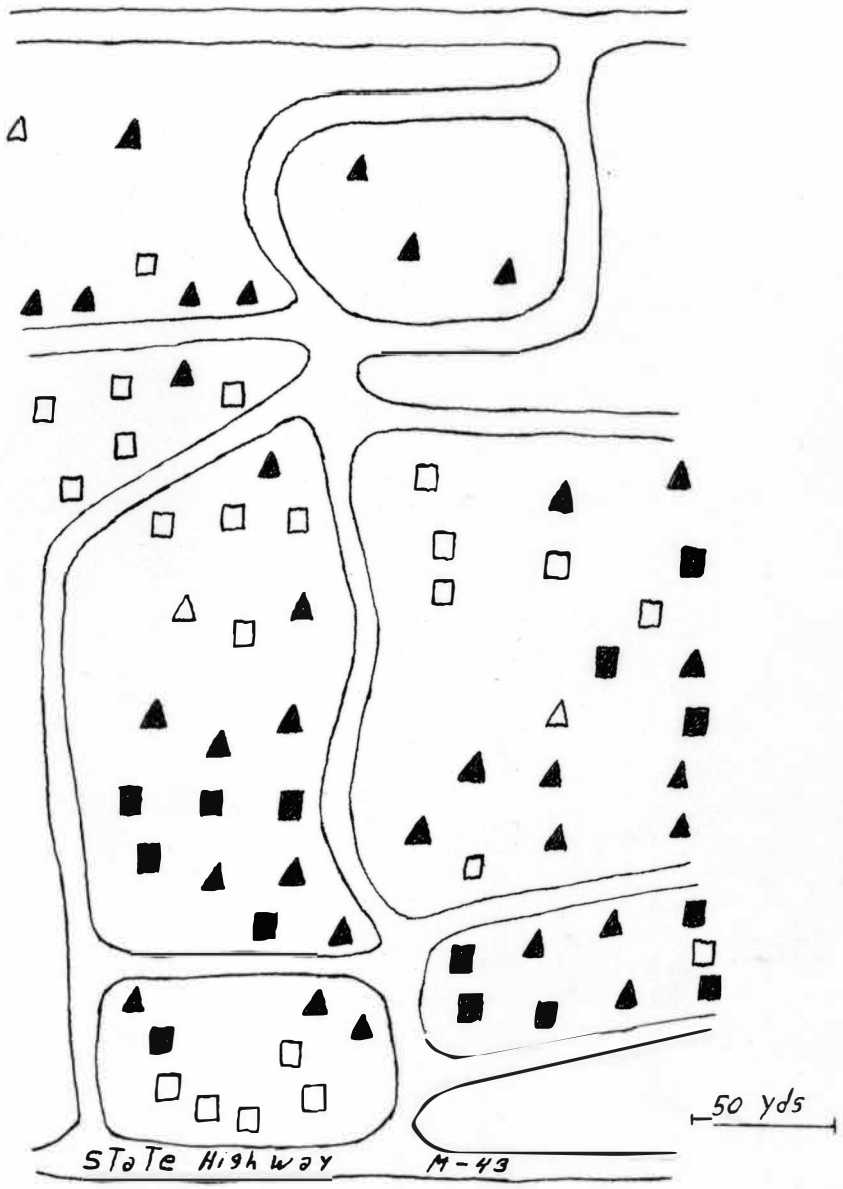

Fig. 2. Map of study area showing location of canopy trees. Key: Solid squares, oaks; open squares, hickories; solid triangles, maples; open triangles, elms.

During this time most of the squirrels seen were scurrying about on the ground burying mast or storing it in the hollows of trees. During this rash of activity squirrels seemingly have a tendency to move about or reshuffle. This behavior seems to be related to the general redistribution of the fox squirrel population and in particular to the scattering of the year's young. In this manner, a balance tends to be reached between population density and the carrying capacity of the habitat (D. L. Allen, 1943:151-152). Activity declined during the latter part of November and December, but increased again during the latter part of January and February when fox squirrels come into breeding condition. Late in February or in March, when female squirrels are pregnant or have young in the nest, activity decreased. Based on general observations, in late April and May, there was another increase in activity asscciated with a second breeding period. This was followed by a decline in activity throughout the summer.

FACTORS OF THE PHYSICAL ENVIRONMENT

The data, presented in Figures 3-6, were collected over a six-months period, extending from October 1, 1959 to March 31, 1960. During this period two peaks of activity occurred, one in the fall associated with the mast harvest, the other in February associated with the breeding season. A decline in activity occurred in December following the mast harvest

and continued into the latter part of January. The data were arranged in three groups, roughly corresponding to the three periods of activity. The groups, October-November, December-January and February-March consist of 130, 70 and 90 observations, respectively. Activity was based on the number of squirrels seen per hour. Care was taken to avoid counting the same animal more than once. Because of the time limit, it was impossible to obtain measurements of the physical environment for every squirrel seen. The total referred to in Figures 3-6 pertains to the number of squirrels for which I made measurements. This consists of 130 for the first two-month period, and 70 and 90 for the other two periods, respectively.

WIND VELOCITY

The fox squirrel is most active (see Fig. 3) when the wind velocity is between zero and five miles per hour. With wind velocities exceeding five miles per hour there is relatively little activity. This may be due to the effect of increased evaporation and cooling on the fox squirrel or to the difficulty involved in moving about in the trees when the branches are swaying. Although the level of activity differed from one part of the study period to another, the reaction to wind velocity was essentially the same in all months of observation.

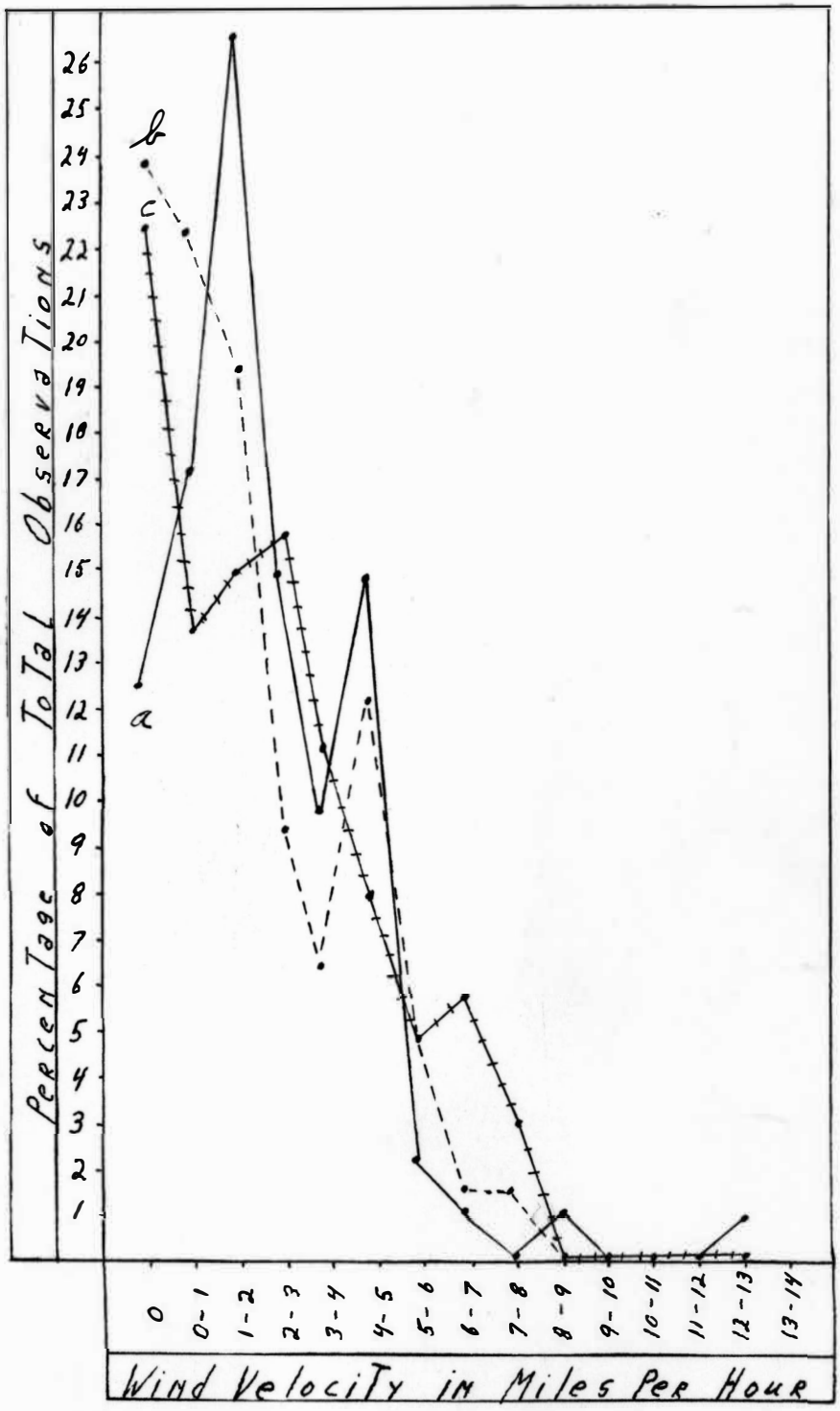

Fig. 3. Activity of squirrels compared with wind velocity.
a. October-November period (130 observations).
b. December-January period (70 observations).
c. February-March period (90 observations).

RELATIVE HUMIDITY

Fox squirrels were most active when the relative humidity was between 60 and 100 percent (see Fig. 4). The reaction to relative humidity was essentially the same throughout the entire period of observation. Contrary to the findings of others (Hicks, 1949, and Packard, 1956), my investigation indicates the occurrence of considerable activity during light rain and snow.

LIGHT

When the light intensity (measured six-inches from the ground) was between 650 and 2500 foot-candles, the fox squirrels were most active (see Fig. 5). In the fall, fox squirrel activity was greatest when the light intensity was between 250 and 1500 foot-candles. During December and January most activity occurred when the incident light was between 950 and 2500 foot-candles, and a minor peak of activity occurred when light intensities were between 250 and 350 foot-candles. In the early spring, most activity occurred when the incident light ranged between 950 and 4500 foot-candles.

TEMPERATURE

Examination of Figure 6 indicates that fox squirrels are most active when the temperature is between 30° and 60° Fahrenheit. In the fall, fox squirrel activity is greatest when the

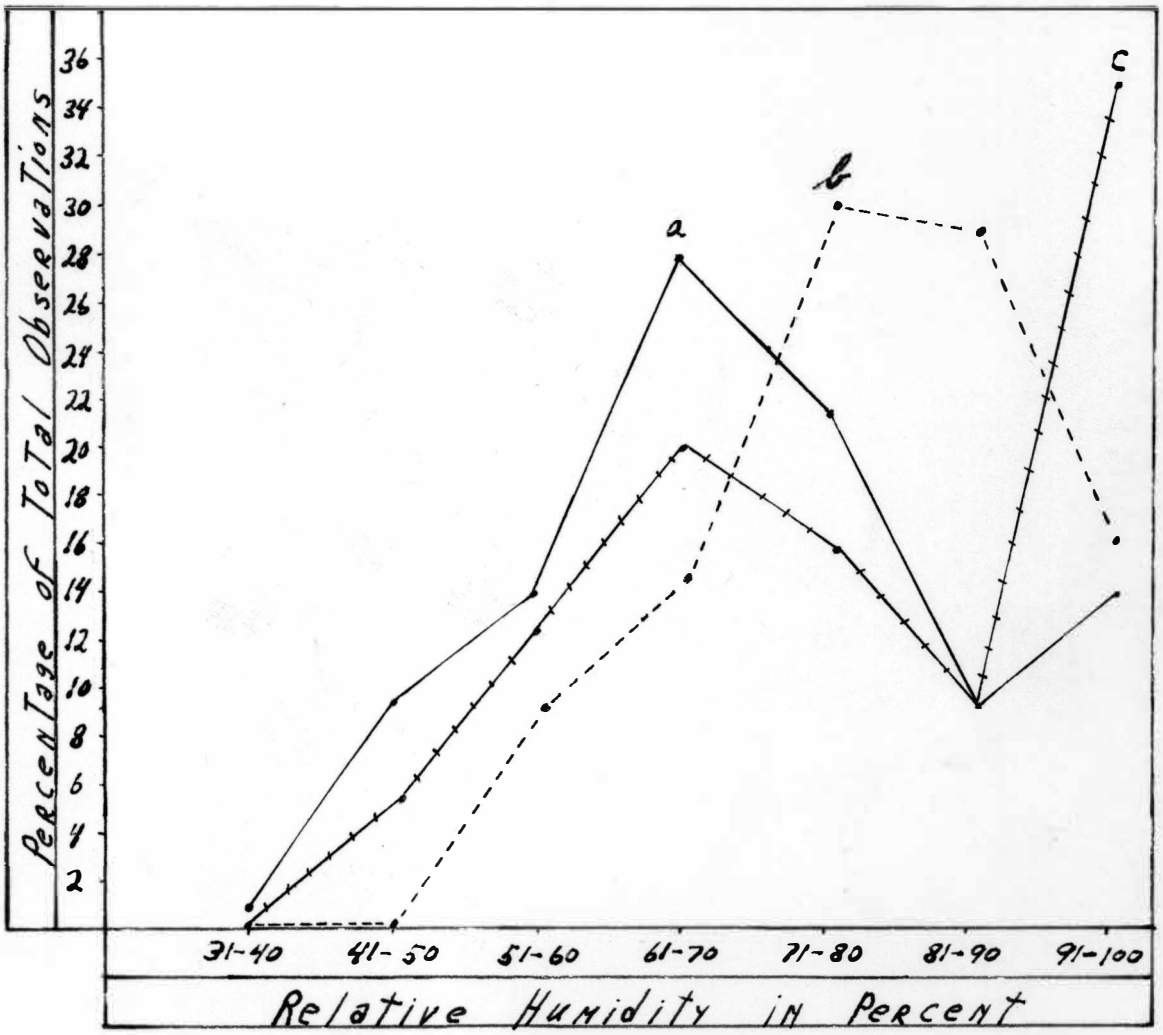

Fig. 4. Activity of fox squirrels compared with relative humidity.
a. October-November period (130 observations).
b. December-January period (70 observations).
c. February-March period (90 observations).

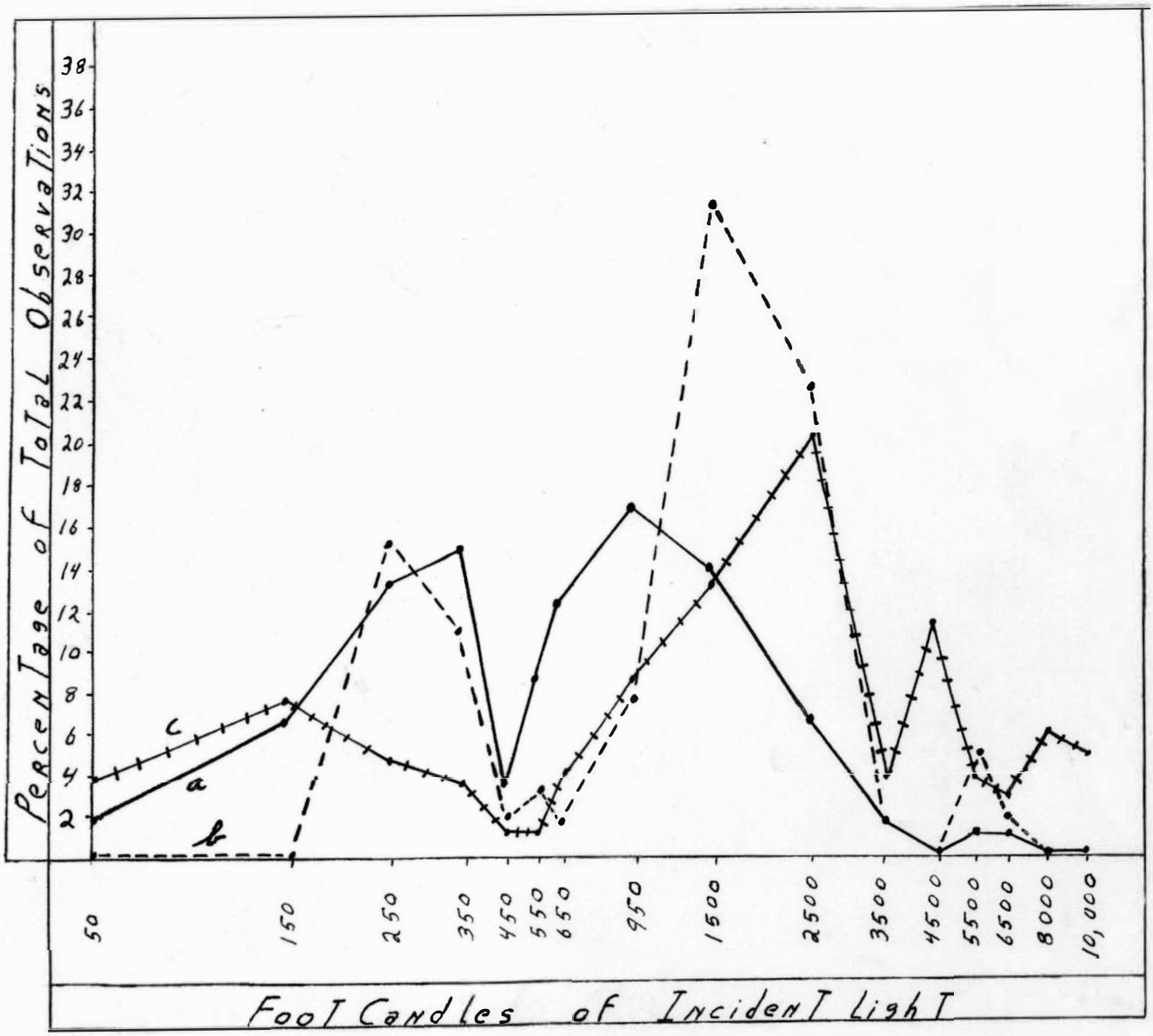

Fig. 5. Fox squirrel activity compared with light intensity.
a. October-November period (130 observations).
b. December-January period (70 observations).
c. February-March period (90 observations).

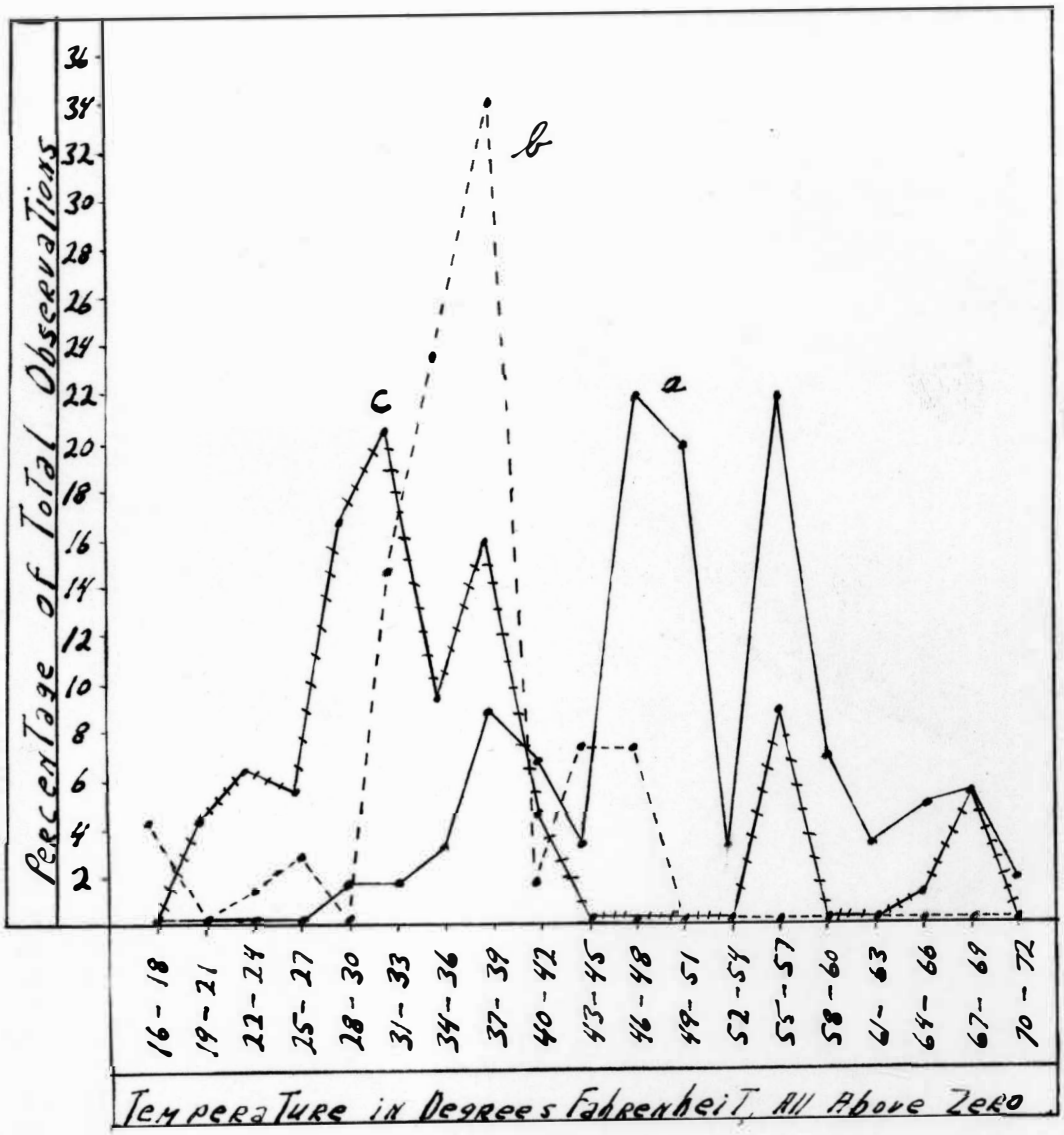

Fig. 6. A comparison of fox squirrel activity with temperature.
a. October-November period (130 observations).
b. December-January period (70 observations).
c. February-March period (90 observations).

temperature is between 46° to 60° F., in the winter and early spring, fox squirrels appear to be most active when the temperature is between 30° to 39° F.

FOOD HABITS

In optimum squirrel habitat there should be a variety of mast producing trees. If one species should then fail to produce an adequate mast crop, production by the other species will lessen the severity of the food shortage. In the study area, oaks and hickories were plentiful and produced a large mast crop. There were no indications of squirrels migrating out of the area owing to a shortage of food. It is quite probable that squirrels from adjacent areas might have migrated into the study area owing to the abundance of mast. In addition to mast produced by the oaks and hickories, buds and seeds of elms and maples were utilized for food when the snow cover was deep. The study area seems an excellent habitat for fox squirrels in one other respect; there exists a large number of dens suitable for squirrel occupancy. Only a few leaf-nests were observed and these fell into disrepair when the weather became colder, indicating that the nests were no longer being used. Dens are probably superior to leaf-nests in that the former provide better protection from inclement weather and predators.

During the investigation, no squirrels were collected. Therefore no stomach analyses were made.

By moving carefully, one could walk to within twenty feet of a squirrel, on many occasions from this distance it was possible to see what was being eaten. During the autumn, hickory nuts seemed to be favored over acorns as a source of food. While walking through the study area it was a common sight to see piles of hickory nut shells on the ground beneath a squirrel perch. With the arrival of winter, the hickory nut crop was nearly exhausted; as a result acorns became the predominant source of food. In March, during some particularly severe weather, squirrels were seen eating elm buds. In the spring, both acorns and hickory nuts were eaten, with acorns constituting the larger portion of the diet.

PREDATION

Predation, as far as I could determine, was a minor source of mortality among the squirrels studied. Hunting is not allowed in the area, therefore there were no deaths or injuries due to this cause. Stray dogs and cats probably constituted the major threat. However, because of the fences and walls surrounding the cemetery few predators of this nature get in. On three occasions hawks of undetermined species were seen in the study area, and it is possible that they may occasionally take a squirrel. Throughout the six-month study period a few squirrels were killed by traffic on highway M-43. The squirrels under observation were not

marked, therefore it was impossible to determine whether those animals killed were from the study plot or adjacent areas.

TERRITORIALITY

From what I could determine by actual observation, the fox squirrel seemingly makes little effort to defend an extensive territory. However, the area immediately around its den or nest tree is vigorously defended against other fox squirrels. Following periods of severe weather (when the squirrels sought shelter) territorial behavior diminished. This was evidenced by seeing several squirrels feeding in an area usually defended by a single squirrel. Hunger may have been a cause for this unusual behavior.

DISCUSSION

This investigation was carried out near the northern limits of the fox squirrel's geographic range. The relationships which exist between an organism and its environment are often more clearly demonstrated near the border of the animal's range then near the center. With this in mind, wind velocity, relative humidity, light intensity and temperature were studied as interacting factors affecting the activity of S. niger.

The fox squirrel, as indicated by my study, is most active when the wind velocity does not exceed five miles per hour. Packard (1956) in a similar investigation in Kansas (near the western edge of the fox squirrel's range) found the same relationship. Our results differ considerably concerning light intensity. My studies indicate that fox squirrels are most active when the light intensity is between 650 and 2500 foot-candles. Packard (1956:32) states that, in Kansas, most fox squirrel activity occurred when the incident light was between 1500 and 6500 foot-candles. Part of this difference may be due to the manner in which the light intensity measurements were made. Packard took readings at a height of six inches above the ground, but as he did not take readings for individual squirrels, his measurements may have been high. It has been my experience that on bright days the activity of squirrels on the ground is usually confined

to the shaded areas around trees. Concerning relative humidity, my findings and those of Packard are about the same. My study indicates that activity is greatest when the relative humidity is between 60 and 100 percent; Packard (1956:35) found that activity was greatest when the humidity was between 70 and 99 percent. He indicated that activity declines during light precipitation, but I found that considerable activity occurred during light rain or snow.

In Kansas, Packard (1956:33) found the fox squirrel to be most active when the temperature was between 43° and 72° F. My investigation indicated that most activity occurred when the temperature was between 30° and 60° F. However, Packard's study covered a thirteen month period which included the warmer seasons of the year, and this must be taken into consideration when comparing the data.

In general, the fox squirrel is most active when there is a combination of low wind velocity, moderate light intensity, high relative humidity and low temperature.

SUMMARY

1. This investigation was carried out in the Mountain Home Cemetery, in Kalamazoo, Michigan, from October 1, 1959 to March 31, 1960. This site was chosen because of its relatively dense squirrel population and its lack of obscuring midstory vegetation.

2. A study area, 200 by 400 yards, was selected. Within this area 82 one-hour observations were made.

3. All activity was recorded, whether it occurred on the ground or in the trees. However, only data gathered at ground level were used in the study.

4. The major mast-producing vegetation consisted of oaks and hickories. Mast was plentiful.

5. The trees within the study area contained an abundance of dens. Dens seemingly give better protection from the elements and predators then do leaf-nests.

6. The results of this study indicate that the fox squirrel, near the border of its geographic range, is most active in late autumn, winter and early spring, when there is a combination of low wind velocity, low temperature, high relative humidity and moderate incident light.

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