A COMMENTARY ON THE BEHAVIOR OF FREE-RUNNING GRAY SQUIRRELS*

By WARD M. SHARP
The Pennsylvania Cooperative Wildlife Research Unit
Pennsylvania State University
University Park, Pa.

When I accepted Dr. Vaughn Flyger's invitation to participate in this meeting and to discuss behavior in the gray squirrel, I did so with the feeling that I would not be expected to enter into an exhaustive treatment of the psychology behind squirrel behavior, nor do I expect to present the entire behavior pattern of the gray squirrel. Just as we do not understand the behavior patterns in our domestic animals, so we do not claim to know much about wild animals in their native habitats. Although I have been deeply interested in the scenting ability in bird dogs, I am at a loss because one cannot measure scent trails which the dog detects without difficulty. Gray-squirrel behavior is even more baffling, but one can record and report his observations. One can be quite certain after years of field experience that the gray squirrel possesses more than blind instinct. Its knowledge, its instincts, and its supernatural something make it more than just a "dumb animal."

Free-ranging gray squirrels are those squirrels living in the wild, choosing their inherent ecological niches, coping with the annual fluctuations of food supplies, living with and forecasting the weather throughout the year, reproducing their populations, and avoiding their enemies. Free-ranging is the living in and surviving in the elements of their climate and their habitat. In captivity the gray squirrel's initiative to seek food, to elude pursuit, to respond to breeding periods, and to live by their cunning is suppressed.

In order to understand behavior in the squirrels of the genus *Sciurus* one must re-examine the genera within the subfamily *Sciurinae*, the family *Sciuridae*, of the order *Rodentia*. Miller and Kellogg (1955) list seven genera—*Marmota, Cynomys, Citellus, Tamias, Eutamias, Sciurus,* and *Tamiasciurus*—which belong to the *Sciurinae;* and all are to be found in the United States. In the eastern United States we encounter the woodchuck or ground hog (*Marmota monax*), the eastern chipmunks (*Tamias*), the gray and fox squirrels (*Sciurus*), and the red squirrels (*Tamiasciurus*). The representative genera cited all have many behavorial traits in common. A language, a tendency towards gregariousness, and an inclination to become subdormant to dormant in cold seasons are traits in common among these genera.

The genera of the subfamily *Sciurinae,* which live in ground dens and feed exclusively upon grasses and forbs, have less need for specialized behaviors than have the tree squirrels. Because tree squirrels have adapted to a specialized arboreal habitat, they have developed special patterns of behavior and thus have achieved high survival qualities. Their food habits, their den habits, and their survival habits contrast with their cousin genera living in ground dens where food in season is always available in habitat niches that afford optimum site requirements. Since our tree squirrels of the eastern United States are not true hibernators they have had to adapt themselves for living in all four seasons. Food storage is necessary to survival during the winter months. The chief foods of gray squirrels are the nuts and other fruits of trees. The result is a specialized feeding habit complicated by frequent mast failures. Gray squirrels have thus been compelled to develop survival mannerisms not needed in the grass and forb feeding genera of the *Sciurinae.*

The Language of the Gray Squirrel: All of the above genera have one call in common which they use to warn others of the approach or presence of a natural enemy. For example, woodchucks often signal a warning at the approach of a dog. Anyone who has hunted woodchucks with a well-trained

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woodchuck dog will have been exasperated on many occasions by their sharp, whistling signals. The woodchuck less commonly warns of the approach of man. In remote, isolated regions where man is seldom seen golden-mantled marmots will signal man's approach by their warning calls.

The gray squirrel has a language consisting of several calls which may be relegated to five categories as follows: the call of apprehension, the call of fright, the after-feeding call, fussing calls, a variety of clucking calls, and the squeal of death. In apprehension of another animal when a squirrel cannot determine the intruder's motives a barking call is uttered in rapid succession. This is a challenge to tease and to draw out the intent of the intruder. A concealed hunter is frequently teased into moving, thus satisfying the squirrel that the intruder has unfriendly intentions. The cat-call is the language of fright when the potential enemy has been identified and a warning is emitted. The presence of a hawk provokes the call of fright. The feeding call is emitted just prior to or upon the completion of feeding. Squirrels moving in to a food supply first feed and then perch on a limb and bark. This feeding call is similar to the barking call of apprehension, except that its tone and rapidity are modulated. The clucking and sucking sounds are emitted usually when two or more squirrels are closely associated. Mating chases are characterized by a variety of chucking or sucking calls. The fussing or growling call is most frequently heard when another squirrel, upon seeing a hunter, runs into a tree den already inhabited by another squirrel. A female, weary and tired, may emit this call when molested by a persistent male.

BEHAVIOR IN YEARS OF FOOD SCARCITY AND ABUNDANCE

1. *Behavior in the wake of a food shortage:* In 1956 the dearth of mast in many parts of Pennsylvania resulted in a movement of the squirrel population from the Cameron County study areas, where the mast crop was a complete or almost complete failure (Creed, 1957). Squirrels began deserting the study areas by early August and, by early September, squirrels were seldom seen in our beech-maple-birch study area. This exodus began before the mast would have filled out had there been a crop. Squirrels tagged in March had moved from the beech-maple area as far as 62 miles by November. Although this area had supported 56 squirrels in the late winter and spring of 1956, only three were present in December and January the following winter.

Do gray squirrels have the ability to detect years of food shortage months in advance of the time that it will be needed? Schorger (1949), in discussing gray squirrel migrations in early Wisconsin, cites reports where squirrels migrated out of areas of mast failure in advance of the season in which the nut crop would normally mature.

2. *Behavior in the wake of food abundance:* The Barrens Grouse Study Area in Central Pennsylvania experienced mast failures in 1956, 1957, and 1958. The squirrel population declined on the 1,470-acre area to about 6 squirrels.

A heavy mast crop for 1959 was evident by late June, but the acorns would not be filled before late July and early August. Squirrels began to appear in early July. Since the area had a scarcity of den trees, the squirrels resorted to building leaf nests. The population had increased noticeably by mid-July. Can gray squirrels in passing through an area determine the maturing food potential?

TERRITORIALITY AND GREGARIOUSNESS

Territoriality and gregariousness of the gray squirrel are here treated under the same heading because the two are related. The gray squirrel is not so gregarious as the prairie dog or the golden-mantled marmot. In the first place the arboreal habitat of the gray squirrel prevents it. But gray squirrels do desire the presence of others and, in a sense, are gregarious. As many as four have been found using a nesting box during the winter in Pennsylvania. Since they are somewhat gregarious, they do not demonstrate territoriality.

I have observed no indication that a territorial habit prevails in free-ranging gray squirrels. Rank in their social hierachy may suggest this, but this type

of dominance prevails among all groups of social animals. A female may defend the den tree in which her young are located. A female may, in some manner, entice her young to sources of food once they are sufficiently active to leave the den tree. I have observed at least three cases in which young were brought to artificial feeding sites. One was at a residence, and in two separate cases young came to a basket-type feeder.

Observations have led me to believe that without a gregarious tendency a gray squirrel population would be less able to survive. One squirrel attracts or directs others to a newly found food source by its after-feeding calls. Food cached by a squirrel may be used by others inhabiting the same forest community.

When squirrels evacuate a range because of a dearth of mast, the entire population appears to be alerted to this unrest. Such united action must indicate some sort of social tie. Since their departure is timed, there must be a means of communication. Although the number of gray squirrels appeared normal in Cameron County in March and April 1956, by late August the population had virtually vanished. One of these squirrels moved a distance of 62 miles, two others 40 and 42 miles. Where others went we do not know. In 1958 when there was an abundance of food the squirrels did not move, but there was a late November ingress that increased the population (Kriz, 1959).

HIBERNATION

Gray squirrels do not hibernate as do the chipmunk or woodchuck, but they do fast for varying periods. During very cold weather a squirrel may eat only an acorn then return to its tree den for the remainder of the day; if the weather is cold and windy, it may not reappear for several days. Gray squirrels in nesting boxes in midwinter have appeared to be in a deep sleep. They would not move until the observer reached into the box, located their heads by the hand, and tightened his grip. Their first struggles occurred as they were lifted out of the box. In warm weather an adult rarely remains in the box but escapes while the investigator climbs the tree.

Fasting experiments were conducted at Penn State by subjecting some squirrels to *ad libitum* feeding, others to a starvation diet. When underfed for a period, the squirrels did not lose weight rapidly. Prolonged scanty feeding caused loss in weight. But when these emaciated animals were subjected to *ad libitum* feeding, their weight gains were rapid. A squirrel may regain a weight loss of five ounces within a week. This could be attributed to an adaptive habit necessary in the survival of squirrels when they are exposed to feast or famine conditions in nature.

FOOD CACHES AND COMMUNAL FEEDING

Feeding habits of the gray squirrel: The gray squirrel is tolerant of others at a source of food. A number of squirrels may feed amicably in a hickory tree. Their habit of caching food at random is a communal behavior, and the food stored on the forest floor by one squirrel which was later bagged in the hunting season may later be utilized by other squirrels that winter in the area. Red squirrels on the other hand are strongly territorial in nature, and in most cases defend a source of food against intrusion. (Gordon, 1936), and (Robinson and Cowan, 1954).

SMALL RODENT CACHES

It was thought at one time that small rodents in the forest competed for the food supply of forest game. The white-footed mouse was believed to be a keen competitor. Our studies in Pennsylvania since 1949 have not confirmed this hypothesis. Much evidence has been disclosed to show that gray squirrels rob food caches of the white-footed mouse and the chipmunk when their caches are placed under the leaves in the upper 2 to 3 inches of the forest duff. Food supplies buried by gray squirrels are not immune from the raids of these small rodents. But food supplies buried by chipmunks, which hibernate, are frequently raided by squirrels during the winter. I am of the opinion that some of the deep scratching done by wild turkeys may uncover caches of wild-cherry stones,

beech-nuts, or acorns concealed by woodland mice, chipmunks, or even gray squirrels.

PRACTICAL USE OF BEHAVIOR MANNERISMS OF THE GRAY SQUIRREL IN ITS MANAGEMENT

Behavior in hiding: When the leaves have fallen in the fall and when squirrels have become wild from hunting pressure, their tendency to hide from the gunner is most noticeable. Even under these wild conditions a gray squirrel will not remain hidden for more than 15 minutes if the hunter is well concealed and if the squirrel has been actively feeding.

We have put this information on hiding behavior into use by incorporating its significance into our time-area counts. Each stop along the route of the time-area count should not exceed 20 minutes. Squirrels which have not been subjected to gunning pressure will become active in about 10 minutes. The difference in the results secured by investigators using the time-area count is that some of them may stop and remain exposed, but others conceal themselves during the stop. To stop in an exposed, open location along the route of the time-area count often results in a low count when compared with the concealed stops.

I use the 15-minute stop method in hunting to approach several squirrels which are too wild to permit stalking. I survey the area and walk boldly within gun range and conceal myself. If I am well concealed, the squirrels in the vicinity become active within about 10-15 minutes. Care must be exercised that I am concealed from all squirrels, for one animal watching the concealed hunter may defeat the purpose of the stalk and foil his chances for a shot. This technique is of little value if the hunter approaches at a time when activity is ready to cease. This is especially true in late morning or late evening hours.

The use of rank in live-trapping operations: The successful live-trapping of gray squirrels is based on their behavior mannerisms. Sharp (1958), in the art and technique of live-trapping gray squirrels, describes the use of a wire basket filled with ear corn. The basket is hung on the trunk of a tree about 6 feet above the ground. Four traps are set on the ground around the tree. Dominant squirrels chase the subdominant from the feeder. These squirrels go to the ground and are first to enter the traps.

The lay-off period in trapping: Gray squirrels will enter traps readily to remove ear corn. But after about three days of trapping, the population refuses the corn in the traps. Traps are then turned bottom-up and prebaited for about three days or until the corn is being removed readily, at which time trapping is resumed until trap-shyness again becomes evident. In Pennsylvania one can trap at least 80-90 percent of a population within a three weeks period by taking advantage of rank and by softening their fear to trap-shyness by lay-off periods.

Pre-baiting and conditioning: Much time may be wasted in live-trapping operations by failing to condition squirrels to live-trapping operations. Uhlig and other investigators have informed me that they had no success with ear corn. Our Pennsylvania studies have revealed no difficulty in enticing squirrels to feed on ear corn. Perhaps there is a regional difference, but I feel that the difficulty lies in a conditioning process. This problem in enticing squirrels to feed on ear corn can be alleviated by establishing feeding stations. A feeding station will serve the needs for each 28 to 30 acres of squirrel habitat (Sharp, *op. cit.*).

INFLUENCE OF BEHAVIOR MANNERISMS ON POPULATION LEVELS

Had the gray squirrel acquired territorial behavior similar to those of the red or pine squirrel (*Tamiasciurus*), their numbers would not have been comparable to their present abundance in good habitats. Their population in a 30-acre woodlot of optimum habitat would have been limited. But since by nature they are tolerant, the 30-acre woodlot becomes common ground for the entire population, and the area could conceivably support one or more squirrels per acre (Flyger, 1956).

The habit of caching food at random over their common territory is a community sharing effort. Where 30 squirrels cache mast over the forest floor of a 30-acre habitat, and where 15 of the population are removed by hunting, the remaining 15 have the chance to resort to the winter's food supply laid away by the effort of 30 animals. But where the population is not reduced, they may be short of food by late winter.

A shortage of late winter foods is offset by the late winter and early spring shuffle. Ten years of spring trapping operations in Pennsylvania has disclosed that there is an annual movement of the squirrel population, especially in March and April. This movement is neither emigrating nor migrating. I have called it a *"floating"* population since it may proceed in a circuitous route, the squirrels wandering no further than a radius of one to one and one-half miles.

When gray squirrels are emigrating or migrating, they appear to move in one general direction. The mass exodus of gray squirrels from Cameron County in 1956 was in a southerly direction (Creed, *op. cit.*). The feeding call can be of particular value to the population under these circumstances. When one animal finds a niche where there is food, its barking may attract others which may otherwise pass by the food source.

The gray squirrel has been and continues to be the leading small game species in many states. In Pennsylvania it has held second place to the cottontail rabbit in importance over the past several years. Had the gray squirrel developed territorial and other traits of nonsocial animals and had it been without any type of social unity within the population, its numbers surely would have declined to the point of extinction from early gunning pressure. Since 1890 its habitat was virtually destroyed by lumbering operations; yet the gray squirrel has survived and has continued to be an important small-game species.

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QUESTIONS

Uhlig: The squirrels in small woodlots took corn but in large forests they had to learn about this. Mr. Johnson has had experience using raisins as bait.

Johnson: Once they found what corn and wheat were they took this bait.

Clark: Have you ever heard of someone being attacked by a female when handling young?

Sharp: No.

Shorten: Once.

Clark: I had a squirrel attack and bite me when a young squirrel from a nest box was being handled by me.

Uhlig: A squirrel ran over me on a similar occasion and bit me twice on a finger.

Bakken: I have noticed a restlessness of squirrel in March and April. Females being found 200 yards or more outside of their range. Could this be due to food availability?

Shorten: I have found this and believe it is partly due to young becoming independent; but both young and adults move about, especially in June.

Bakken: I have some evidence to show that a squirrel has her first litter in a den and that the female frequently moves this litter to a leaf nest shortly after the eyes open.

Uhlig: I feel the leaf nest counts can be used to determine densities but this is open to much controversy.

Moore: My observations have been mostly on fox squirrels building nests in long leaf pines and I found that many of the oak leaf nests in the wild were made by immature squirrels and were badly made.

Lwellyn: Could it be that adults have already appropriated the dens and have their own nests?

Moore: In my study I don't think this occurred. There were plenty of dens available.

Uhlig: I don't believe that anyone has shown an inverse of leaf nest relationship to dens, except perhaps in England.

Shorten: Certainly in England.

Clark: I believe that high temperature and fleas play a part in the use of dens.

Uhlig: What about nests built in October? They are not related to temperature.

Sharp: Leaf nests are a good index to the squirrel population. Squirrel may move into a good food area and construct nests.

Uhlig: It's rough but a good index for management.

Moore: I had 6 to 8 nests per squirrel for fox squirrels in Florida so I am skeptical of their value as a fox squirrel density index.

Sharp: In ridge and valley sections of Pennsylvania, squirrels are relatively sedentary but in birch, beech maple area they move much.

SQUIRREL MANAGEMENT AND RESEARCH

By HANS G. UHLIG
Biologist, Soil Conservation Service
Fergus Falls, Minnesota

When Dr. Flyger requested me to participate in this symposium he practically provided me with an outline. The subjects he suggested that I cover included:

1. How well can we manage squirrels?
2. How is it done?
3. What needs to be known in order to better manage this species?

It is obvious that were I or anyone else able to provide adequate answers to these questions, there would be little need, except for academic interest, for continuing this symposium. However, let us put some facts and ideas together and see how we come out.

The first two points are too closely tied together to separate them. Following Leopold's definition that "game management is the art of producing sustained