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THE FOOD OF MICE AND SHREWS IN A COLORADO MONTANE FOREST

By Olwen Williams*

Following an investigation in 1951 (Williams, in press) of the distribution of mice and shrews in a Colorado montane forest, an attempt was made to determine the food habits of the animals trapped during the course of the study. Since often it has been assumed that an animal's requirements with respect to food and shelter are decisive factors in its selection of habitat, it was thought originally that some correlation might be found between the food habits and the habitat preferences of these mice and shrews.

A number of investigators have concerned themselves with the food habits of small mammals (Moore 1928, Schmidt 1931, Hamilton 1941, Quimby 1951, Jameson 1952) and have given us valuable information relating to life history studies, to the broader aspects of insect control, and to game and forest management. In the present case, food requirements constituted one aspect of an analysis of population and habitat selection.

In presenting this material I want to express my appreciation to Dr. and Mrs. Gordon Alexander for the encouragement and assistance that they lent to the study. I am indebted to Mr. C. C. Sperry of the Fish and Wildlife Service for instruction in the technique used in the examination of stomach contents and for the identification of some of the more difficult items found in those stomachs. Identification of some of the insect material examined was made by Dr. Robert Gregg.

The work that provided the material for the present study was undertaken during the summer of 1951 in Moon Gulch, Gilpin County, Colorado. Moon Gulch, which extends southwest from Rollinsville, Colorado, about twenty miles west of Boulder, is a typical small forested valley on the eastern slope of the Colorado Front Range. It lies at an altitude of 8500 to 9500 feet, although Jumbo Mountain at its western end rises to almost 10,000 feet. During the course of the investigation in Moon Gulch, standardized traplines were set in nine census plots representing seven different plant communities found in the valley and along a transect cutting through four of these communities. These traplines were operated for a total of 3654 trap-nights, during which 187 animals representing eight species of mice and shrews were caught. (One trap set for one night constitutes a trap-night.)

Other students of food habits (Hamilton, Jameson, *op cit.*) have emphasized the

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importance of examining fresh rather than preserved material, but time did not permit this procedure in the present study. Instead, the stomachs of the animals were removed and preserved in formalin shortly after the mice were taken from the traps. Later these stomachs were handled in a routine manner and the contents identified as specifically as possible.

During the course of the field work in 1951, a record was kept of the vegetation in each census plot, and a collection was made of the characteristic forbs, grasses, and shrubs. This material was utilized later in the identification of plant material found in the stomachs.

The stomach-analysis routine was suggested by Mr. C. C. Sperry. Each stomach was cut in half lengthwise and the general appearance of its contents noted. The material was then removed and placed in a flat plastic container measuring approximately 1″ x 4″ x 4½″ and flooded with as much moderately hot water as the container would hold. A piece of fine bolting silk tied securely over the mouth of a small funnel was then used to screen out the washed particles. Thorough washing was important since fat and gastric juice, unless removed, cement food particles together and make their identification impossible. All of the material caught on the screen was removed to a square of white blotting paper (marked with the original trapping data) and dried; then it was placed in an envelope and filed for further study.

The foods eaten by the small mammals were all finely triturated, those of the voles far more so than those of white-footed mice and shrews. Most of the material could not be recognized by features ordinarily used by taxonomists, and other clues to its identification had to be learned. It was found that fragments of grass stems and leaves could be recognized under low magnification of a binocular microscope. The appearance of chewed up broad-leaved plants was more confusing, but under higher magnification characteristic structures, such as stomata, could be recognized. Seeds were identified by the striations and sculpturings of their coats or by distinctive shape. Insect fragments were numerous, but rarely did they consist of more than parts of legs, bits of elytra and sclerites, and sections of antennae. After some experience these fragments could be used to identify most insects to Order.

The Orthoptera eaten by the mice appeared to be wingless grasshoppers. Leg parts were completely absent from these remains. The fragments could be recognized by the quality and color of the chitinous pieces, usually tan, thin, more or less smooth, and free from hairs and spines. The antennal pieces of the Orthoptera were somewhat like those of the millipedes but the segments were conspicuously longer. It had been noted before that white-footed mice (*Peromyscus maniculatus*) caught in live traps ate grasshoppers and crickets, but discarded hard inedible

parts such as legs and wing covers, piling these in the back corners of the traps.

The heavy dark brown or black chitin of Coleoptera was fairly easy to identify. Sometimes these pieces included mouth parts, legs, and bits of elytra. Occasionally heads of Carabidae could be recognized and the lamellate antennae of the Scarabeidae could be picked out. The sub-order Rhynchophora was easily distinguishable by the presence of leg fragments with a characteristically inflated femur with a spur.

Similar clues were used in the identification of other groups. Caterpillar parts comprised most of the remains of Lepidoptera. Caterpillar skin showing spiracles was not hard to recognize, while adult moths were unmistakable. Their presence was indicated by countless scales and by the clear chitinous tubes that form part of the genitalia of these insects. The Hymenoptera could be recognized by the quality of the chitin which had a conspicuous shiny, shellacked appearance, and by pieces of heads and legs. Ants constituted most of the hymenopteran material and in a few instances these fragments were identified to genus and species by Dr. Robert Gregg. Arachnid remains were readily discerned by the quality of the chitin and from leg fragments. Occasionally pieces of heads were found, showing the characteristic arrangement of arachnid eyes, but for the most part legs and pieces of thin hairy chitin alone indicated that spiders had been eaten. Both centipedes and millipedes were recognized. The presence of distinctive antennae served as an indication of this. Mouse hair was readily detected and often occurred as a definite fur ball in the stomach. Presumably the hair was ingested when an animal preened itself. There was no indication of cannibalism.

Certain microchemical tests proved useful in the recognition of otherwise unidentifiable materials. A phloroglucin-hydrochloric acid test for lignin was helpful in identifying as plant material masses that at first looked like the soft parts of insects. An iodine-potassium iodide solution was useful for testing for starchy material that on further examination appeared to be derived from seeds the integuments of which had been discarded. Sudan III solution was of some value in identifying fatty material in plant tissues.

Each stomach was examined twice: once to determine the kind of material present, a second time to obtain a volumetric estimate of the food items eaten. It is understood that the figures serve only as an indication of the kind and amount of food consumed since there was no way to determine to what degree the digestion of the food obscured the results.

Results

Two species of shrews (*Sorex cinereus cinereus* and *Sorex obscurus obscurus*) were trapped in Moon Gulch, but the analyses of stomach contents were not at all sat-

isfactory. Museum Special Traps had been used in the census. These rather large traps caught a number of the shrews by the tail, failing to kill them. In these instances almost all of the food in the stomachs had been digested to the point where little remained to be analyzed. Two specimens, caught in the stream bottom, alone provided an adequate amount of material for analysis. In these two cases invertebrate remains composed 90% of the stomach contents, including Coleoptera, Lepidoptera, Hymenoptera, Diptera, Myriapoda, and Arachnida. Lepidopteran pupal cases and larvae made up more than one third of this percentage.

The analyses of the stomach contents of 125 white-footed mice (*Peromyscus maniculatus rufinus*) trapped during the summer were much more satisfactory. A great variety of foods appeared to be eaten by these mice. Seeds, stem and leaf fragments, and arthropods were all found to comprise part of the food of these animals at one time or another. In a few cases the odor of the flesh made it apparent that the mice were eating wild onion, although no fragments of this plant were actually found in their stomachs. No correlation could be made between their preferred habitat and the food which they ate, but a definite seasonal trend was observable. In the first community, a stand of lodgepole pine trapped early in July, arthropod remains and seeds constituted 80% and 15%, respectively, of the stomach contents. As the season progressed and other plant communities in the valley were trapped, seeds made up an increasingly important part of their diet, while the amount of invertebrate material dropped. Late in July, in a mixed lodgepole pine community, seeds made up 50% of the stomach contents of this mouse while the invertebrate material had fallen to 35%. By the end of August seeds constituted 64% of the diet. Early in September, at the close of the trapping season, arthropod remains and seeds made up 4% and 82%, respectively, of the stomach contents. In the communities where the highest levels of population were maintained by the species, seeds made up roughly half the diet. The results suggest that the white-footed mouse is an opportunist utilizing any foods that are available.

The microtines (*Phenacomys intermedius intermedius*, *Clethrionomys gapperi galei*, *Microtus mordax*, and *Microtus montanus fusus*) all appeared to confine themselves largely to seeds and to the vegetative parts of plants for food. A total of 32 stomachs were examined in this group, but the very finely comminuted condition of the contents made the identification of most of the material very difficult. With one exception it was impossible to determine how specific the dietary requirements of these animals were. In this one case it was found that nearly 90% of the stomach contents of *Phenacomys* consisted of finely chewed stem and leaf fragments. In four out of five communities in which this vole was caught, from 10% to 40% of this material was made up of the stellate hairs from the leaves and twigs of the

buffalo-berry (*Shepherdia canadensis*). In most communities the buffalo-berry was one of the most abundant shrubs, but even where it was not it appeared to constitute an important dietary item for this species None of the other microtines seemed to utilize this plant, since no trace of the distinctive trichomes was found in any of the other stomachs examined.

The jumping mouse (*Zapus princeps princeps*), strictly limited in distribution to the stream bottom community, resembled the white-footed mouse in its food habits. In the nine specimens examined, slightly more than 50% of the stomach contents consisted of plant material, stem and leaf fragments, and seeds. The remains of Orthoptera, Coleoptera (mainly rhyncophorans), Lepidoptera, and Hymenoptera made up the bulk of the rest. For this species as well as for all of the others studied, no correlation seemed to exist between food habits and the herbaceous and shrubby vegetation that characterized the plant communities constituting preferred habitat for the species

Summary

Following an investigation in 1951 of the distribution of mice and shrews in a Colorado montane forest, a study was made of the food habits of the mice and shrews trapped in the former investigation.

By means of stomach analyses some information was secured concerning the food consumed by six genera — namely, *Sorex*, *Peromyscus*, *Clethrionomys*, *Phenacomys*, *Microtus*, and *Zapus*. *Peromyscus* and *Zapus* appeared to utilize many different foods, including seeds, fruit, the vegetative parts of plants, and a variety of arthropods. *Sorex* seemed to be more carnivorous in its habits while the microtines preferred the vegetative parts of plants almost exclusively. No correlation was found to exist between population levels, food habits, and the herbaceous and shrubby vegetation found in the plant communities studied. A definite seasonal trend was seen in the diet of *Peromyscus*. For most of the genera studied the data were insufficient for general conclusions and further investigation is needed.

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