

FOOD HABITS OF THE RED FOX (*VULPES FULVA*) IN UNION COUNTY, ILLINOIS

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ABSTRACT.—A study was conducted to determine the food habits of the red fox in Union County, Illinois. A total of 183 fox stomachs examined showed a variety of food items utilized. Mammalian foods constituted the principal material in the diet of this predator.

Food habits of the red fox (*Vulpes fulva*) have been investigated in detail in New York (Cook and Hamilton, 1944), Pennsylvania (English and Bennett, 1942), Michigan (Murie, 1936), Iowa (Scott and Klimstra, 1955; Scott, 1943 and 1947), and Missouri (Korschgen, 1957). Less comprehensive studies have been conducted in Wisconsin (Richards and Hine, 1953), Minnesota (Hatfield, 1939), Ohio (Gier and Gale, 1946), and Kentucky (Barbour and Gale, 1955). Although the red fox is a common and both economically and aesthetically important species in Illinois, its dietary patterns here have not been adequately investigated. This was the object of the present study.

MATERIALS AND METHODS

Stomachs used were collected by the Cooperative Wildlife Research Laboratory of Southern Illinois University in Union County, Illinois, over a period of 11 years, from March, 1956, to March, 1967. Union County, located in extreme southwestern Illinois, lies within the

Southern physiographic region as described by King and Winters (1952). The most distinctive feature of this region is the range of hills in the Ozark ridge which is an extension of the Ozark highlands of Missouri and Arkansas. The hills extend across southern Illinois from east to west and encompass most of Union County. This physiographic region is the most extensively forested area in the state with 26 per cent of the area in forest — primarily of mixed oaks and hickories. Union County has 38 per cent of its area in forest cover (King and Winter, 1952). Agricultural practices in this region are classified as general farming and fruit growing; of the farmable land in Union County, 36 per cent is in pasture (includes woodland pastures), 19 per cent in corn, 13 per cent in idle land, 12 per cent in hay, with the remaining farming land devoted to soybean, grains, and other crops (Ross and Case, 1956). Union County is also a major center of fruit production in southern Illinois.

A total of 183 red fox stomachs were examined of which 13 were empty or otherwise unproductive of data. Stomach contents were initially preserved in a 10 per cent formalin solution. The analysis of materials followed standard food habit procedures. Contents of stom-

achs were placed in a fine sieve and rinsed with water. After washed materials were placed on absorbent paper towels to remove excess water, samples were weighed to the nearest 0.1 g; volume, to the nearest 0.1 ml, was then determined by water displacement in a graduated cylinder. Weights and volumes of each food item were recorded on special food habit data cards; items of less than 0.1 g, 0.1 ml, or 0.1 per cent by volume were designated as trace items (T). Percentage calculations were made for occurrence, weight, and volume of foods; per cent weight showed no significant differences from per cent volume and was excluded from final analyses.

RESULTS AND DISCUSSION

Examination of stomach contents suggested that a variety of food items is utilized by the red fox; 59 animal, 30 plant, and 4 miscellaneous dietary items were identified (Table 1). Animal materials represented the highest percentage of food utilized, constituting 98.8 per cent by frequency of occurrence and 81.2 per cent by volume. Plant foods were found in similar frequency but yielded only 18.6 per cent of the total volume. Only 11 animal foods and 5 plant foods represented volumetrically 1.0 per cent or more of the diet. Occurrences of such items as lead shot, stones, and aluminum foil were considered accidental.

Animal Foods

Mammalian foods constituted the principal materials in the diet of the red fox, appearing in 95.0 per cent of the stomachs examined and con-

tributing 67.1 per cent of the total volume. The cottontail rabbit was the single most important prey item (Table 1). It was also shown to be the principal food of the red fox in Iowa (Scott, 1943 and 1947), Michigan (Murie, 1936), and Missouri (Korschgen, 1957).

The prairie vole represented the second ranking mammalian food; it was recorded in 20.6 per cent of the stomachs and yielded a volume of 15.2 per cent. Deer mice, although an important mammalian food, were found less frequently and contributed less bulk to the diet of the red fox than the prairie vole (Table 1). Hoffmeister and Mohr (1957), however, reported both the prairie vole and deer mice, especially *Peromyscus leucopus*, abundant in Illinois. Higher proportions of voles to deer mice in the diet of red foxes have been documented. Scott (1943) demonstrated that even when deer mice were more abundant than prairie voles, foxes consumed more of the latter. Scott believed that preference for voles over deer mice plus differences in the daily rhythmic nature of these species might be important in accounting for differential consumption of these foods. Evidence from Scott and Klimstra (1955) showed that red fox pups preferred prairie voles to deer mice. Murie (1936) suspected that ease of capture and a more vulnerable habitat were important in the higher use of voles.

Raccoons were found to be a significant dietary item of the red fox in this study (Table 1). Scott (1943 and 1950), Scott and Klimstra (1955), and Korschgen (1957) reported finding raccoon remains in

TABLE 1.—Stomach contents of 170 red foxes collected in Union County, Illinois, 1956-1967.

Food Item	Percent Volume	Percent Frequency of Occurrence	Food Item	Percent Volume	Percent Frequency of Occurrence
Animal.....	81.2	98.8	Undetermined Canidae.....	T	0.6
Mammals.....	67.1	95.0	Birds.....	10.3	25.3
Cottontail (<i>Sylvilagus floridanus</i>).....	25.2	31.8	Domestic Chicken (<i>Gallus gallus</i>).....	8.9	2.4
Prairie Vole (<i>Microtus ochrogaster</i>).....	15.2	20.6	Meadowlark (<i>Sturnella magna</i>).....	0.8	1.2
Deer Mice (<i>Peromyscus</i> spp.).....	6.4	15.3	Undetermined Bird.....	0.3	14.7
Raccoon (<i>Procyon lotor</i>).....	5.5	10.0	Towhee (<i>Pipilo erythrophthalmus</i>).....	0.1	1.8
Domestic Pig (<i>Sus scrofa</i>).....	2.6	2.4	Slate-colored Junco (<i>Junco hyemalis</i>).....	0.1	1.2
House Mouse (<i>Mus musculus</i>).....	2.5	4.7	Cardinal (<i>Richmondia cardinalis</i>).....	T	3.5
Fox Squirrel (<i>Sciurus niger</i>).....	2.3	2.4	Undetermined Goose (Anserinae).....	T	0.6
Opossum (<i>Didelphis marsupialis</i>).....	1.7	4.1	Grackle (<i>Quiscalus quiscula</i>).....	T	0.6
Red Fox (<i>Vulpes fulva</i>).....	1.0	28.2	Guinea Hen (<i>Numida meleagris</i>).....	T	0.6
Eastern Mole (<i>Scalopus aquaticus</i>).....	0.9	0.6	Flicker (<i>Colaptes auratus</i>).....	T	0.6
Pine Vole (<i>Polymys pinetorum</i>).....	0.8	2.9	Reptiles.....	0.3	2.4
Undetermined Mammal.....	0.7	8.2	Undetermined Snake.....	0.2	0.6
Short-tailed Shrew (<i>Blarina brevicauda</i>).....	0.7	4.7	Prairie Kingsnake (<i>Lampropeltis calligaster</i>).....	0.1	0.6
Woodchuck (<i>Marmota monax</i>).....	0.6	2.9	Fence Lizard (<i>Sceloporus undulatus</i>).....	T	0.6
Least Shrew (<i>Cryptotis parva</i>).....	0.2	2.4	Skink (<i>Eumeces</i> sp.).....	T	0.6
Eastern Chipmunk (<i>Tamias striatus</i>).....	0.2	1.2	Invertebrates.....	2.9	31.8
Bog Lemming (<i>Synaptomys cooperi</i>).....	0.2	0.6	Short-horned Grasshoppers (Acrididae).....	1.0	11.8
Striped Skunk (<i>Mephitis mephitis</i>).....	0.1	1.8	Caterpillars (Lepidoptera).....	0.9	2.4
White-tailed Deer (<i>Odocoileus virginianus</i>).....	0.1	1.8	Long-horned Grasshoppers (Tettigoniidae).....	0.8	4.1
Domestic Dog (<i>Canis familiaris</i>).....	0.1	1.2	Scarab Beetles (Scarabaeidae).....	0.1	9.4
Undetermined Rodent.....	T	0.6			
Beaver (<i>Castor canadensis</i>).....	T	0.6			
Cow (<i>Bos taurus</i>).....	T	0.6			
Undetermined Shrew (Soricidae).....	T	0.6			

TABLE 1.—(Cont.)

Food Item	Percent Volume	Percent Frequency of Occurrence	Food Item	Percent Volume	Percent Frequency of Occurrence
Crickets (Gryllidae).....	0.1	4.1	Lespedeza (<i>Lespedeza</i> spp.).....	T	3.5
Flesh Flies (Sarcophagidae).....	T	7.6	Undetermined Rose (Rosaceae).....	T	2.9
Undetermined Grasshoppers (Orthoptera).....	T	4.7	Elm (<i>Ulmus</i> spp.).....	T	2.9
Undetermined Beetles (Coleoptera).....	T	2.9	Tick-clover (<i>Desmodium</i> spp.).....	T	2.4
Ants (Formicidae).....	T	2.4	Moss (Polytrichaceae).....	T	1.8
Undetermined Insects.....	T	1.8	Corn (<i>Zea mays</i>).....	T	1.8
Ground Beetles (Carabidae).....	T	1.2	Brambles (<i>Rubus</i> spp.).....	T	1.2
Ticks (Ixodidae).....	T	1.2	Honey Locust (<i>Gladiolus triacanthos</i>).....	T	1.2
Nocturid Moths (Nocturidae).....	T	0.6	Ragweed (<i>Ambrosia</i> spp.).....	T	1.2
Undetermined Diptera.....	T	0.6	Broomweed (<i>Gutierrezia</i> sp.).....	T	0.6
Spiders (Arachnida).....	T	0.6	Cherries (<i>Prunus serotina</i>).....	T	0.6
Centipedes (Chilopoda).....	T	0.6	Moss (Dicranaceae).....	T	0.6
Leaf-footed Bugs (Coreidae).....	T	0.6	Spanish Needle (<i>Bidens bipinnata</i>).....	T	0.6
Leafhoppers (Cicadellidae).....	T	0.6	Field Bindweed (<i>Convolvulus arvensis</i>).....	T	0.6
Marsh Flies (Sciomyzidae).....	T	0.6	Mullein (<i>Verbascum thapsus</i>).....	T	0.6
Carriion Beetles (Silphidae).....	T	0.6	Smartweed (<i>Polygonum</i> sp.).....	T	0.6
Undetermined Animal Materials.....	0.6	4.7	Partridge-pea (<i>Cassia fasciculata</i>).....	T	0.6
Plants.....	18.6	97.1	Moss (Hypnaceae).....	T	0.6
Persimmon (<i>Diospyros virginiana</i>).....	10.2	15.9	Carrot (<i>Daucus carota</i>).....	T	0.6
Apple (<i>Malus</i> sp.).....	3.1	5.9	Smooth Sumac (<i>Rhus glabra</i>).....	T	0.6
Leaf-Stem-Bark Fragments.....	2.3	80.0	Grape (<i>Vitis</i> sp.).....	T	0.6
Grass (Gramineae).....	1.6	86.5	White Avens (<i>Geum canadense</i>).....	T	0.6
Plum (<i>Prunus</i> sp.).....	1.0	0.6	Miscellaneous Materials.....	0.2	15.9
Pokeweed (<i>Phytolacca americana</i>).....	0.2	4.1	Undetermined Material.....	0.2	8.2
Undetermined Plant.....	T	5.3	Stones.....	T	5.9
Clover (<i>Trifolium</i> spp.).....	T	3.5	Lead Shot.....	T	1.8
			Aluminum Foil.....	T	1.2

their investigations of red fox food habits but showed this food, for the most part, as an incidental item. Foxes ordinarily do not kill prey larger than woodchucks or chickens, but juvenile raccoons may be vulnerable (Errington, 1935). It was difficult to determine from stomach analysis whether raccoons were killed by foxes or were available as carrion. In 2 of 17 occurrences of raccoons, certain associated materials (flesh fly larvae or lead shot) suggested carrion.

The domestic pig, which appeared in 2.4 per cent of the foxes examined and contributed 2.6 per cent of the total volume, was suspected as being taken as carrion; flesh fly larvae were found in association with one occurrence. Korschgen (1957) reported pigs yielding a volume of 3.9 per cent and occurring in 5.2 per cent of his examinations. The disposal of dead pigs in fields is a common practice of farmers, and such procedures provide an easy source of food.

Mammalian foods of lesser importance which contributed 1.0 per cent or more of the total volume included the house mouse, fox squirrel, opossum, and red fox (Table 1). Remains of fox squirrels were detected in four foxes; two of these occurrences coincided with the squirrel hunting season in southern Illinois and might partially account for their presence in the diet of the red fox. The high occurrence (28.2 per cent) and low volumetric percentage (1.0) of red fox materials in the foxes examined may be largely attributed to accidental ingestion rather than to cannibalism. Mammals yielding minor quantities (Table 1) of food

(less than 1.0 per cent by volume), although insignificant quantitatively, are important in that they demonstrate acceptance of a variety of foods by the red fox. Fourteen occurrences of undetermined mammalian remains were recorded; these contributed 0.7 per cent of the total volume.

Avian remains comprised 10.3 per cent by volume and 25.3 per cent by frequency of occurrence. Identification of birds was difficult because frequently little remained except a few feathers; hence, most identifications were "probable". In 25 instances birds could only be designated as undetermined avian material.

Volumetrically the domestic chicken was the most prominent bird in this study (Table 1). Scott and Klimstra (1955) reported that in Iowa this item proved to be one of the most frequent specific foods in the diet of the red fox. Two other large birds, a goose and a guinea hen, were also identified. Small birds such as the cardinal, meadowlark, towhee, etc. were recorded but added little quantitatively to the diet of the red fox (Table 1).

Although southern Illinois is rich in reptilian fauna, this was not reflected in the food habits of the red fox. Reptilian remains were detected in only four stomachs (Table 1); these included a fence lizard, skink, prairie kingsnake, and an unidentified snake. Scott (1943) recorded 5 reptiles in 923 red fox scats from trails. Korschgen (1957) found that cold-blooded vertebrates (fish and reptiles) occurred in 8 of 1006 red foxes; Scott and Klimstra (1955) reported 11 cold-blooded ver-

tebrates in 758 red fox seats from trails.

Invertebrates are common foods for the red fox but do not constitute a major food on a volumetric basis (Table 1). The principal invertebrates were insects; of these, only a few were prominent. Orthopterans (grasshoppers and crickets) were probably taken in greater relative amounts than any other insect (Table 1). Three families of beetles were identified. The prominent coleopteran family, the Scarabaeidae, had a frequency of occurrence of 9.4 per cent; most scarabs were *Phyllophaga*. Caterpillars comprised 0.9 per cent by volume and 2.4 per cent by frequency of occurrence; one stomach examined was gorged with this food.

Other invertebrates (Table 1) probably represented items picked up indirectly by the red fox. One of these items may have importance as an indicator of the nature of fox foods. Larvae of Sarcophagids, which may breed and give birth to young larvae in carrion (Borror and DeLong, 1964), were detected in 12 stomachs; in 8 there were indications that these larvae were associated with carrion.

Certain materials, such as bits of meat, bone fragments, and other associated items, could not be positively identified. Such items, designated as undetermined animal material, occurred in 4.7 per cent of the animals examined and composed 0.6 per cent of the volume.

Plant Foods

Plant materials were recorded in nearly all foxes examined but amounted to only 18.6 per cent of

the total volume (Table 1). Grass or leaf, stem, and bark fragments, although frequently detected, usually were found in small quantities. Probably some of these items were accidentally acquired while the fox was engaged in normal food gathering activities or while the animal was in distress (trapped or wounded); Hamilton (1935) reported various grasses in the stomachs of foxes that had been shot. In a few instances the amount of grass suggested that a specific intent was shown by the fox to procure this material; Hamilton (1935) found that winter wheat was often consumed by foxes.

More than one-half of the total volume of plant food was persimmon which was recorded in 15.9 per cent of the stomachs and contributed 10.2 per cent of the volume. Gier and Gale (1946) found persimmon in similar proportions in Ohio red foxes. Apples, reported utilized by the red fox (Hamilton, 1935), were found to be a notable item in this study (Table 1). Apple orchards are abundant in southern Illinois and constitute a major agricultural land use. Other fruits, detected in lesser amounts, included cherry, plum, pokeweed, corn, bramble, and grape. Remaining plant items represented accidental ingestions.

SUMMARY

Stomachs from 183 red foxes taken in Union County, Illinois, 1956-1967, were examined; 13 were unproductive of data. Animal foods were found in 98.8 per cent of the stomachs and constituted 81.2 per cent of the dietary volume. Plant materials, although frequently recorded, yielded only 18.6 per cent

of the total volume. Fifty-nine animal, 30 plant, and 4 miscellaneous items were identified; by volume only 11 animal and 5 plant foods represented 1 per cent or more of the diet. The most important foods by per cent volume were cottontail (25.2), prairie vole (15.2), persimmon (10.2), deer mice (6.4), and raccoon (5.5). The leading items by per cent frequency of occurrence were grass (86.5), leaf, stem, and bark fragments (80.0), cottontail (31.8), red fox (28.2), and prairie vole (20.6).

ACKNOWLEDGMENT

Appreciation is expressed to Dr. Willard D. Klimstra, Professor of Zoology and Director of the Cooperative Wildlife Research Laboratory, Southern Illinois University, for availability of the materials used and assistance in this study. This report represents a contribution of Project 46, Cooperative Wildlife Research Laboratory.

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Manuscript received May 11, 1970