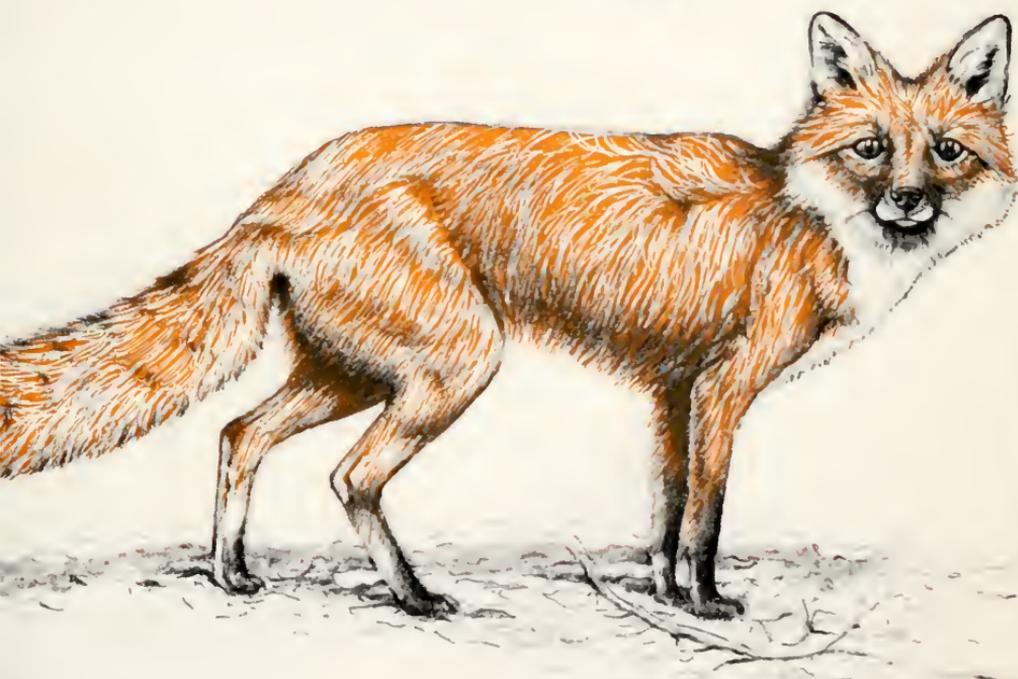


Habits of the Red Fox in Northeastern Kansas

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**STATE
BIOLOGICAL SURVEY
OF KANSAS**

by William C. Stanley

Habits of the Red Fox In Northeastern Kansas

BY

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MUSEUM OF NATURAL HISTORY

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INTRODUCTION

The red fox, *Vulpes vulpes*, in eastern Kansas frequents agricultural areas along wooded streams and rivers and seems to prefer areas where patches of timber alternate with pastures and cultivated fields. The species occurs also in places in western Kansas but is not abundant there.

The red fox is a native of the northern and western parts of the continent and also of northern Eurasia but is thought not to have occurred in the unbroken timbered areas of the eastern United States south of approximately the 40th parallel before the white man settled there. According to Seton (1929:472) and others the red fox was introduced in that timbered area from Europe by sportsmen sometime between 1650 and 1750. At about the same time, clearing of vast areas of timber increased the number of annual plants that served as an important source of food and cover for rodents and rabbits, and thus made the region more suitable as fox habitat. It is not known certainly whether the foxes there are all descendants of their introduced European ancestors, whether mating between introduced foxes and native foxes occurred, or whether introduced stocks died out and, due to changes brought about by man, native stocks dispersed into the region. Comparison of adequate numbers of adult specimens from Europe with American specimens may clarify the taxonomic status of the red fox of the southeastern United States. Regardless of its origin, the red fox now occurs throughout most of the eastern United States.

The history of this species in Kansas is not well documented, but I suspect that our red fox is a native and not an introduced stock. Parmalee and Jacobson (1959:403) reported finding remains of red fox in a cave in Ralls County, Missouri, in deposits thought to be several hundred years old. Knox (1875:19) reported the red fox as "common in all parts of the State." Baker (1887), however, recorded none from western Kansas between latitudes 38.30° and 39.30°. Lantz (1904:383) wrote that "The Red fox (*Vulpes fulvus* Desmarest) was indigenous in eastern Kansas. After the settlement of the country they soon became very rare or entirely disappeared. Sportsmen who were fond of fox-chasing restocked the country with animals brought from the East. These introduced animals have thrived well, and have increased in numbers until the species threatens to become a pest in some of the eastern counties." Recent

records (Anderson and Nelson, 1958:307) indicate that the species occurs in some of the western counties of Kansas (Finney, Meade, and Ellis, for example) and possibly indicate a westward dispersal of this species in the past decade.

METHODS

With the aim of learning about food habits, denning habits, reproduction, and parasites of the red fox in eastern Kansas, observations were made on the free-living population of the species in Douglas County and areas immediately adjacent from November, 1960, through April, 1962, excepting two months in the summer of 1961. Douglas County is part of an area of approximately 5,400 square miles in northeastern Kansas that is ecologically homogenous (Jones, F. H., MS., 1950). This area corresponds closely to that described by Schoewe (1949) as the Dissected Tilled Plain. Through the processes of weathering, much of the loess mantle that at one time covered this area has been eroded, leaving mounds and low hills. The area is dissected by many small streams.

The climate is characterized by warm summers and moderate to severe winters, with "frequent sharp changes, usually of short duration" (Flora, 1948:1). Recorded temperature extremes for Douglas County range from a high of 108° F to a low of —18° F. The mean annual precipitation is 35.4 inches. The average annual snowfall approximates 18 inches; but, in the winter of 1961-1962 a total of 33.4 inches fell.

Approximately half of the 299,520 acres in Douglas County is cultivated; of the remaining half, two-thirds is open pastureland and one-third is divisible between rivers, streams, lakes, woodlands, and towns (Jones, F. H., MS., 1950).

McGregor (1948) listed bluestems, *Andropogon*, as the dominant grasses, and oak, *Quercus*, hickory, *Carya*, elm, *Ulmus*, ash, *Fraxinus*, maple, *Acer*, walnut, *Juglans*, cottonwood, *Populus*, and willow, *Salix*, as the dominant trees. Cottonwoods and willows are the dominants along the Kansas River where foxes were found to be abundant.

Twenty foxes were obtained by me or by C. W. Ogle, a local fur dealer, in the course of my study. The foxes all came from Douglas County or counties bordering it. In trapping, number three steel traps were used so as to reduce the number of animals that were caught only by the toes. Some foxes caught by the toes "pull out" of the traps and escape. The most productive sets were made at the entrances of dens or along trails frequented by foxes. Several types of sets, usually baited, were made, including the "dirt hole" set; few animals were taken in these. Foxes seemed to be wary of any type of set that did not appear to be a part of the natural surroundings. The majority of the specimens trapped were taken in the autumn and winter, the seasons in which foxes seemingly enlarge their home ranges and are therefore more easily captured.

After a fox was obtained, it was first examined for external parasites and then skinned. The visceral organs were removed and placed in a solution of ten per cent formalin. Later, one side of the digestive tract was opened and the contents were washed, over a fine-meshed sieve, with running water. The material from the tract was examined for parasites; those found were preserved for future identification. The remaining food materials were dried

and stored. At this time other visceral organs such as the heart, lungs, liver, and kidneys also were opened and examined for macroparasites. With the aid of a dissecting scope and reference collections, the various kinds of foods later were separated and identified. Fecal droppings that were collected in the course of my study also were examined and the contents identified.

In the winter of 1961-1962 in order to determine the habits and home ranges of foxes, their tracks were followed in the snow. As a result much was learned about the activities of each of several animals over an extended period of time.

A total of 34 dens was studied; data were recorded as to their location with respect to the physical environment. Several dens were excavated in order to determine the types of burrow systems used by foxes. Photographs are by the author.

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I am especially grateful to Prof. E. Raymond Hall and Dr. J. Knox Jones, Jr., who advised me in the course of this study and who critically read the manuscript. I express my appreciation to the following: Dr. Richard F. Johnston and Dr. Robert M. Mengel for identifying avian remains, Mr. Paul Thomas for identifying external parasites, Prof. H. T. Gier of Kansas State University for identifying internal parasites, Mr. C. W. Ogle, fur buyer, for allowing me to examine animals that he purchased, Mr. Tom Swearingen for art work, Messrs. Robert L. Merz and Tim Lawlor for assistance in the field, and Hugh B. House and John Wellman for data on rodent populations in critical areas. I am indebted also to my wife, Nona R. Stanley, who typed the manuscript and helped in many other ways, and the State Biological Survey of Kansas for financial assistance during the last four months of my work.

DESCRIPTION OF THE RED FOX

The red fox is doglike in appearance, having long, pointed ears, an elongate pointed muzzle, moderately long legs, and a long, heavily furred, bushy tail. The upper parts of the body are reddish yellow, darkest middorsally. The tail also is reddish yellow, usually mixed in varying degrees with black, and is tipped with white. The nose pad, backs of the ears, legs, and feet are black, whereas the cheeks, chin, throat, and belly are pale. The paler underparts vary from almost creamy white to dark gray.

Although several color phases (black, silver, cross, and red) may occur in the same litter in the boreal regions of North America, insofar as I am aware only the red phase has been taken in Kansas.

Twelve adult males from Douglas and bordering counties, examined in my study, yielded measurements of approximately three and a half feet for total length, 15 inches for length of tail, six and a half inches for length of hind foot, and four inches for length of ear from notch to tip. Actual measurements in millimeters were as follows: total length, 949-1136; tail, 350-406; hind foot, 153-171; and ear, 88-110. Corresponding measurements of seven females from the same area were: total length, 894-984; tail, 310-355; hind foot, 138-165; and ear, 82-97. Males varied in weight from 8 to 12½ pounds; females averaged slightly smaller, varying from 6 to 9½ pounds. Specimens of Kansan foxes that were studied resemble specimens of the sub-

species *Vulpes vulpes fulva* (Desmarest) of the eastern United States in external and cranial measurements and in color to a greater degree than they resemble specimens of the subspecies *V. v. regalis* (Merriam) of Nebraska and the Dakotas to the north. The subspecific name *fulva* is tentatively applied, therefore, to the animals in eastern Kansas.

Variation

All available specimens in the University of Kansas Museum of Natural History were examined in order to ascertain which variations were ascribable to age, which to sex, and which to individualism.

Age Variation

At birth the coat is dark grayish over most of the body, but is reddish brown immediately anterior to the ears and across the top of the head. The underparts are dark gray and the tail is tipped with white. Fine guard hairs tipped with red are scattered over the back. At about six weeks of age the pup acquires a reddish brown coat on the sides and back. The underparts, although still gray, are paler than at birth. By the time an animal is six months old its pelage resembles that of a mature individual but is more glossy. Adult pelage is acquired at approximately one year of age. After reaching about five years of age, the pelage on the rump and middorsal area is definitely paler than in younger animals.

In the skull of a first-year fox the basioccipital-basisphenoid suture is open. It closes in the second year of life. In the third year the basisphenoid-presphenoid suture closes and the temporal region becomes roughened. In the fourth year the postorbital processes become spatulately rounded instead of triangularly pointed. In the sixth year the premaxillary-maxillary suture is partly obliterated and by the eighth year is completely so.

By using Churcher's (1960) key for aging fox skulls, progressive degree of wear can be noted on the incisors and molars with increasing age. Also, with increasing age, the temporal ridges become more pronounced and closer together.

Secondary Sexual Variation

In total length, weight, and measurements of the skull, males average slightly larger (7.2 per cent in total length, for example) than females of the same age (see Table I).

Individual Variation

Although most variations in color can be attributed to differences in age, there is some individual variation. For example, color of the tail varies depending on the number of black hairs that it contains. The white tip of the tail also varies in length from approximately three inches to almost nothing. The pale stripe along the belly varies in width from one-fourth inch to four and one-half inches, and the black stockings reach to varying heights on the legs and hips. Individual variation in external and cranial dimensions also was noted as indicated in Table I.

TABLE 1.—VARIATION OWING TO AGE AND SEX OF RED FOXES FROM NORTH-EASTERN KANSAS. (Figures within parentheses are averages.) Age-groups are those described by Churcher (1960:353): 1 = less than 12 months old; 2 = two years old; 8 = eight years old.

Sex	Age group	Number of specimens	Total length	Basal length of skull	Zygomatic breadth of skull	Weight in pounds
♂	1	1	910	123.4	67.1	
♂	2	8	945-1136 (1019)	126.0-136.7 (130.4)	67.9-75.4 (71.8)	9.0-12.0 (10.25)
♀	2	6	900-1070 (963)	120.0-134.0 (125.9)	65.8-77.0 (69.4)	6.0-8.5 (7.5)
♂	3	5	955-1065 (1006)	125.9-136.2 (131.2)	67.6-74.8 (72.0)	9.5-10.0 (9.75)
♀	3	4	894-935 (918)	121.5-127.0 (123.9)	68.0-70.0 (69.2)	8.25-9.13 (8.5)
♂	4-5	6	949-1036 (994)	127.3-136.5 (131.5)	71.0-78.6 (75.5)	9.0-12.5 (10.5)
♂	6-7	2	999-1025 (1012)	103.5	75.3-78.7 (77.0)	10.0-11.5 (10.75)
♀	6-7	1	925	121.4	70.3	9.0
♂	8 or more	3	1000-1004 (1002)	127.6-129.7 (128.6)	72.8-73.5 (73.1)	9.5

FOOD HABITS

The red fox feeds on many different plant and animal materials (Table 2), but the food consists chiefly of small mammals, birds, fruits, and insects. Errington (1935) and Murie (1936) found that the cottontail rabbit constituted 30 to 40 per cent of the diet, mice 40 to 50 per cent, and various birds, insects, and fruits the remaining 10 to 30 per cent. Inasmuch as foxes are in large measure opportunistic feeders, the availability of prey species seems to be the most important consideration governing food habits.

To determine the foods of red foxes, observations were made in the field, digestive tracts were examined, and 69 fecal droppings were collected and their contents analyzed. Field observations included both the reading of "sign" at kills and notations concerning food materials found at entrances to dens. The majority of the digestive tracts and droppings analyzed were collected in the autumn and winter and the results presented here are primarily for those seasons.

Contents of Droppings and Digestive Tracts

The eastern cottontail (*Sylvilagus floridanus*) was the most important species in the diet of foxes studied. It was represented in 38 of the 69 droppings examined and ten of the 18 digestive tracts. This species made up 45.8 per cent of the total volume of the contents of the digestive tracts; it was found in 71 per cent of the digestive tracts taken in autumn and in 83 per cent of those taken in winter. Predation on the cottontail increased in the winter of 1961-1962 possibly because many of the smaller prey-species foraged under the unusually heavy cover of snow, and therefore were not readily available to foxes.

The cotton rat (*Sigmodon hispidus*) was found in 14 droppings and five digestive tracts, comprising 8.6 per cent of the total volume of the latter. The prairie vole (*Microtus ochrogaster*) occurred in 13 droppings and four digestive tracts and the white-footed mouse (*Peromyscus* sp.) was noted in two droppings and five digestive tracts. Those three rodents comprised 13.7 per cent of the contents of the digestive tracts. Remains of the woodland vole (*Microtus pinetorum*) were found in a single dropping, the eastern woodrat (*Neotoma floridana*) occurred in two droppings, and the western harvest mouse (*Reithrodontomys*—probably *megalotis*), in four. The muskrat (*Ondatra zibethicus*) was found in a single September dropping in 1961.

The striped skunk (*Mephitis mephitis*) was represented in two autumn droppings, and in two droppings and a digestive tract collected in winter. The skunk probably was carrion, because lead shot was found in one of the droppings along with remains of the skunk. Fur of opossum (*Didelphis marsupialis*) was in one autumn dropping and two winter droppings. Fur and the left ramus of the lower jaw of an eastern mole (*Scalopus aquaticus*) were recovered from one dropping.

Remains of wild birds were found in 12 droppings and six digestive tracts and comprised 11 per cent of the total volume of the latter. The mallard (*Anas platyrhynchos*) was the only game species noted, remains being found in one dropping and two digestive tracts. All three occurrences were in the month of November and may have been of birds killed or wounded by hunters. Other species represented were the cardinal, starling, and long-eared owl.

Domestic fowl (chickens and turkeys) appeared in three digestive tracts, but some of these remains may have been carrion because

foxes were known to frequent areas where carcasses were discarded.

Insects were noted in only three droppings and three digestive tracts. Probably insects are an important food only in the warm

TABLE 2. ANALYSIS OF FOODS FOUND IN DROPPINGS AND DIGESTIVE TRACTS OF RED FOXES

Item	Number of occurrences in 69 droppings	Per cent of occurrence in droppings	Number of occurrences in 18 digestive tracts	Per cent of occurrence in digestive tracts	Per cent of total volume of digestive tracts
Unidentified mammal.....			1	5.6	0.4
<i>Didelphis marsupialis</i>	3	4.3			
<i>Scalopus aquaticus</i>	1	1.4			
<i>Sylvilagus floridanus</i>	38	55.1	10	55.6	45.8
<i>Reithrodontomys megalotis</i>	4	5.8			
<i>Peromyscus</i> sp.	2	2.9	5	27.8	3.0
<i>Sigmodon hispidus</i>	14	20.3	5	27.8	8.6
<i>Neotoma floridana</i>	2	2.9			
<i>Ondatra zibethicus</i>	1	1.4			
<i>Microtus ochrogaster</i>	13	18.8	4	22.2	2.1
<i>Microtus pinetorum</i>	1	1.4			
<i>Mephitis mephitis</i>	4	5.8	1	5.6	3.9
Fox fur.....			1	5.6	4.3
Mallard.....	1	1.4	2	11.1	10.0
Cardinal.....	1	1.4	1	5.6	0.4
Starling.....			1	5.6	0.2
Long-eared owl.....			1	5.6	0.2
Domestic chicken.....			1	5.6	0.4
Domestic turkey.....			2	11.1	1.1
Unidentified birds.....	11	15.9	1	5.6	0.4
Insects.....	3	4.3	3	16.7	0.4
Grasses.....			7	33.3	9.6
Corn.....			1	5.6	4.3
Inorganic debris.....			4	22.2	3.6

months. Murie (1936:40) recorded insects as common among food items taken by foxes in Michigan in May and June.

Various grasses were noted in seven digestive tracts; corn was represented in a single autumn tract. Inorganic materials such as sand and gravel occurred in four digestive tracts and probably were ingested accidentally by foxes.

Food Items Found at Dens

Food was found at the entrances of dens chiefly in spring and summer when pups were being reared. Mammals were represented primarily by the fur and bones of the cottontail, but remains of opossum were found at one den and remains of raccoon at another. Bird remains were of chicken and turkey, and consisted primarily of feathers. A single snake was found in the spring of 1961. In March of 1962 two yellow bullheads and a large carp were at the entrance of a den. These fish probably had been stranded in shallow pools as a result of flooding along the Kansas River in February of the same year.

HUNTING HABITS

Hunting habits were studied by actual observations of foxes and by tracking individuals in the snow. When hunting along the edge of a field, a fox walks slowly, holding its nose close to the ground. It moves from 30 to 50 yards in this manner before raising its head to look around. Foxes evidently hunt most of the time along the edges of fields and in timbered areas; they rarely cross open fields except on the run. Red foxes are chiefly nocturnal but hunt also in the daylight, especially in the late morning and early evening. Individuals often traveled the same routes until they became well defined trails.

While hunting in timber, foxes seem to wander at random, but rarely pass up the opportunity to investigate a dense thicket, brush-pile, or burrow. Also, clumps of grass and snow drifted around the bases of trees ordinarily are investigated. While hunting, foxes take advantage of elevated points in order to survey the surrounding area. Seldom in my experience, for example, was a log of any size passed by. Instead, a fox would leap on a log and walk from one end to the other several times. Elevated mounds of drifted sand, which are common along the Kansas River, also were used as observation points.

In the breeding season foxes commonly hunt in pairs. In some instances, one fox appeared merely to follow another, but on most occasions sign indicated that the pair hunted side by side. The distance between the two individuals ordinarily varied from two to fifteen yards. Hunting in pairs probably is of great advantage to foxes. When approaching a thicket or brush-pile, the two would often separate and circle it from opposite sides. On two occasions one fox was noted to stand on an elevated mound at one side of the

thicket while the other circled the thicket and walked through from the opposite side. Another trick used by foraging pairs, which I observed twice, was for one of them to crawl through a drainage culvert while the mate waited at the other end. The first sure sign of foxes hunting in pairs in 1962 was noted on January 19. After that date it was more common than not to find foxes in pairs.

When snow covered the ground the eastern cottontail, *Sylvilagus floridanus*, was the species of prey captured more often than any other (see also section on food habits). Most of the cottontails that were killed apparently were surprised as they hid beneath cover. On no occasion did tracks indicate that a fox caught a rabbit once the latter had left cover. Usually foxes chased rabbits only short distances—in no case more than 15 yards. On one occasion sign indicated that a fox had dug a rabbit from a burrow about 18 inches long.

Hunting Techniques of Foxes

By way of example of where and how foxes hunt, the following observations are taken from my field notebook. The observations were based upon sign left by foxes in the snow. Each observation was made within one mile of the city limits of Lawrence, Kansas.

January 15, 1961.—Approximately two inches of fresh snow were on the ground this morning. In approximately three hours in the field, I noted only two fox trails. One was followed for about three-fourths of a mile. This trail was first noted as it followed along the edge of a brushy fence row toward a timbered area. The fox upon reaching the timber began to hunt just inside its edge (see Fig. 1). Two instances were noted where the individual seemingly pounced on a mouse, but there was no definite sign of a kill having been made at either spot. The fox left the timber and moved into the edge of the field for a distance of about ten yards, where it dug up part of a rabbit from beneath the snow and lay down to chew on it. After leaving the rabbit, the fox moved around the edge of the field for a distance of about 150 yards where the individual dug up and chewed on a cardinal that had been buried in some leaves. Upon leaving the cardinal, the fox entered some felled timber. While in the timber this fox used several logs as vantage points for looking over the area. After leaving the timber the fox moved onto ice covering the Wakarusa River and proceeded upstream.

December 11, 1961.—A fresh set of tracks was found about 100 yards to the north of my house this morning. The trail wandered

through an apple orchard for about 150 yards and then crossed a railroad track. From there the fox proceeded across an open field on the run and entered a narrow band of timber along the edge of a small creek. Within 20 yards after entering the timber the individual found and killed a rabbit, which was carried to the edge of the field and eaten.

February 21, 1962.—This morning tracking was difficult because only a little snow was on the ground. A pair of foxes had played at the west end of the University's dog kennels last night. One fox crossed the road (see Fig. 2) and waited at the end of a drainage culvert while the other crawled through it. After leaving the hilltop the pair moved down the slope to a sink hole over an old sewer pipe. Here, one of the individuals evidently crawled in while the other waited outside. Upon leaving the sink, one of the foxes returned to the den; the other foraged along a brushy fence row that paralleled a small creek. This individual finally left the fence, crossed the creek, and moved into an open field where the trail was lost. Both individuals took advantage of logs as lookout points while hunting.

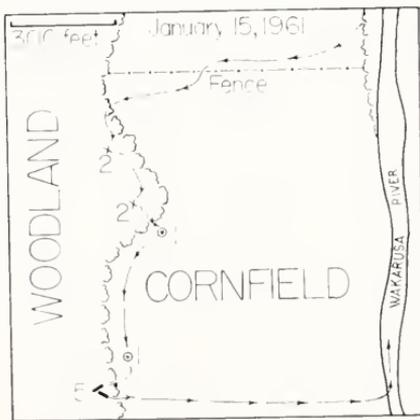


FIG. 1.

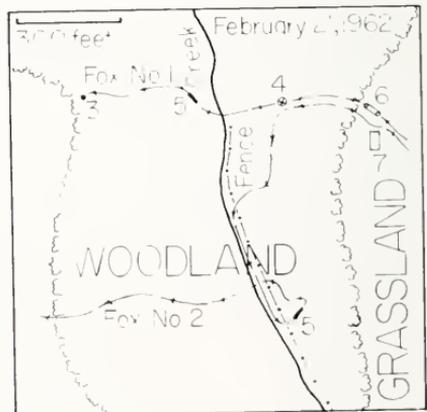


FIG. 2.

FIGURES 1 AND 2. Trails of red foxes as indicated by tracks in snow (see "Hunting Techniques" in text). 1, cache; 2, pounced on prey; 3, den; 4, sink hole; 5, log; 6, culvert; 7, kennel. Arrows indicate path taken by fox.

Food Caches

The habit of storing food is strongly developed in many animals, especially in herbivorous kinds. Carnivores, too, store food but their caches are usually of a relatively temporary nature. Of 60 food items taken by Michigan foxes, for example, Murie (1936:25)

reports that 26, 40.3 per cent, were cached. He indicated that food items for which there was no immediate need ordinarily were cached for use on occasions when hunting yielded poor returns. The use of a cache was noted on only two occasions in my study, both on the same night by the same fox, but I could not determine whether or not this individual had originally made the caches (see *Hunting Techniques* of January 15, 1961 above).

Foxes possibly used caches sparingly because the supply of food was relatively abundant in the area studied, or possibly because the large number of kinds of animals that probably raided caches (skunks, opossums, dogs, coyotes, hawks, owls, crows, and others) made it almost impossible for foxes to cache a food surplus.

DENS

The red fox uses dens only in severe winter weather and in the breeding season. In summer and early autumn, individuals prefer to rest on some vantage point such as a log or knoll. Even when pursued by hounds, an adult seeks a den only as a last resort. This does not hold true for young foxes in summer; they will enter the den at the slightest sign of danger. Most dens are modified burrows of woodchucks, but some are dug by the foxes. It is not uncommon for the same den to be used in successive years by foxes. On occasions individuals have been reported to use hollow logs or the space beneath an abandoned building as a den. One den was reported as being within an abandoned barn.

The first sign of a fox actively using a den in the autumn of 1961 was noted on October 15. That den was approximately six miles east of Lawrence, Kansas, in an alfalfa field. On October 31, 1961, a second den for this season was noted in a drainage ditch between two corn fields, approximately two miles east of Lawrence. Eight new dens were noted in November and eight more in December. In January three new dens were found, in February two, in March three, and in April one.

Den Sites

Most dens of the red fox are along wooded rivers and streams in rural areas where there is an abundance of food. But, some dens of this species were in wooded areas within the city limits of some of the larger towns and cities; in these instances the foxes feed either upon natural prey or at garbage cans and refuse dumps. Type of soil, presence of water, presence of cleared areas, and absence of man are factors importantly influencing foxes in selecting den sites (see Table 3).

Type of soil.—Of the factors mentioned, type of soil may be the most important in the selection of a den site. Sheldon (1950:34) noted that all but four of 50 dens examined in an area in New York were in sandy soils. Of the 34 dens observed in my study 21 (65.6 per cent) were in sandy soils, ten (31.3 per cent) in dark loam, and one on a rocky hillside.

Presence of cleared areas.—Possibly the second most important factor influencing the location of a den is the presence of open areas such as meadows or cultivated fields. This may be explained partly by the fact that foxes frequently inhabit abandoned woodchuck dens, which usually are situated near the borders of fields; however, dens so situated are within easy reach of places where woodlands and fields meet; these are the places where foxes seem to prefer to hunt, and provide also a good field of vision of at least a part of the immediate surroundings of the den. Of the 34 dens observed, only three were farther than 30 yards from a clearing of some sort. Twenty, 59 per cent, of the dens were within ten yards of clearings and three actually were in open fields. Two of these three dens were within five yards of protective cover, but the third was approximately 100 yards from the nearest timber. The average distance of all 34 dens from cleared areas was 12.8 yards, and the greatest distance of any one den from a clearing was 50 yards.

TABLE 3. DISTANCE FROM WATER AND DISTANCE FROM CLEARED AREAS OF 34 RED FOX DENS.

Distance from water		Distance from cleared areas	
Yards	Number of dens	Yards	Number of dens
0- 5.....	7 (20.6%)	0- 5.....	13 (38.2%)
5- 10.....	3 (8.8%)	5-10.....	8 (23.6%)
10- 25.....	7 (20.6%)	10-15.....	5 (14.8%)
25- 50.....	6 (17.7%)	15-20.....	3 (8.8%)
50-100.....	4 (11.8%)	20-25.....	0
100-150.....	3 (8.8%)	25-30.....	2 (5.9%)
150-200.....	1 (2.9%)	30-35.....	1 (2.9%)
over 200.....	3 (8.8%)	35-40.....	1 (2.9%)
		over 40.....	1 (2.9%)

Presence of water.—This seems also to be a governing factor in the selection of a den site, although not so important possibly as the two factors mentioned above. Of the dens studied, only three were farther than 200 yards from a permanent source of water.

The average distance for all dens studied was 62.6 yards. Twenty-two, 71 per cent, were within 50 yards of water. Along the Kansas River, foxes never occupied dens below the average high water mark. Even so, two dens were lost in February of 1962, when high water and ice cut away as much as ten yards of the river bank in places.

Influence of man.—Most dens found were 200 or more yards from human habitations, but a few were much nearer. One den found in January was within 50 yards of a residential area in south Lawrence, and in the breeding season of 1961 a female was known to have raised a litter of pups within 100 yards of a residence in north Lawrence.

Use of an Island for Denning

Three fox dens were found on an island in the Kansas River in the early spring of 1961. Farmers in the area informed me that there were as many as four or five dens there in previous years. In the breeding season of 1962, however, there was no sign of foxes on the island, probably because high water in the preceding January and February excluded foxes from the island. Foxes select dens in January and February.

The island, of approximately 53 acres, mostly supports dense stands of maple, elm, cottonwood, mulberry, and willow and was separated from the south bank of the river by the severe flood of 1951. In summer, when the river is low, the island is separated from the south side of the river by a channel of water two and a half feet deep. The narrowest part of this channel is approximately 20 yards across. Foxes probably reach the island by swimming across this channel.

In January of 1961 John Wellman and Hugh B. House found opossum, eastern mole, eastern cottontail, deer mouse, and hispid cotton rat living on the island. Some of these species may have been preyed on by foxes, but chicken feathers at one den indicated that the foxes foraged on the mainland as well.

Communal Denning

Seton (1929) and Murie (1936:42) described in detail the behavior of foxes in the breeding season. In each account, the assumption was made that inhabitants of a single den were members of one family. Scott (1943:441) mentioned territoriality in foxes, and noted the possibility of intraspecific intolerance during the breeding season. On the other hand, Sheldon (1950) recorded

concentrations of foxes in spring and summer in New York, and noted that the occurrence of two litters in the same den was not uncommon. In the course of my work one instance of population concentration was noted. This was in 1961 on the island mentioned above. No definite evidence of more than one family using a single den for breeding was obtained; nevertheless, on the night of March 21, 1962, two male foxes were caught at the same den. There was no evidence that both or even one of these males had a mate in the den, although it was being used extensively by foxes.

Entrances

According to Sheldon (1950) the number of entrances to fox dens varies from two to more than 20, and are between eight and 15 inches in diameter. In my study, the number of entrances varied from one (which was fairly common) to nine (one den). The diameter of the entrances varied from six to 13 inches, but each den usually had at least one entrance that was ten inches or more in diameter. Entrances were located at various places—on the level floor of the woods, under fallen logs, under tree roots, on hillsides, in drainage culverts, and in cut banks (see Plates 1-3). Entrances to dens that had been in use for several years sometimes were difficult to locate, but new dens, especially those in sandy soil, were easily located by the large mound of fresh soil that was piled in front of each. A den that had been used for sometime frequently could be found because bones were scattered in the vicinity of the opening. Usually a den that was in use was permeated by the strong, distinctive odor of foxes.

Structure and Size of Dens

Sheldon (*op. cit.*) described several dens that had entrances up to 26 feet apart. One burrow was 75 feet long. He recorded the average depth of dens studied as approximately four feet, but made reference to one that was 14 feet in depth. The depth of dens studied by me averaged between three and four feet. Sheldon also described two types of dens, temporary and breeding. Temporary dens were relatively unbranched and breeding dens had several branching tunnels. The three dens described below are typical of those found in my study in eastern Kansas.

Den (Fig. 3a) was on an island in the Kansas River. The den was beneath a pile of rotten wood, had four entrances ranging in diameter from eight to 13 inches, and consisted of 28 feet of tunnels.

PLATE 1



FIG. 1. Male red fox (in trap) at entrance of den, March 21, 1962 (one mile West of Eudora, Douglas County, Kansas).



FIG. 2. Red fox den (see arrow) in relationship to timber and open field (one and one-half miles east of Lawrence, Douglas County, Kansas).

PLATE 2

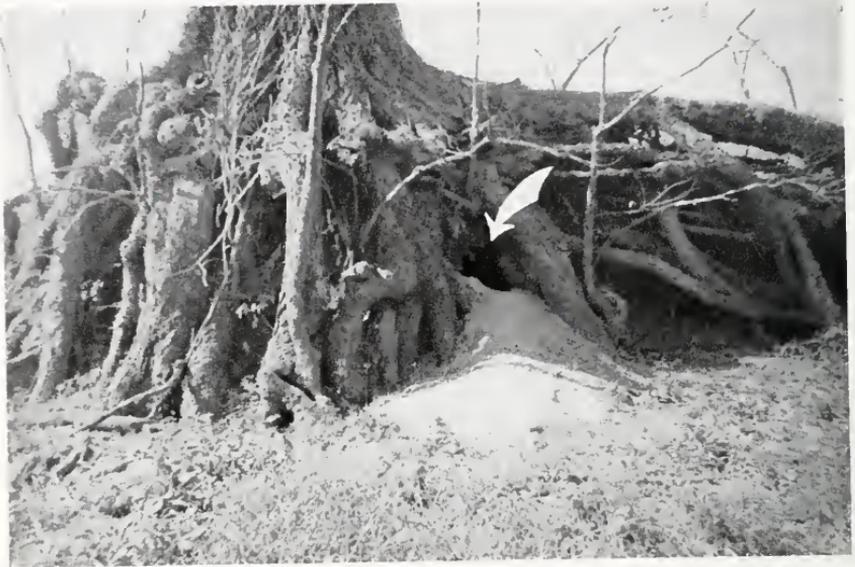


FIG. 1. Fox den, at base of elm tree, used in winter of 1961-62 (three miles east of Lawrence, Douglas County, Kansas).



FIG. 2. Entrances to fox den in cut bank at edge of timber (two and one-half miles east of Lawrence, Douglas County, Kansas).

PLATE 3



FIG. 1. Entrance to red fox den in drainage culvert, used as a reproductive den in the spring of 1961 (100 yards east of intersection of Walnut and North Ninth streets, Lawrence, Douglas County, Kansas).



FIG. 2. Den in pile of logs, used in the winter of 1961-62 as well as for breeding in the spring of 1962 (one mile east of Lawrence, Douglas County, Kansas).

The tunnels averaged about seven inches in diameter and were from two to four feet below the surface of the ground. The single large cavity in the den measured 20 inches wide and 30 inches long. The northernmost entrance was plugged with dry leaves but no nesting material was found within the burrow system, which was excavated on April 30, 1961.

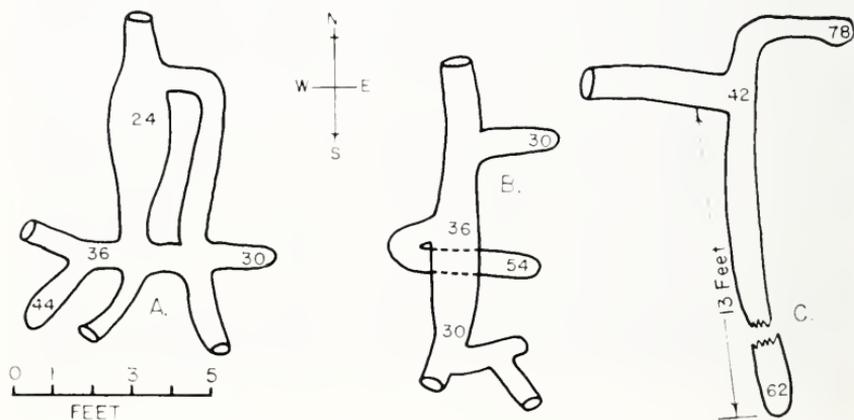


FIGURE 3. Dens of red fox. Figures in burrows indicate distance in inches from the ground surface to the bottom of the burrow. See account of "Dens" in text.

Den (Fig. 3B) was in a flat, sandy area beneath a decaying log, and had three entrances, two of which were being used regularly. The greatest distance between any two entrances was ten feet, and the diameter of the entrances varied from six to 12 inches. Two of the entrance-tunnels sloped at an angle of about 45° to a depth of approximately two and one-half feet, whereas the third sloped at an angle of about 30° to a depth of two feet. The burrows totaled approximately 20 feet in length and had an average diameter of seven inches. The den consisted of a central passage, three blind tunnels, and a single large cavity. The cavity was between the two main entrances and was approximately 18 inches wide and three feet long. The greatest depth of any part of the burrow was four feet, but its average depth below the surface was two and one-half feet. No nesting materials were found in the burrow, which was excavated on May 6, 1961.

A den, dug out on April 21, 1962, was at the top of a sandy bank and had but a single entrance, which was 11 inches wide and nine inches high (see Fig. 3C). The den consisted of one main passage and two side passages. The tunnels averaged about ten inches in

diameter, totaled 26 feet in length, and reached a depth of six and one-half feet. Here again no nesting materials were found in the burrow system.

REPRODUCTION

The red fox is monestrous, and breeding takes place from December to March according to Asdell (1946:157). Most matings (76 per cent) in New York occur between mid-January and mid-March according to Layne and McKcon (1956:53). Young are born after a gestation period of about 53 days, usually in March or April. A litter consists of from one to 11 young; Hoffman and Kirkpatrick (1954:506) recorded an average of 4.92 per litter. Of eight litters reported in Kansas, the average was 4.5 and the range was from two to nine. Asdell reported that litter size increases until a female reaches an age of five to seven years, and that litters born early in the season tend to be larger than those born later.

According to Asdell the testes become smaller and cease producing sperm at the onset of the anestrus period. Spermatogenesis begins in November and ends in April. Of three foxes taken by me on November 7, 10, and 25, 1961, sperm were absent in the first two but present in the third.

Of 52 females examined by Hoffman and Kirkpatrick (1954:506) between December 17 and February 24, 31 were pregnant and four were either in or near estrus. Of three specimens collected in my study between the first and tenth of January, none showed any sign of pregnancy.

At birth the pups are blind and weigh about three and one-half ounces. Their eyes open at an age of about one week, but the pups remain within the den for about five weeks, at which time they are approximately 500 mm. (20 inches) in total length and weigh about one and one-half pounds. As the pups grow older, they are allowed to play in front of the den with bones, feathers, bits of fur, and other objects. Some parents move their pups from den to den frequently, possibly because the activity of the pups makes the entrance to a den conspicuous. Upon reaching an age of about two months, the pups are weaned and begin to accompany the parents on hunting trips. Milk teeth are lost in the fourth month; shortly thereafter the pups begin to forage for themselves. During the remainder of the summer the young remain in the vicinity of the home den; in early autumn, when full grown, they disperse. A young animal trapped on August 2, 1961, at an approximate age

of five months, had attained a total length of 913 mm. and a weight of four pounds, twelve ounces.

W. R. Brecheisen (personal communication, May 4, 1962) related that on April 11, 1962, approximately two miles north and two miles west of Humboldt, Allen County, Kansas, he saw a female fox carry a chicken across a field and enter an abandoned barn. Examination revealed a den with nine entrances inside the barn. Bits of fish, muskrat, and chicken lay about. When the den was excavated the female ran from one of the entrances, leaped upon a six inch by eight inch beam approximately eight feet above the floor, ran along this beam to its end, and leaped to a two inch bar on which she ran for about eight feet before falling to the floor. Then she jumped out a window that was about seven and one-half feet above the ground. A litter of six pups, three males and three females, were taken from the den and kept in captivity until April 16, at which time they were returned to the barn. On April 17 and 18 the female fox was noted feeding the young; on the following day there was no sign of the foxes in the area.

Paul C. Lyons in the spring of 1962 observed a vixen feeding her young at a den beneath an abandoned barn approximately one mile east and five miles south of Lawrence, Douglas County, Kansas. According to him (personal communication, May 21, 1962) the female brought rabbits to the pups on each of the first few days that he observed the family. She opened the abdominal cavity of each rabbit. After presenting a rabbit to the young she retreated a short distance and laid down. While the pups were feeding, the vixen always lay on her stomach; that position prevented the pups from nursing. When the pups became accustomed to feeding on rabbits the female ceased to open the body cavity of the prey and allowed the pups to do so. Approximately two weeks after the first observations were made the female began to bring crippled prey to the pups and allowed them to kill it. Shortly after this time the pups were moved to some unknown den and no other observations were made.

Sex Ratio

Linhart (1959:116) recorded the sex ratio of 9,473 fox pups in New York state as being about 92.3 males to 100 females; among 17,482 adults he found a ratio of 116.6 males to 100 females. Sexes were noted in four litters studied by me and the ratio was 50:50. Of the 20 adult foxes taken in the course of my study 13 (65 per

cent) were males. Adult males tend to wander more than females do and are therefore more apt to be trapped.

Home Range

Sheldon (1950:41) reported that the female establishes the home range of a family and that the male remains with the family for only a short period. In times of plenty when food is easily obtained, the range of a fox may be no more than a mile in diameter, but if food becomes difficult to obtain, the home range may be five miles or more in diameter. In the winter of 1961-1962, foxes frequently hunted over an area approximately two miles in diameter. Sheldon reported one instance of an adult fox that, in 11 days, moved from one place to another place 23 miles distant.

PARASITES

All specimens obtained were examined for both external and internal parasites. Few references were found in the literature dealing specifically with the parasites of wild foxes, although several papers have been published on parasites of foxes on fur farms.

External Parasites

From a total of 20 animals examined, four species of fleas were found on four foxes, three males and one female, taken in late summer, autumn, and winter. The fleas were *Ctenocephalides felis* (Bouche), *Pulex simulans* (Baker), *Cediopsylla simplex* (Baker), and *Chaetopsylla lotoris* (Stewart). *Pulex simulans* was the commonest of the four, occurring on three animals. The largest number of this species taken from a single fox was seven, three males and four females. The second most abundant species was the cat flea, *Ctenocephalides felis*, which occurred on two foxes. One *Cediopsylla simplex*, the rabbit flea, was taken from a fox in November. *Chaetopsylla lotoris* also was recorded from a single fox, on which two individuals (one male and one female) were found. *Ctenocephalides felis*, *Pulex simulans*, and *Cediopsylla simplex* all have been reported previously as occurring on foxes in Kansas. *Chaetopsylla lotoris* has been recorded on the coyote, gray fox, raccoon, and badger in Kansas, but not previously on the red fox. The first three species mentioned have been recorded as infesting man. The cat flea, *Ctenocephalides felis*, has been reported as an intermediate host for the tapeworms *Dipylidium caninum* and *Hymenolepis diminuta*, both of which as adults parasitize man and dogs.

A single species of tick, *Dermacentor variabilis* (Say), was found on three foxes, all of which were captured in late spring and summer. This species, the common dog tick, reportedly causes tick paralysis and is a known vector of spotted fever and tularemia.

Internal Parasites

The best single source of information about internal parasites of foxes is the key and catalogue of Stiles and Baker (1935), in which the following parasites of the red fox in the eastern United States are reported:

Alaria arisaemoides, *Cryptocotyle lingua*, *Opisthorchis conjunctus*, *Parametorchis intermedius*, *Pseudamphistomum coeui*, Ancylostomidae, *Capillaria plica*, *Eucoleus aerophilus*, *Toxascaris limbata*, *Toxocara canis*, *T. cati*, *T. marginata*, *Trichuris vulpis*, *Uncinaria polaris*, and *U. stenocephala*.

The internal parasites taken from foxes in my study were found to be of the same species as those occurring in Kansan coyotes (Gier, 1957:48). My foxes had fewer and less severe infections than Gier's coyotes. Twelve of the 20 foxes examined had parasites. Of these 12, nine were males and three were females. The parasites represented four species of roundworms and one species of cestode.

The dog tapeworm, *Taenia pisiformis* (Bloch), was found in two digestive tracts, ten per cent of those examined; Gier found this species in 95 per cent of the coyotes that he examined. The worms probably were acquired by foxes by eating rabbits, in which the larval forms encyst.

The stomach worm, *Physaloptera rara* (Hall and Wigdor), was found in three of the 18 stomachs examined; the number of worms recovered varied from one to five. This worm was recovered from nearly half the coyotes examined by Gier and infections were as heavy as 65 worms in a single individual. Carnivorous mammals probably become infected with stomach worms by eating insects that carry the larval stages of the species. *P. rara* is a common parasite of domestic carnivores.

Intestinal worms, *Toxascaris leonina* (von Linstow), were by far the commonest of the internal parasites found, and occurred in eight of the 12 foxes infected with internal parasites. Gier found this species in 38 per cent of the coyotes he examined; the average number recovered being nine. The largest number taken from a single fox was 11. These worms are found in the small intestine and have been reported frequently from domestic carnivores.

Two individuals of the dog hookworm, *Ancylostoma caninum* (Ercolani), were found in a single fox. Infections by this hook-

worm usually are picked up through the soles of the feet or by eating infected soil. This species is known to infect man.

Heart worms, *Dirofilaria immitis* (Leidy), were found in a single fox. Heart worms are known to infect dogs and cats, possibly even occurring in man. The larval forms of these worms are transmitted by sucking insects from the blood of one animal to another.

ECONOMIC IMPORTANCE AND MANAGEMENT

Because the value of any fur is governed chiefly by fashion and because long-haired furs are not now in style, there is little or no market for red fox pelts at present. In the past, when "No. 1 extra large" fox pelts brought as much as \$40 (see Swink, 1957:7), vast numbers of foxes were sold each year by trappers and hunters. Today, however, the price paid for fox pelts in Kansas usually varies between \$.50 and \$1.50 and the species, therefore, is rarely sought for its pelt. If fashions change, the red fox again could be a valuable fur-bearer.

In certain regions fox hunting is more of a business than a sport, with large sums of money being spent for the purchase and care of hounds and other equipment. Swink (1957:7) gives the total figures for the entire nation as being in excess of \$100,000,000. In Kansas, fox hunting clubs are beginning to spring up.

The red fox has esthetic value for outdoorsmen, who enjoy tracking a fox or take pleasure in seeing a fox or litter of pups in the field.

The parasites found on and in red foxes of Kansas are those of other carnivores of the region. Red foxes have fewer than do coyotes and probably play only a minor role in transmitting diseases to other mammals.

Possibly the most important economic aspect of the fox is its food habits. As has been previously stated, the food habits of this species depend largely upon the availability of prey. Foxes feed primarily on small mammals and constitute one of the forces preventing population explosions of rodents and rabbits. Thereby foxes compensate for losses that they cause among more desirable prey species.

Much of the widely circulated information concerning destruction of domestic poultry by foxes will not stand the test of investigation. Many accounts of foxes associated with poultry or "signs" of poultry in the vicinity of dens can be traced to piles of carrion. Although individual foxes are known to prey on flocks in vulnerable situations, much of this loss could be prevented if poultrymen would follow recommended poultry husbandry practices. The restriction of

flocks to pens or houses, especially during the night and early morning, would greatly reduce predation by foxes.

As for predation on game species, foxes take mostly individuals that the environment cannot accommodate in terms of cover and food (Errington, 1935:200)—in other words the excess. The only game bird used as food in this study was the mallard, individuals of which probably had been crippled or killed by hunters.

The economic status of the red fox probably could be improved by (1) the encouragement of its use for sport hunting, (2) education of the population as to the esthetic and economic value of the species, and (3) sound management practices. In areas where local residents are unable to eliminate foxes that have become troublesome, the extension trapper employed by the state could teach farmers how best to trap marauding individuals at the place damage was caused.

SUMMARY AND CONCLUSIONS

The natural history of the red fox, *Vulpes vulpes*, was studied in eastern Kansas from November, 1960, through April, 1962. Most of the field work was done in Douglas County, Kansas, an area which includes woodlands, cultivated fields, and pastureland.

Examination of skins and skulls of foxes in the Museum of Natural History revealed that closing of cranial sutures, roughening of temporal areas, rounding of postorbital processes, and gradual paling of the middorsal region of the pelage are correlated with increasing age. Males averaged larger than females of the same age group. Individual variations of one sort or another were common, mostly relating to slight variations in color or color-pattern of the pelage.

Observations in the field indicated that the red fox uses a den only in severe winter weather and in the reproductive season. It was noted that the selection of denning sites was influenced by type of soil, presence of cleared areas, and availability of water. A secluded island in the Kansas River was a favored breeding area in the years when it was easily accessible; four or five dens were used at the same time within its 53 acres. In North Lawrence one den was only 100 yards from an occupied house at the edge of the residential district. In the course of my study no definite evidence was found to indicate the use of a single den by more than one family of foxes at the same time.

Examination of the reproductive tracts of males disclosed that they were capable of breeding as early as late November. Most

matings probably occur in January and February, and litters are born in March and April, after a gestation period of 53 days. The average size of eight litters reported from Kansas was 4.5 pups. Young foxes grew rapidly during their first few months and attained nearly adult size by the time they were five to six months old.

The parasites associated with fox are of the same species reported from Kansan coyotes, but the incidence of infection was lower in foxes than in coyotes. Four species of fleas, one species of tick, four species of roundworms, and one species of cestode were found in red foxes. All of these species have been reported from man and/or his domesticated animals.

Tracking provided information as to the hunting habits of this species. The red fox forages individually in late summer and autumn, but hunts in pairs and family groups in winter and spring. While foraging in pairs, foxes used various maneuvers for capturing prey that could not have been employed by individuals. When snow covered the ground, foxes foraged over an area two miles in diameter.

In order to study the food habits of foxes, digestive tracts and fecal droppings were analyzed and field observations at dens were made. The majority of the material analyzed was obtained in the autumn and winter. Small mammals comprised the bulk of the material eaten in these seasons, with the cottontail rabbit constituting 46 per cent of the total contents of the digestive tracts, and small rodents 14 per cent. Cottontails comprised the staple food in winter possibly because the other prey species were hidden beneath the heavy snow-cover. Remains of birds comprised approximately 13 per cent of the total volume, and insects, plants, and inorganic debris made up the remainder.

In general, the food habits of the red fox in autumn and winter are beneficial to man, but certain foxes are harmful because they develop the habit of catching poultry.

Present fashions have made the pelt of the red fox so nearly valueless on the fur market that the species is not sought by trappers. As fashions change, long-haired furs may again be in demand and of correspondingly higher value. Then the red fox may again be sought intensively by fur-trappers.

LITERATURE CITED

- ANDERSON, S. AND NELSON, B. C.
1958. Additional records of mammals of Kansas. *Trans. Kansas Acad. Sci.*, 61:302-312, November 21.
- ASDELL, S. A.
1946. Patterns of mammalian reproduction. Comstock Publ. Co., Ithaca, New York, x + 437 pp., 12 pls., 1 fig., 20 tables.
- BAKER, A. B.
1887. Mammals of western Kansas. *Trans. Kansas Acad. Sci.*, 11:56-58.
- CHURCHER, C. S.
1960. Cranial variation in the North American red fox. *Journ. Mamm.*, 41:349-360, 6 figs., 5 tables, August 15.
- ERRINGTON, P. L.
1935. Food habits of mid-west foxes. *Journ. Mamm.*, 16:192-200, 1 table, August 12.
- FLORA, S. D.
1948. Climate of Kansas. Report Kansas St. Bd. Agric., 67:1-320, 17 figs., June.
- GIER, H. T.
1957. Coyotes in Kansas. *Kansas Agric. Exp. Station Bull.*, 393:1-96, 32 figs., 14 tables, August.
- HOFFMAN, R. A. and KIRKPATRICK, C. M.
1954. Red fox weights and reproduction in Tippecanoe County, Indiana. *Journ. Mamm.*, 35:504-509, 3 tables, November 29.
- KNOX, M. V. B.
1875. Kansas Mammalia. *Trans. Kansas Acad. Sci.*, 4:19-22.
- LANTZ, D. E.
1904. Kansas mammals in their relation to agriculture. *Bull. 129, Kansas State College Exp. Sta. Bull.*, 129:331-404, December.
- LAYNE, J. N. and MCKEON, W. H.
1956. Some aspects of red fox and gray fox reproduction in New York. *New York Fish and Game Journ.*, 3:44-74, 2 figs., 8 tables, January.
- LINHART, S. B.
1959. Sex ratios of the red fox and gray fox in New York. *New York Fish and Game Journ.*, 6:116-117, 1 table, January.
- MCGREGOR, R. L.
1948. Flora of Douglas County, Kansas. *Trans. Kansas Acad. Sci.*, 51:77-106, 1 fig.
- MURIE, A.
1936. Following fox trails. *Univ. Michigan Mus. Zool., Misc. Publ.*, 32:1-45, 6 pls., 6 figs., August 7.
- PARMALEE, P. W. and JACOBSON, K. W.
1959. Vertebrate remains from a Missouri cave. *Journ. Mamm.*, 40:401-405, 1 table, August 20.
- SCHOEWE, W. H.
1949. The geography of Kansas, Part II. *Trans. Kansas Acad. Sci.*, 52:261-333, 43 figs., 3 tables, September.
- SCOTT, T. C.
1943. Some food coactions of the northern plains red fox. *Ecol. Monog.* 13:427-479, 30 figs., 16 tables, October.
- SETON, E. T.
1929. Lives of game animals. Doubleday, Doran and Co., New York, N. Y., 1:xxxix + 640 pp., 122 pls., and other illus.

SHELDON, W. G.

1950. Denning habits and home range of red foxes in New York State. Journ. Wildl. Mgt., 14:33-42, 2 tables, January.

STILES, C. W. and BAKER, C. E.

1935. Key-catalogue of parasites reported for Carnivora (cats, dogs, bears, etc.) with their possible public health importance. Bull. 163, U. S. Natl. Inst. Health Bull., 163:913-1223, December, 1934.

SWINK, F. N., JR.

1957. Red foxes—facts and fancies. Virginia Wildlife, 18(8):5-7, 22, 5 photos, August.

Transmitted November 21, 1963.



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25. Guide to the Panorama of North American Mammals. By E. Raymond Hall, *et al.* Pp. 1-31, silhouettes in black and white of Panorama, life-zones, and taped commentary for each zone. December 15, 1960.
26. Beaver in Kansas. By F. Robert Henderson. Pp. 1-85, illustrated. December 16, 1960.
27. Land and fresh-water mammals of the Ungava Peninsula. By Francis Harper. Pp. 1-178, plates 1-8, 3 figures in text. August 11, 1961. Paperbound, \$2.00 postpaid from the Arctic Institute of North America, 1530 P Street, NW, Washington 5, D. C.
28. Handbook of unionid mussels in Kansas. By Harold D. Murray and A. Byron Leonard. Pp. 1-184, 45 plates, 42 figures. May 10, 1962. Paperbound, \$1.00 postpaid.
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