OCCASIONAL PAPERS:14

BELL MUSEUM
OF NATURAL HISTORY
UNIVERSITY OF MINNESOTA

Distribution, Natural History, and Parasites of Mammals of Cook County, Minnesota

BELL MUSEUM OF NATURAL HISTORY • UNIVERSITY OF MINNESOTA

17TH AND UNIVERSITY AVES. S.E. • MINNEAPOLIS, MINNESOTA

OCCASIONAL PAPERS: NUMBER 14

Distribution, Natural History, and Parasites of Mammals of Cook County, Minnesota

By

Robert M. Timm
Bell Museum of Natural History
University of Minnesota
Minneapolis, 55455

30 December 1975
Price: $3.00

Table of Contents

ABSTRACT

Natural history, distributions, and parasites of mammals of Cook County, Minnesota, were studied from the summer of 1971 through the summer of 1973. The purposes of this research were twofold. First, to determine species composition and relative abundance of individual species present in the county today. These base-line data may be used to project both back in time and into the future to assess man's effects on the mammalian fauna of the area. Second, to develop a technique for analyzing similarities and differences between the parasite fauna of groups of hosts as a tool in systematic and ecological research. Data on the mammalian fauna of Cook County were obtained through field collecting, by examination of mammal specimens from the county in collections, from discussions with individuals familiar with the local mammalian fauna, and from the published literature.

The present mammalian fauna of Cook County is composed of 48 species of verified occurrence. Eleven other species may be inhabitants of the county, but documentation of their occurrence there is lacking. Data presented for verified species includes localities of record, comments on abundance, reproduction, habitats, taxonomy, parasites, and pertinent literature. Known distributions and pertinent literature are presented for the eleven species of unverified occurrence. All mammalian species of verified occurrence have been reported from the state previously; however, the records of *Sorex arcticus, Sorex palustris, Condylura cristata, Myotis keenii, Lasionycteris noctivagans, Lasiurus borealis, Microtus chrotorrhinus, Synaptomys cooperi, Napaeozapus insignis, Procyon lotor, Martes americana, Martes pennanti,* and *Lynx canadensis* especially aid in our understanding of their distribution and natural history.

Ectoparasites representing three widespread groups of parasitic arthropods (Anoplura, Siphonaptera, Acari) were found parasitizing 20 species of small mammals in the county. Host-parasite records are presented for 23 species of fleas, 11 species of mites, 6 species of sucking lice, and 3 species of ticks. New host records are reported for six species of mites and one species of tick. New state records are recorded for seven species of mites and five species of fleas.

A technique was developed which produced an artificial classification of the mammalian fauna based entirely on the similarity of the ectoparasitic fauna between species. Similarity was calculated using Sorensen's similarity coefficient. An agglomerative clustering program utilizing within-group sums of squares was used to produce a two dimensional phenogram of the hosts. This clustering technique may prove to be of value in comparisons of similarity and difference between hosts or other communities.

Man's effect on the mammalian fauna has been to increase species diversity. The recent additions to the mammalian fauna are of deciduous forest affinity, are widespread in North America, or are introduced. Two species of coniferous forest affinity, *Gulo gulo* and *Rangifer tarandus*, have been extirpated recently from the county. It is hypothesized that most future additions to the mammalian fauna of Cook County, Minnesota, will be of deciduous forest, widespread, or the introduced category of faunal affinity.

INTRODUCTION

History

Cook County was organized in 1874 as the extreme northeastern county in Minnesota. Named in honor of Major Michael Cook, a territorial and state senator who was killed during the Civil War, the county is situated between 89° 30′ and 91° 00′ west longitude and between 47° 30′ and 48° 15′ north latitude (Fig. 1). The Canadian province of Ontario borders to the north, Lake County, Minnesota, to the west, and Lake Superior to the south and east. The northern boundary was negotiated with the British at the 1783 Treaty of Paris. The center of the voyageurs canoe route from Lake of the Woods in the western part of the state east to the mouth of the Pigeon River was designated as the final international boundary (Upham, 1920). Shaped roughly as an isosceles triangle with the base to the west, Cook County has an east-west length of 72 miles and a north-south greatest breadth of 54 miles. Grant (1899) estimated that the county covered 1680 square miles including 274 square miles of lakes. The highest point in Minnesota, Eagle Mountain (elevation 2,301 feet), is centrally located in the county. Grand Marais is the county seat and the largest town within the county, having a population of approximately 1,200.

Cook County contains a large portion of the Superior National Forest, several state parks, and the Grand Portage Indian Reservation. Superior National Forest was established in Cook, Lake, and St. Louis counties by proclamation of President Theodore Roosevelt on February 13, 1909. Numerous tracts of land have been added to the national forest since 1909. Under the Wilderness Act of 1964, 1,062,000 acres of the forest were set aside as the Boundary Waters Canoe Area (BWCA) for preservation of

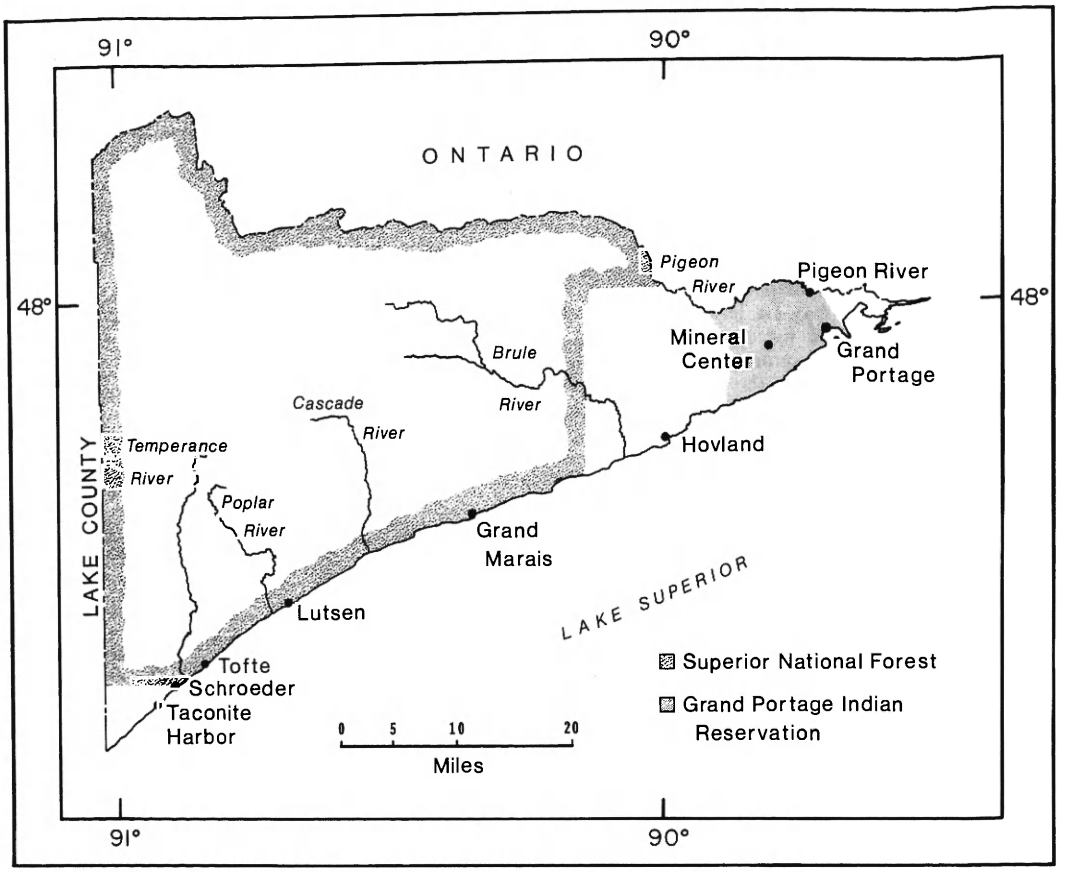

FIGURE 1. Map of Cook County, Minnesota, showing locations of place-names mentioned in text.

wilderness areas. Grand Portage, the earliest settlement inhabited by European man in Minnesota, played a major role in the northwestern fur trade from the 1730's until the early 1800's when it served as a trading post and rendezvous site. Grand Portage Indian Reservation, which covers approximately 65 square miles on the extreme eastern edge of the county, was established for the Chippewas in 1854.

Soils

The bedrock exposed as surface outcrops in many areas of Cook County consists primarily of Duluth gabbro, basalts, Saganaga granite, rhyolite, diabase, lavas, and greenstones of Precambrian origin, some 2.6-2.7 billion years old. Other deposits are of Pleistocene or Holocene origin. The area was covered by continental glaciers at least four times during the Pleistocene, i.e., Nebraskan, Kansan, Illinoian, and Wisconsin. The youngest of these, of Wisconsin age, was represented in the county by two separate glacier lobes. The Rainey Lobe, the first chronologically, moved north to south depositing a brown sandy till upon which developed the Milaca-Cloquet soil type. The Superior Lobe, which came from the east-northeast, followed the Lake Superior basin and covered only a narrow strip of the county bordering the lake. It deposited the red clay or till that provided the parent material for the Ontonagan soil group of gray and light grayish-brown clay loams. The Ontonagan soils are suitable for agriculture and support the limited farming that takes place along the coastal hills. The Milaca-Cloquet soils are best suited for forest production (Grout *et al.*, 1959; McMiller, 1947). Discussions of the geological history of the area may be found in Grout *et al.* (1959), Sharp (1953), and Wright and Ruhe (1965).

Topography

Cook County was divided into three physiographic regions by Grout *et al.*

(1959). The Coastal Hills area, which extends in a narrow belt along the north shore of Lake Superior, ranges in altitude from 602 feet near the shore to 1840 feet at its highest point. It is characterized by long parallel, northeasterly trending ridges with long intervening valleys. The Interior Uplands are typically gentle, rolling hills with altitudes of 1300-2200 feet, separated by broad, shallow valleys. Two parallel sets of ridges, the Brule Hills and the Misquah Hills, are located there. The third physiographic region, the Northern Ridges and Valleys, are characterized by rugged, parallel ridges with long, intervening narrow valleys. However, wide, flat valleys of glacial lake clay are found in some areas. The altitudes range from 602 feet to 2100 feet.

Grout *et al.* (1959) divided the approximately 1124 lakes in Cook County into five major classes depending on their origin as follows: ". . . (1) lakes lying wholly in bedrock basins; (2) lakes in bedrock basins but with depth of water increased through damming by glacial debris; (3) lakes in bedrock valleys dammed soley by glacial debris; (4) lakes within depressions in glacial deposits; and (5) lakes dammed by shoreline bars." The numerous rivers and streams of the county form two diverse drainage systems. The northwestern townships of the county, draining to the north, lie within the Hudson Bay watershed. The remainder of the county is part of the St. Lawrence watershed and drains via several rivers into Lake Superior.

Climate

The climate of Cook County is best described as cool-temperate (Hovde, 1941). Long severe winters and short, cool, wet summers are normal. Annual precipitation averages about 27 inches with the majority falling during the five-month period from May through September. Snowfall averages 55-60 inches per year. Lake Superior's great volume of water tends to have a moderating effect on the local climate, especially in the Coastal Hills area. The mean January temperature for Grand Marais, along the north shore, is 14.6° F; that for Gunflint Lake, 32 miles inland to the northwest, is −2.8° F. The average July temperature for Grand Marais is 59.4° F, that for Gunflint Lake is 62.4° F. Winter temperatures of −30° F to −40° F are not uncommon. (Climatography of the United States, no. 85-17, Dicennial census of United States climate-monthly averages for state climatic divisions, 1931-1960, Minnesota, 1963; and United States Weather Bureau, Climatological Data, Minnesota Sec., Washington, D.C., Annual Summary 1972, vol. 78, no. 13, pp. 215-225.)

Vegetation

Before the instigation of logging in the 1870's, much of the vegetation of Cook County was that of a true coniferous forest with immense stands of white pine (*Pinus strobus*) and red pine (*Pinus resinosa*). Because of forest fires and extensive logging in subsequent years, little of the climax forest remains today. Weaver and Clements (1938) described the Great Lakes area as the Lake Forest Climax Formation, with white pine, red pine, and hemlock (*Tsuga canadensis*) as the climax dominants. Hemlock is continually expanding its range, but has not yet reached northeastern Minnesota. Küchler (1964) included northeastern Minnesota in the Great Lakes Spruce Fir Forest with the present dominants of balsam fir (*Abies balsamea*) and white spruce (*Picea glauca*). He included red maple (*Acer rubrum*), mountain maple (*Acer spicatum*), paper birch (*Betula papyrifera*), red pine, white pine, quaking aspen (*Populus tremuloides*), mountain-ash (*Sorbus americana*), and white-cedar (*Thuja occidentalis*) as secondary components.

I have followed Ohmann and Ream's (1971) classification of the present plant communities in the Boundary Waters Canoe Area into 12 community types (Table 1). Several categories are successional stages found in association with habitat disturbance. In many cases, the community types are easily discernible in the field, thereby allowing for correlation of the distribution and abundance of mammals with the respective habitats.

History of Mammalian Investigations in Cook County

Field investigations of mammals in Cook County began in August, 1879, with the work of E. Surber and T. S. Roberts. Subsequent collecting trips by Surber were made in 1922 and 1923. W. J. Breckenridge, H. L.

TABLE 1. The twelve major plant communities in northeastern Minnesota as defined by Ohmann and Ream (1971). Names of the community type, its dominants, codominants, and abundant species are listed along with comments concerning each.

Community Type	Dominants-Codominants	Abundant Species	Comments
1. Lichen	*Cladonia mitis* *Cladonia rangiferina* Spotted peltigera (*Peltigera aphthosa*)	Pink corydalis (*Corydalis sempervirens*) Hairy-cap moss (*Polytrichum*)	Restricted to rock outcrops on ridges and upper slopes.
2. Jack pine (Oak)	Jack pine (*Pinus banksiana*)	Red oak (*Quercus rubra*) Bebb willow (*Salix bebbiana*) Late sweet blueberry (*Vaccinium angustifolium*) Wintergreen (*Gaultheria procumbens*)	Found on bald rock ridges and rock outcrops.
3. Jack pine (Fir)	Jack pine	White spruce (*Picea glauca*) Goldthread (*Coptis groenlandica*) Twin-flower (*Linnaea borealis*) Running clubmoss (*Lycopodium clavatum*)	Similar to Jack pine (Oak), but more consistently found on lower slopes and on northern and northeastern slopes.
4. Jack pine-Black spruce	Jack pine Black spruce (*Picea mariana*)	Bunchberry (*Cornus canadensis*)	Usually on southern and southwestern slopes.
5. Black spruce-Jack pine	Black spruce	Jack pine Dicranum (*Dicranum* spp.) Plume moss (*Hypnum crista-castrensis*) Schreber's moss (*Calliergonella schreberi*)	Mid to lower slopes usually facing south and west.
6. Aspen-Birch	Quaking aspen (*Populus tremuloides*) Paper birch (*Betula papyrifera*)	Beaked hazel (*Corylus cornuta*) Green alder (*Alnus crispa*) Round-leaved dogwood (*Cornus rugosa*) Clinton's lily (*Clintonia borealis*) Large-leaf northern aster (*Aster macrophyllus*) Upland strawberry (*Fragaria vesca*) Bracken fern (*Pteridium aquilinum*)	Widespread, especially along Lake Superior. Contains the greatest diversity, having at least 112 different species.
7. Maple-Aspen-Birch	Red maple (*Acer rubrum*)	Quaking aspen Paper birch Common twisted-stalk (*Streptopus roseus*)	Frequently in valleys but also on some upper slopes.

Table 1.—Continued.

Community Type	Dominants-Codominants	Abundant Species	Comments
		False lily-of-the-valley (*Maianthemum canadense*) Star-flower (*Trientalis borealis*) Ground pine (*Lycopodium obscurum*)	
8. White pine	White pine (*Pinus strobus*)	Bush honeysuckle (*Diervilla lonicera*) Wild sarsaparilla (*Aralia nudicaulis*) Wood anemone (*Anemone quinquefolia*)	Generally on midslopes to ridgetops and usually northeast, east, or south facing.
9. Red pine	Red pine (*Pinus resinosa*) White pine	Red Oak Juneberry (*Amelanchier* spp.) Sweet fern (*Comptonia peregrina*) Velvet-lead blueberry (*Vaccinium myrtilloides*) Cow-wheat (*Melampyrum lineare*)	Least diversity of the forest community types, with only 67 different species.
10. Budworm-disturbed	Balsam fir (*Abies balsamea*)	White spruce Dewberry (*Rubus pubescens*) Red raspberry (*Rubus strigosus*) Fringed bindweed (*Polygonum cilinode*) One-sided pyrola (*Pyrola secunda*)	Spruce budworm damage opens the canopy, allowing dense growth of seedlings, saplings, and shrubs.
11. Fir-Birch	Balsam fir Paper birch	Mountain maple (*Acer spicatum*) Sweet bedstraw (*Galium triflorum*) Stiff clubmoss (*Lycopodium annotinum*) other mosses	Usually close to water and with a sparse ground flora.
12. White-Cedar	White-cedar (*Thuja occidentalis*)	Balsam fir Mountain-ash (*Strobus americana*) White spruce Fly honeysuckle (*Lonicera canadensis*) Ground-hemlock (*Taxus canadensis*) Thimbleberry (*Rubus parviflorus*) Bishop's cap (*Mitella nuda*) Violet (*Viola* spp.) Oak fern (*Gymnocarpium dryopteris*) Hylocomium (*Hylocomium splendens*)	Generally found on northern and northeastern slopes.

FIGURE 2. View of the Coastal Hills area and Lake Superior near the town of Tofte.

FIGURE 3. Boulder accumulation along the Gunflint Trail where an isolated population of rock voles, *Microtus chrotorrhinus*, was discovered. *Sorex arcticus*, *S. cinereus*, *Blarina brevicauda*, *Eutamias minimus*, *Tamiasciurus hudsonicus*, *Peromyscus maniculatus*, *Clethrionomys gapperi*, and *Napaeozapus insignis* were taken in the surrounding forest.

FIGURE 4. Birch forest along the Temperance River on 15 April 1974. Black spruce commonly was found growing along river banks. *Sorex palustris, Blarina brevicauda, Condylura cristata, Tamiasciurus hudsonicus, Peromyscus maniculatus,* and *Clethrionomys gapperi* were taken frequently in this habitat type.

FIGURE 5. Second growth vegetation as a result of recent logging along the Gunflint Trail north of Grand Marais. *Eutamias minimus* and *Clethrionomys gapperi* were the most common mammals found in this habitat.

Gunderson, and B. Hayward made collections of small mammals in the late 1940's and early 1950's. O. T. Kalin and R. J. Oehlenschlager collected at several localities during the summers of 1966 and 1967 as part of an investigation on small mammals of Minnesota. These field crews were sponsored by the Minnesota Museum of Natural History (now Bell Museum of Natural History) or the Minnesota State Department of Natural Resources. Specimens and some field notes from these investigations are on deposit in the Museum. Mammal specimens from Cook County in the University of Michigan Museum of Zoology were obtained by W. Koelz in September of 1921. A few miscellaneous specimens obtained previously from the county are also on deposit in the Bell Museum of Natural History, the American Museum of Natural History, the United States National Museum of Natural History, and The University of Kansas Museum of Natural History.

Due in part to the limited amount of field work, there is a paucity of information on the natural history of the mammalian fauna of northeastern Minnesota. Notable exceptions are a few studies on game species, including autecological studies of black bears (Rogers, 1970; 1974), ecological studies of moose (Peek, 1971; Peek *et al.*, 1974; and Van Ballenberghe and Peek, 1971), food habits and parasites of bobcats (Rollings, 1945), and extensive research on timber wolves (Byman, 1972; Mech, 1970 and elsewhere; Seal *et al.*, 1975; Stenlund, 1955; Van Ballenberghe, 1972; Van Ballenberghe and Mech, 1975; and Van Ballenberghe *et al.*, 1975). Published distributional and natural history records on Cook County mammals include those on the woodland jumping mouse (Surber, 1923), least chipmunk (Orr, 1930), snowshoe hare (Cox, 1936), marten (Gunderson, 1965), fisher (Balser and Longley, 1966), wolf (Van Ballenberghe and Erickson, 1973), and rock vole (Timm, 1974).

State mammalian faunal accounts (see Ames, 1873; Herrick, 1892; Johnson, 1916; Johnson, 1930; Surber, 1932; Swanson, 1945; and Gunderson and Beer, 1953) are of a general nature as are those of adjoining smaller areas (Quetico Provincial Park by Cahn, 1937; northern Lake County, Minnesota, by Johnson, 1922; and northeastern Lake County by Rom, 1940). Major descriptive accounts are available for some of the same mammals in other parts of their range (Eastern United States by Hamilton, 1943; Eastern Canada by Peterson, 1966; Wisconsin by Jackson, 1972; and Canada by Banfield, 1974).

METHODS AND MATERIALS

My interest in the mammals of Cook County, Minnesota began in the summer of 1971 when a small collection of mammals was obtained there during two brief trips. Subsequently, extensive collecting was conducted during the spring and summer of 1972 followed by periodic field work through the summer of 1973. During this time, more than four months were spent in the field studying the mammals of the area. At the beginning of this study, permission was obtained from the United States Forest Service and the Minnesota Department of Game and Fish to collect in Superior National Forest and the state parks in the county. Restricted collecting on the Grand Portage Indian Reservation was authorized by the local Indian council. Local trappers, conservation officers, and the area game manager were contacted to solicit their assistance in obtaining specimens and to assemble data on distribution and abundance of local game and fur-bearing species.

Each species of mammal recorded presently or historically from Cook County, as well as those possibly occurring there but whose presence is unverified by a specimen, is treated separately in the accounts that follow. The basis of each species account is the natural history data obtained during this study, including distribution, relative abundance, reproductive characteristics, habitat use, molt, parasites, food habits, and taxonomic comments as appropriate. All known records from the county and references to pertinent literature are included.

Standard external measurements (total length, length of tail vertebrae, length of hind foot, and height of ear from notch) were recorded in millimeters and weight in

grams. On the basis of size and pelage characteristics, each animal was placed into one of three age classes: juvenile, subadult, or adult. Molt was classified as maturational or adult. The following reproductive data were recorded for males—(1) seminal vesicles; minute, small, or large: (2) epididymus; not convoluted, slightly convoluted, or convoluted: (3) testes; length and width. The following reproductive data were recorded for females—(1) vulva; inactive, turgid, or cornified: (2) mammae; small, large, or lactating: (3) pubic symphysis; closed, slightly open, or open: (4) normal embryos; number left and right: (5) resorbing embryos; number left and right: (6) embryo length; crown-rump length in millimeters: (7) new uterine scars; number left and right: (8) highly pigmented old uterine scars; number left and right: (9) lightly pigmented old uterine scars; number left and right: (10) corpora lutea; number left and right: (11) corpora lutea (corpora albicantia) association; unimplanted ova, embryos, new uterine scars, or old uterine scars: (12) corpora albicantia; present or absent. Cranial measurements were taken with dial calipers and recorded to the nearest tenth of a millimeter unless otherwise noted. Definitions of cranial measurements used are those provided by Choate (1970) for shrews and by Hall (1946) for other species.

Although counts of placental scars may not give an accurate account of an individual female's reproductive history, general trends in reproduction can be detected by detailed examination of placental scars and ovaries. The dangers of utilizing data from placental scars to determine breeding potential for individual *Rattus* were pointed out by Davis and Emlen (1948). However, they emphasized that placental scars could be utilized to distinguish between parous and nonparous individuals and as a crude record of reproductive history.

All specimens listed under "Specimens examined" were personally examined during the course of this study. Voucher specimens from each collecting locality were saved for all except the most abundant species. All specimens preserved as skin and skull or complete skeletons have been accessioned into the main collection of the Bell Museum, as have some preserved in liquid or only as a skull. However, many specimens of common species preserved in liquid or as skulls have not beeen accessioned and are being preserved temporarily. Specimens listed under "Other records" were taken from the literature or were examined for me in the collections in which they are housed. The order for listing specimens is according to locality of capture as follows: alphabetical by reference point, then sequential north to south; those from the same latitude referenced to the same point are in order west to east. Sight records are listed in the individual species accounts and unless otherwise described, include only my sightings. The arrangement of orders and genera follows Hall and Kelson (1959). Species within a genus are treated in alphabetical order. Scientific and common names follow Jones *et al.* (1973). In a few cases common names judged to be better known within the area are listed first, followed in parentheses by the common name suggested by Jones *et al.* (1973).

Legal descriptions of collecting localities were used for animals collected during this study insofar as was possible. For the sake of brevity within accounts of species and for convenience of future workers, however, only distance in miles to the nearest town is routinely reported herein. Exceptions exist when the locality is not a "point" (i.e. Lower Brule River, T. 62 N, R. 3 E) or when confusion might result such as with specimens collected at or near the United States-Canadian border crossing of Pigeon River. Two separate "point" localities within the county and a river are known as "Pigeon River." The old border crossing (Fig. 1) is designated Pigeon River on all present state and federal maps. When the border crossing was moved to its present locality some 5½ miles east of the original site, it also became known as Pigeon River and is so designated by recent highway markers. It is likely that future maps also will designate the new site as Pigeon River. Localities plotted from the old town of Pigeon River are labeled "Pigeon River" with a legal description. All localities near the second site will be referenced by mileage from Grand Portage. Localities of specimens collected prior to this study were standardized in accordance with the above conventions. Data labels of some specimens from Cook County provide only a legal description of the locality where the specimen originated. These were converted to a form

with mileage from some point of reference as follows:

NW ¼ Sec. 8, T. 64 N; R. 1 W (=20 mi. N, 6 mi. W Grand Marais)
Sec. 33, T. 63 N, R. 1 E (=10 mi. N Grand Marais)
NE ¼ Sec. 8, T. 64 N, R. 3 E (=14 mi. N, 5 mi. W Hovland)
NE ¼ Sec. 22, T. 64 N, R. 3 E (=12 mi. N, 3 mi. W Hovland)
NE ¼ Sec. 32, T. 63 N, R. 4 E (=4½ mi. N, 1 mi. E Hovland)
NW ¼ Sec. 33, T. 63 N, R. 4 E (=4 mi. N, 1 mi. E Hovland)
SE ¼ Sec. 8, T. 62 N, R. 3 E (=2 mi. N, 5 mi. W Hovland)
NW ¼ Sec. 16, T. 62 N, R. 3 E (=1 mi. N, 5 mi. W Hovland)
NE ¼ Sec. 25, T. 62 N, R. 3 E (=¾ mi. S, 1 mi. W Hovland)
NE ¼ Sec. 33, T. 62 N, R. 3 E (=2 mi. S, 4 mi. W Hovland)
NW ¼ Sec. 31, T. 65 N, R. 2 W (=30 mi. N, 2 mi. E Lutsen)
SW ¼ Sec. 1, T. 62 N, R. 5 W (=Alton Lake, 23 mi. N, 1 mi. W Schroeder)
SW ¼ Sec. 7, T. 62 N, R. 4 W (=22 mi. N Schroeder)
NW ¼ Sec. 18, T. 62 N, R. 4 W (=21½ mi. N Schroeder)
NW ¼ Sec. 19, T. 62 N, R. 4 W (=20½ mi. N Schroeder)
NE ¼ Sec. 29, T. 58 N, R. 5 W (=2½ mi. S, 3 mi. W Taconite Harbor)

Mammalian specimens collected from Cook County during this study are housed in the Bell Museum of Natural History (MMNH) at the University of Minnesota, Minneapolis, and the United States National Museum of Natural History. Field Catalogs, field notes, and data sheets are on permanent file in the Bell Museum. Parasites reported herein were identified by the following individuals: lice by Ke Chung Kim, Pennsylvania State University, University Falls; fleas by Allen H. Benton, State University College, Fredonia, New York; ticks by James E. Keirans, National Institute of Allergy and Infectious Diseases, Hamilton, Montana; mites by Nixon Wilson, University of Northern Iowa, Cedar Falls; and nematodes by Henry J. Griffiths, University of Minnesota, St. Paul. Parasite specimens are deposited in the collections of the respective authorities or the institutions which they represent, the Entomology collection at the University of Minnesota, and the collection of the author.

Abbreviations designating specimens in other collections are as follows:

AMNH	American Museum of Natural History
CM	Carnegie Museum
KU	Museum of Natural History, The University of Kansas
FMNH	Field Museum of Natural History
UMMZ	Museum of Zoology, University of Michigan
USNM	United States National Museum of Natural History (including collections of the United States Biological Survey).

No taxonomic keys are included in this report. For identification of specimens from this area, consult Burt (1969), Gunderson and Beer (1953), and Jackson (1972). Hall and Kelson (1959) provided keys for the mammals of North America.

ACCOUNTS OF SPECIES

In the following accounts of mammals from Cook County, 48 species belonging to six orders and 16 families are included on the basis of documentation of their occurrence in the county. These incorporate 1,244 specimens listed in "Specimens examined." In addition, comments are made concerning eleven species that may live or have lived within the county, but whose presence there lacks adequate documentation.

Species of Verified Occurrence

Order Insectivora

Sorex arcticus laricorum Jackson, 1925

Arctic Shrew

Specimens examined (16).—17 mi. N, 3 mi. W Grand Marais, 1; 17 mi. N, 1 mi. W Grand Marais, 1; 6 mi. W Grand Marais, 2; Grand Marais, 2 (USNM); Grand Portage, 1; 2 mi. S, 4 mi. W Hovland, 2; 1 mi. E Mineral Center, 1; Poplar

River, Mouth of Caribou, 1; 37 mi. N, 7½ mi. E Schroeder, 2; 21 mi. N Schroeder, 1; 1 mi. N, 1½ mi. E Schroeder, 2.

This boreal shrew is widespread and relatively common throughout the county. Specimens were collected in a variety of habitats, but most were associated with open areas, either non-forested areas or clearings within the forest. Arctic shrews were taken in dense grass along road ditches; in forest openings of grasses, strawberries, and ferns; in a speckled alder thicket (*Alnus rugosa*) cohabited with ferns and *Rubus*; and in old field habitats. One arctic shrew was obtained from a white-cedar, black spruce, and balsam fir forest. Bailey (1929) also reported this shrew as common in marshes surrounding rice lakes in Sherburne County.

No embryos or placental scars were noted in any of six female *Sorex arcticus*, but two adult males from 22 June and 8 July appeared to be in reproductive condition, each having testes measurements of 7 × 5 mm., convoluted epididymides, and well developed seminal vesicles. Included among Bailey's (1929) specimens were two pregnant females, one with six and one with nine embryos. None of the specimens taken from Cook County was molting. A specimen from Grand Portage had abnormally pallid pelage.

Hall and Kelson (1959) indicated that Cook County was within the geographic range of S. *arcticus arcticus*, but they did not examine specimens from the area. Arctic shrews examined during the course of this study from northeastern Minnesota conform well to Jackson's (1928) descriptions and measurements of the southern subspecies, S. *arcticus laricorum* (see Table 2). Accordingly, all arctic shrews from Cook County were assigned to this subspecies on the basis that the length of the palate, the interorbital breadth, and the condylobasal length are substantially larger in S. *arcticus laricorum* than in S. *arcticus arcticus*.

Species of ectoparasites recovered from arctic shrews include fleas, *Corrodopsylla curvata*; mites, *Haemogamasus liponyssoides*; and ticks, *Ixodes angustus* and *I. muris*. In Pine County, Minnesota, Whitaker and Pascal (1971) reported a tick, *Ixodes muris*, and mites, *Labidophorus soricis*, *Protomyobia onoi*, *Amorphacarus elongatus*, and *Androlaelaps fahrenholzi*, from *Sorex arcticus* taken from an old field (see also Whitaker and Schmeltz, 1973).

Sorex cinereus cinereus Kerr, 1792

Masked Shrew

Specimens examined (88).—Four Mile Lake, 1; 20 mi. N, 6 mi. W Grand Marais, 2; 18 mi. N, 4 mi. E Grand Marais, 1; 17 mi. N, 3 mi. W Grand Marais, 1; 17 mi. N, 1 mi. W Grand Marais, 2; 16 mi. N, 2 mi. E Grand Marais, 1; 15 mi. N, 4½ mi. E Grand Marais, 2; 13½ mi. N, 4½ mi. E Grand Marais, 1; 13 mi. N, 3 mi. W Grand Marais, 1; 13 mi. N, 1 mi. E Grand Marais, 2; Kimball Lake, 8 mi. N, 5 mi. E Grand Marais, 1; 2½ mi. N, 8½ mi. W Grand Marais, 2; 2½ mi. N, 2½ mi. W Grand Marais, 1; 1½ mi. N, 5 mi. W Grand Marais, 2; 1 mi. N, 3 mi. W Grand Marais, 1; Grand Marais, 1; ½ mi. S, 1 mi. W Grand Marais, 3; 1½ mi. S, 7½ mi. W Grand Marais, 2; ½ mi. N, 1 mi. W Grand Portage, 10; Grand Portage, 1; Horseshoe Lake Portage, 1; 14 mi. N, 5 mi. W Hovland, 3; 14 mi. N, 3½ mi. W Hovland, 1; 12 mi. N, 3 mi. W Hovland, 1; Otter Lake, 10 mi. N, 1½ mi. W Hovland, 3; 10 mi. N, 1 mi. E Hovland, 1; 10 mi. N, 3 mi. E Hovland, 2; 9 mi. N, 3½ mi. W Hovland, 5; 4 mi. N, 6 mi. E Hovland, 1; 4 mi. NE Hovland, 2; 3 mi. N, 1 mi. W Hovland, 1; 3 mi. N Hovland, 1; 2½ mi. W Hovland on highway 61, 5; 2 mi. S, 4 mi. W Hovland, 1; 30 mi. N, 2 mi. E Lutsen, 1; 15 mi. N, 4½ mi. E Lutsen, 1; 14½ mi. N, 1 mi. W Lutsen, 1; 8 mi. N, 1½ mi. W Lutsen, 1; Northern Lights Lake, 1; Pigeon River, SW ¼ sec. 20, T. 64 N, R. 6 E, 3; 37 mi. N, 7½ mi. E Schroeder, 1; 22 mi. N Schroeder, 2; 1 mi. N, 1½ mi. E Schroeder, 2; 4 mi. W Schroeder, 1; 3½ mi. W Schroeder, 3; 2 mi. S, 2 mi. W Taconite Harbor, 2.

Additional record.—Grand Marais (UMMZ).

The masked shrew is abundant and widespread in northeastern Minnesota. Specimens have been collected from almost all habitat types within Cook County. It appeared to be the most abundant mammalian species at one locality, a balsam-fir mountain-maple forest with leaf litter floor. Ten *Sorex cinereus* were trapped at this site along with two *Blarina brevicauda*, five *Peromyscus maniculatus*, and a *Clethrionomys gapperi*. This shrew was especially abundant in Aspen-Birch, balsam fir, white spruce forests, and sphagnum bogs. Quimby (1943) found S. *cinereus* to be extremely abundant and to occupy a wide variety of habitats in Minnesota. Cahn (1937) found it common in birch and poplar groves in Ontario.

Four pregnant females have been collected in Cook County: one taken on 20 July 1972 contained seven embryos, 11 mm. long (3L-4R); one from 29 August 1972

TABLE 2. Selected cranial measurements of *Sorex arcticus laricorum* and *S. palustris palustris* from Cook County, Minnesota. Means, range, and N are included.

Condylobasal Length	Palatal Length	Cranial Breadth	Interorbital Breadth	Maxillary Breadth	Maxillary Toothrow
		Sorex arcticus laricorum			
19.2 (18.6-19.5) 10	8.2 (7.7-8.4) 12	9.4 (9.0- 9.8) 10	3.8 (3.6-4.0) 12	5.3 (5.1-5.4) 8	6.9 (6.5-7.1) 12
		Sorex palustris palustris			
20.6 (20.0-21.2) 24	9.0 (8.8-9.2) 27	10.4 (10.1-10.7) 25	4.2 (4.1-4.4) 25	6.3 (5.9-6.4) 19	7.7 (7.4-8.0) 27

carried six embryos, 4 mm. long (3L-3R); and two other females from 12 August and 2 September 1966 contained large, fresh corpora lutea, but implantation sites of embryos were not yet visible. Two males collected on 24 March 1973 each had testes measurements of 4 × 3 mm., slightly convoluted epididymides, and well developed seminal vesicles (indicating that they were entering breeding condition). Males in full breeding condition (testicular measurements of 6 × 3, 6 × 4, and 5 × 3 mm., respectively, highly convoluted epididymides, and well developed seminal vesicles) were collected on 9 July, 1 August, and 31 August 1972. All masked shrews collected between mid-September and early March appeared reproductively inactive. An adult *S. cinereus* obtained on 24 March 1973 was molting into summer pelage and an individual taken on 29 December 1972 displayed complete winter pelage.

Invertebrates recovered from this species include fleas (*Nearctopsylla genalis*), parasitic mites (*Androlaelaps fahrenholzi*), and various non-parasitic mites. Whitaker and Pascal (1971) noted two species of mites (*Labidophorus soricis* and *Androlaelaps fahrenholzi*) and one species of tick (*Ixodes muris*) from *Sorex cinereus* in Pine County, Minnesota. In St. Louis County crickets and lepidopterous larvae were found to be the most common foods of the masked shrew (Whitaker and Schmeltz, 1973).

Sorex palustris palustris Richardson, 1828

Water Shrew

Specimens examined (32).—15½ mi. N, 6 mi. E Grand Marais, 1; Kimball Lake, 8 mi. N, 5 mi. E Grand Marais, 1; 6 mi. N, 9 mi. E Grand Marais, 1; ¼ mi. S, 1 mi. W Grand Marais, 1; Grand Portage, 2; 2 mi. S, 5¾ mi. W Grand Portage, 1; Otter Lake, 10 mi. N, 1¼ mi. W Hovland, 2; 4 mi. NE Hovland, 1; 15¼ mi. N, 1 mi. E Lutsen, 1; 14½ mi. N, 1 mi. W Lutsen, 1; 11 mi. N, 3 mi. W Lutsen, 1; 22 mi. N Schroeder, 19.

This semi-aquatic insectivore is distributed throughout Cook County and may be locally abundant. All of the 32 specimens known from the county were collected in close proximity to water. Nineteen specimens were taken from a single locality, a mixed forest of white pine, paper birch, balsam fir, mountain maple, black spruce, beaked hazel, and black ash (*Fraxinus nigra*) at the headwaters of Sawbill Creek near Sawbill Lake. Most were trapped on moss-covered rocks along the creek or on the forest floor, but two were taken in holes under the roots of paper birch and *Salix*. Other specimens obtained during this study were trapped in dense grass around creeks and beaver ponds or in hollows under white-cedar in low marshy areas.

Testicular lengths of 11 adult males from June, July, and August averaged 1.6 mm. (1-3 mm.). Two females obtained on 18 August 1966 showed signs of reproductive activity: corpora albicantia and an undeterminable number of old scars were present in one female; the second possessed nine placental scars. No other female showed sign of reproductive activity. Conaway (1952) found that *Sorex palustris navigator* bred from February to August in Montana, with several litters being produced each season and a modal litter size of six.

Autumnal molt was noted on animals taken on 10 August, with the fresh winter pelage being fairly comprehensive except on the head and neck regions of animals collected on 20-25 August. Individuals trapped on 1 September and 27 December were in complete winter pelage, but none of eight specimens collected on 18 and 19 August had begun autumnal molt. The series of non-molting specimens was collected in 1966, whereas all those that were molting were obtained in 1972. Interestingly, this appears contradictory to the current concept of mammalian molt

being regulated by day length. Conaway (1952) thought that the autumnal molt was the first molt for young of the year, but otherwise was similar for both young and adults.

Ectoparasites recovered from this species include fleas (*Corrodopsylla curvata*), ticks (*Ixodes angustus*), and mites (*Haemogamasus ambulans*). Whitaker and Schmeltz (1973) identified ten species of ectoparasites from *Sorex palustris* and compared food habits of *S. palustris* and *S. cinereus* from St. Louis County, Minnesota.

Blarina brevicauda brevicauda (Say, 1823)
Short-tailed Shrew

Specimens examined (131).—Lower Brule River, 1; Caribou River, 1; Cascade Lake, 2; Cascade Lookout, 1 (KU); Cascade River, 1; Cascade River, near Eagle Mountain, 2 (KU); Mouth of Cascade River, 1; Cross River, 2; West Devil Track Lake, 2; Devil Track Lake, 2; Devil Track River, 5; Fourmile Lake, 1; 20 mi. N, 6 mi. W Grand Marais, 1; 18 mi. N, 4 mi. E Grand Marais, 2; 17 mi. N, 3 mi. W Grand Marais, 1; 17 mi. N, 1 mi. W Grand Marais, 4; 15½ mi. N, 6 mi. E Grand Marais, 1; 13½ mi. N, 4½ mi. W Grand Marais, 1; Kimball Lake, 8 mi. N, 5 mi. E Grand Marais, 1; 6 mi. N, 9 mi. E Grand Marais, 3; 2 mi. N, 7½ mi. W Grand Marais, 1; 2 mi. N, 3 mi. E Grand Marais, 1; 1½ mi. N, 10 mi. W Grand Marais, 1; 6 mi. W Grand Marais, 1; ½ mi. S, 1 mi. W Grand Marais, 1; 1½ mi. S, 7½ mi. W Grand Marais, 2; 2 mi. N, 4 mi. E Grand Portage, 4; Mount Maud, ½ mi. N, 4 mi. W Grand Portage, 3; ½ mi. N, 1 mi. W Grand Portage, 3; Grand Portage, 3; 1½ mi. S, 2 mi. W Grand Portage, 2; 14 mi. N, 5 mi. W Hovland, 1; Otter Lake, 10 mi. N, 1½ mi. W Hovland, 4; 10 mi. N, 2 mi. E Hovland, 3; 10 mi. N, 3 mi. E Hovland, 1; 9 mi. N, 3½ mi. W Hovland, 1; 4½ mi. N, 1 mi. E Hovland, 1; 3½ mi. N, 1 mi. W Hovland, 3; 3 mi. N, 1 mi. W Hovland, 2; 3 mi. N Hovland, 1; 4 mi. NE Hovland, 1; 2 mi. N, 5 mi. W Hovland, 1; 4 mi. W, 2 mi. S Hovland, 3; ¾ mi. S, 1 mi. W Hovland, 2; 30 mi. N, 2 mi. E Lutsen, 1; 15 mi. N, 4½ mi. E Lutsen, 1; 11 mi. N, 3 mi. W Lutsen, 1; 1½ mi. N, 4½ mi. W Lutsen, 1; 5 mi. W Lutsen, 2; 2 mi. W Mineral Center, 2; 1 mi. E Mineral Center, 1; Pigeon River, SW ¼ sec. 20, T. 64 N, R. 6 E, 1; Poplar Lake, 1; Poplar River, 4; Saganaga Lake, Superior National Forest, 1 (USNM); Islands in Lake Saganaga, 1; 39 mi. N, 3½ mi. E Schroeder, 1; 38½ mi. N, 4½ mi. E Schroeder, 2; 37½ mi. N, 4 mi. E Schroeder, 1; 37 mi. N, 7½ mi. E Schroeder, 2; 23 mi. N, 1 mi. W Schroeder, 1; 22 mi. N Schroeder, 5; 21 mi. N Schroeder, 1; 4 mi. N, 5 mi. W Schroeder, 5; 2 mi. N Schroeder, 2; 1 mi. N, 1½ mi. E Schroeder, 2; 4 mi. W Schroeder, 3; 2 mi. S, 2 mi. W Taconite Harbor, 3; Temperance River, 1 (KU); Mouth of Temperance River, 2 (1 KU); 15 mi. N, 2 mi. W Tofte, 1; Tofte, 1.

Additional records.—Grand Marais, (Bole and Moulthrop, 1942); Poplar Lake, (FMNH).

The short-tailed shrew is one of the most abundant and widely distributed mammals of northeastern Minnesota. During the course of this study only the deer mouse, *Peromyscus maniculatus*, and meadow vole, *Microtus pennsylvanicus*, exceeded *Blarina brevicauda* in abundance. Short-tailed shrews were found commonly in all habitats, especially the Aspen-Birch community, low-lying white cedar forests, and marshes. In Ontario, Cahn (1937) found this insectivore "almost everywhere" and thus very abundant. T. Surber's field notes recorded in Cook and Lake counties in 1922 noted this species as "the most abundant small mammal found in the region."

Four pregnant females and four females containing placental scars were obtained (see Table 3). Mean litter size, as determined by embryo and placental scar counts, was 6.6, with a range of 5-8. All females containing embryos or placental scars from June through September appeared to be young of the year (as determined by tooth wear) and none of the reproductively active females appeared to be multiparous. Only 10.9% of the adult population (6 ♀♀ and 2 ♂♂) sampled during the summer of 1972 were judged to be reproductively active (i.e., embryos or uterine scars in females and testicular lengths over 6 mm. for males). Pearson (1944) found *Blarina* from several localities in the northeastern United States to have a mean litter size of 4.5 with some females producing at least two litters a year.

Of the 130 short-tailed shrews from the county, only two were molting: one from 27 July 1923 and one from 24 August 1973.

Arthropodous ectoparasites obtained from *Blarina brevicauda* in Cook County include the following: fleas (*Corrodopsylla curvata, Ctenophthalmus pseudagyrtes, Nearctopsylla genalis, Epitedia wenmanni,* and *Megabothris asio*), mites (*Eulaelaps stabularis, Haemogamasus ambulans, H. liponyssoides,* and *Myonyssus jamesoni*), and ticks (*Ixodes angustus*).

Condylura cristata cristata (Linnaeus, 1758)
Star-nosed Mole

Specimens examined (18).—Cascade River, near Eagle Mountain, 1; 2½ mi. N, 2½ mi. W Grand Marais, 1; 2 mi. N, 2 mi. W Grand Portage, 1; 1½ mi. S, 2 mi. W Grand Portage, 1; Otter Lake, 10 mi. N, 1½ mi. W Hovland, 2; 30 mi. N, 2 mi. E Lutsen, 3; 8 mi. N, 1½ mi. W Lutsen, 2; 37½ mi.

TABLE 3. Reproductive data from eight female *Blarina brevicauda* from Cook County, Minnesota.

Date	Embryos or Placental Scars	Uterine Horn		Embryo Length
		Left	Right	
21 May 1972	7 embryos	4	3	10.0
21 June 1972	5 embryos	3	2	11.0
7 July 1972	5 placental scars	2	3	
1 August 1966	8 embryos	4	4	—
3 August 1972	8 placental scars	4	4	
3 August 1972	7 placental scars	4	3	
26 August 1972	7 placental scars	4	3	
1 September 1972	6 embryos	4	2	—

N, 4 mi. E Schroeder, 1; 22 mi. N Schroeder, 1; 5 mi. N, 2 mi. E Schroeder, 1; 1 mi. N, 1½ mi. E Schroeder, 2; Schroeder, 1; Swan Lake portage, South Brule River, 1.

The star-nosed mole, the most amphibious of the North American talpids, was taken only in close proximity to water. High populations of *Condylura cristata* were noted in the Aspen-Birch community type near Lake Superior and in lowland cedar forests. Other specimens were collected in associaion with sedges, willows, and sparse to dense grasses around lakes, streams, marshes, and springs. Runs of star-nosed moles, both surface and subterranean, were seen commonly in moist areas and were noted in snow, attesting to the winter activity of this species.

A single female obtained on 18 July 1972 had five placental scars (3L-2R), whereas three others collected in June and July evinced no sign of reproductive activity. Testes of adult males showed appreciable regression from July to December, as follows (length × width—actual measurements or mean and number of specimens examined): July, 11 × 6 mm. (1); mid August, 8 × 5.5 mm. (2); late August, 6 × 4 mm. (3); and December, 3 × 2 mm. (1). In New York, *Condylura cristata* was found to have only a single litter a year following mating in early spring; mean litter size was 5.25 (Eadie and Hamilton, 1956).

One adult male obtained on 9 July 1972 was in the process of molting, and adults collected on 27 October and 28 December 1972 were in fresh winter pelage. The remains of a *Condylura* were found in the stomach of a fisher trapped in early February of 1973.

A single species of tick, *Ixodes angustus*, and four species of mites, *Androlaelaps fahrenholzi, Eulaelaps stabularis, Haemogamasus ambulans*, and *Hirstionyssus talpae* were found parasitizing *Condylura cristata* in Cook County. This is the first record of *Androlaelaps fahrenholzi, Eulaelaps stabularis*, and *Hirstionyssus talpae* from star-nosed moles.

ORDER CHIROPTERA
Myotis keenii septentrionalis (Trouessart, 1897)

Keen's Myotis

Specimens examined (5).—Otter Lake, 10 mi. N, 1½ mi. W Hovland, 2; 1 mi. E Mineral Center, 1; 21 mi. N Schroeder, 2.

Myotis keenii, a small brownish bat having long ears, is distributed throughout Minnesota and relatively common in the northeastern part of the state. It is second in abundance only to the little brown bat, which it resembles superficially. However, it is greatly outnumbered by the latter species.

Four adult males and one adult female were collected. Three males and the female were shot early in the evenings of 16-18 August as they foraged for insects along roads and over gravel pits. One male was dislodged from underneath the tarpaper covering of a shack on 4 July 1971. No evidence of molt, reproductive activity, or external parasites was detected from any of the specimens. Testicular measurements of four adult males taken in July and August are as follows: 5 × 3 mm., 5 × 3 mm., 3 × 2 mm., 3 ×—mm. It generally is believed that a single young is born early each summer (Hamilton, 1943). Swanson and Evans (1936) and Rysgaard (1942) occasionally found Keen's myotis hibernating with *Eptesicus fuscus* and *Myotis lucifugus* in the sandstone caves of southern Minnesota.

Myotis lucifugus lucifugus (Le Conte, 1831)

Little Brown Myotis

Specimens examined (24).—6 mi. N, 9 mi. E Grand Marais, 2; Grand Marais, 7; Otter Lake, 10 mi. N, 1½ mi. W Hovland, 4; 15 mi. N, 1 mi. E Lutsen, 1; Caribou Lake, 5 mi. N, ½ mi. E Lutsen, 5; 2½ mi. N, 1½ mi. E Mineral Center, 1; 1¾ mi. N Mineral Center, 2; Pigeon River, SW ¼ sec. 20, T. 64 N, R. 6 E, 1; Carlton Peak, 1 mi. N, 1 mi. W Tofte, 1.

The little brown bat, *Myotis lucifugus*, is the most abundant chiropteran in northeastern Minnesota. This widespread species is found throughout much of North America in a variety of habitats, ranging from arid grasslands to coniferous forests. *Myotis lucifugus* often utilizes attics, shingles, and siding of buildings for daytime retreats. In Cook County, individuals were taken from underneath the tarpaper coverings of shacks, in attics, in exterior opening crevices of log cabins, and foraging over roads.

Five little brown bats were removed from a large colony in an attic in Grand Marais on 3 August 1972. The five included two adult females, each possessing a single placental scar, an apparently nonreproductive adult female, and two volant subadults (1 male and 1 female). Testicular regression during July and August was evident for all males captured in 1972 (Table 4).

An adult male obtained on 6 July was molting. Fat deposits were noted first on individuals captured on 8 August 1972. Ectoparasites collected from the little brown myotis include fleas (*Myodopsylla insignis*), mites (*Spinturnix americanus*), and chiggers (Trombiculidae).

Lasionycteris noctivagans (Le Conte, 1831)

Silver-haired Bat

Specimen examined (1).—Pigeon River, SW ¼ sec. 20, T. 64 N, R. 6 E.

An adult female silver-haired bat was captured in a cabin at the closed border crossing of Pigeon River on 29 August 1972. She evinced no sign of molt or reproductive activity. Although widespread in North America, *Lasionycteris* apparently is uncommon in Cook County. In Sherburne County, Bailey (1929) considered this bat to be outnumbered only by *Myotis lucifugus*.

TABLE 4. Testicular measurements (length and width in mm.) of 11 adult male *Myotis lucifugus* collected in 1972.

Date	Testicular Measurements
6 July	6 × 4
21 July	8 × 5
27 July	7 × 5
28 July	10 × 6
10 August	6 × 4
17 August	6 × 4
19 August	6 × 3
23 August	6 × 4
23 August	5 × 3
25 August	4 × 2
25 August	4 × 3

Perhaps the three tree bats (*Lasionycteris noctivagans*, *Lasiurus borealis*, and *Lasiurus cinereus*) are actually more common than data suggests, largely because they are difficult to detect with the large expanses of forest and water available to them in this area.

Eptesicus fuscus fuscus (Palisot de Beauvios, 1796)

Big Brown Bat

The big brown bat is an uncommon resident of northeastern Minnesota. A bat of this species was roosting with a small colony of *Myotis lucifugus* in an attic at Grand Marais on 23 July 1972. Identification of this bat was certain but it escaped. Peterson (1966) reported *Eptesicus fuscus* in the District of Thunder Bay, Ontario, and Allin (1942) found a colony of big brown bats hibernating in an Ontario cave approximately 60 miles northeast of Grand Portage.

Eptesicus often is found utilizing man-made structures for daytime retreats and for hibernacula. Such habits probably have aided the species to increase its range and numbers. Several studies have been conducted on hibernating *Eptesicus* in central and southern Minnesota (Beer, 1955; Beer and Richards, 1956; Evans, 1934; Goehring, 1954; Goehring, 1971; Goehring, 1972; Rysgaard, 1942; and Swanson and Evans, 1936), but little is known of its movements and natural history elsewhere within the state.

Lasiurus borealis borealis (Muller, 1776)

Red Bat

Specimen examined (1).—9 mi. N, 3½ mi. W Lutsen.

An adult female red bat was shot on 25 August 1972 as she foraged over a gravel road. She contained no embryos or placental scars and was not molting. No other individual having the characteristic flight of this species was observed. Red bats apparently are uncommon summer residents in Cook County (but see account of *Lasionycteris noctivagans*). Cahn (1937) reported this species as common in Quetico Provincial Park, Ontario.

Lasiurus cinereus cinereus (Palisot de Beavois, 1796)

Hoary Bat

Specimen examined (1).—21 mi. N Schroeder.

Lasiurus cinereus is the largest bat that occurs in Minnesota. Like *Lasionycteris* and *Lasiurus borealis*, it is a solitary, tree inhabiting species. One adult female was shot on 30 July 1967 as it foraged over a gravel pit; it displayed no evidence of molt or reproductive activity. Extensive efforts made during the summer of 1972 to net and shoot bats failed to produce additional specimens of this species, which therefore cannot be considered a common species in the area.

Order Lagomorpha

Lepus americanus phaeonotus J. A. Allen, 1899

Snowshoe Hare

Specimens examined (16).—20 mi. NE Grand Marais, 2 mi. W Greenwood Lake, 3; 10 mi. W Grand Marais, 1; Grand Marais, 1 (KU); North Shore, W of Grand Marais, 2; Mount Maud, ½ mi. N, 4 mi. W Grand Portage, 2; McFarland Lake, 14 mi. N, 4 mi. W Hovland, 1; 22 mi. N Schroeder, 1; Sawbill Lake, 22 mi. N Schroeder, 2; 1 mi. N, 1½ mi. E Schroeder, 3.

Additional record.—Grand Marais (UMMZ).

Lepus americanus was found commonly throughout the county. Population densities of this species could not be considered high during the study, but snowshoe hares were seen each of the three summers spent in the field. Tracks in the snow were noted often during the winter. Extreme population fluctuations of this species have been documented by Seton (1909), Keith (1963 and elsewhere), and in Cook County by Cox (1936).

A pregnant adult female carried four embryos (18 mm.), all in the left uterine horn, on 4 July 1972. Two adult females taken on 27 July 1972 were both reproductively active: the first carried a single embryo 62 mm. and had at least two placental scars; the second was lactating and had two placental scars that appeared to be of different ages. An adult female taken 10 August 1966 contained an undeterminable number of placental scars; an adult male taken 18 July 1972 had testes measurements of 30 by 8 mm. Three juveniles are available from the county; two were collected by T. S. Roberts in August of 1879 and the third was obtained on 1 August 1966. Subadults were obtained on 30 July 1967 and 8 and 18 July 1972. The young female from 30 July 1967 and the male from 8 July 1972 were the size of subadults, but molt into the adult pelage was visible. The two reproductively active adult females from 27 July 1972 were completing molt into the adult pelage. Three adults in complete winter pelage were collected on 21 March 1962 and a fourth was obtained on 3 February 1973.

Ectoparasites recovered from this species in Cook County include fleas (*Cediopsylla simplex*, *Tamiophila grandis*, and *Megabothris quirini*) and the common rabbit tick, *Haemaphysalis leporispalustris*.

In Morrison County, Minnesota, pregnant females were found from March through August with an average of 2.84 embryos per female (Aldous, 1937). A large series of *Lepus americanus* was examined for seasonal changes in food habits (Aldous, 1936), and Webb (1937) studied sex ratios over a five-year period for snowshoe hares at this same locality. Rongstad and Tester (1971) investigated maternal behavior of snowshoe hares in south-central Minnesota and damage inflicted on trees by high populations of hares was discussed by Aldous (1947).

Order Rodentia

Tamias striatus griseus Mearns, 1891

Eastern Chipmunk

Specimens examined (27).—Cascade Lookout, 1; 21 mi. N, 2½ mi. W Grand Marais, 3 (1 USNM); North Shore, W of Grand Marais, 3; 1 mi. S, 2½ mi. W Grand Marais, 1 (USNM); 1½ mi. S, 4½ mi. W Grand Marais, 1; 2 mi. N, 2½ mi. E Grand Portage, 1 (USNM); Mount Maud, ½ mi. N, 4 mi. W Grand Portage, 1; 10 mi. N Hovland, 1; 10 mi. N, 2 mi. E Hovland, 1; 4½ mi. N, 1 mi. E Hov-

land, 1; 16 mi. N, 1½ mi. E Lutsen, 1 (USNM); Pigeon River, SW ¼ sec. 20, T. 64 N, R. 6 E, 3; 37 mi. N, 3½ mi. E Schroeder, 1; 22 mi. N Schroeder, 2; 4½ mi. N, 1 mi. W Schroeder, 1; 1 mi. N, 1½ mi. E Schroeder, 2 (1 USNM); 2 mi. S, 2 mi. W Taconite Harbor, 1; Britton Peak, 1 mi. N, ½ mi. W Tofte, 1; 3 mi. N, 1 mi. W Tofte, 1.

Additional records.—Grand Marais (UMMZ).

Tamias striatus was seen frequently in association with pines, spruce, fir, and in the Aspen-Birch community type in northeastern Minnesota. The least chipmunk, *Eutamias minimus*, most often was found in areas disturbed by man (i.e. heavily forested or burned areas), although the two species were occasionally found occupying the same habitat, especially in disturbed hardwood forests and around resorts. A distinct ecological separation was noted between *Tamias* and *Eutamias* where they occur sympatrically in the Itasca State Park region (Forbes, 1966). Johnson (1922) found *Tamias* common in northern Lake County, but Cahn (1937) described eastern chipmunks as being rare in adjacent Canada except near the United States-Canadian boundary.

All adult females collected in 1972 were or had been reproductively active that season as evidenced by embryos or placental scars (Table 5). No female young-of-the-year was found to be reproductively active. Data obtained during this study suggest that a single litter per year is the norm in northeastern Minnesota. A single female obtained on 8 July 1972 had both highly pigmented and lightly pigmented placental scars, but it could not be determined if they represented a single litter in which two embryos had been resorbed or if they were from two separate litters. The only reproductively active male was obtained on 15 April 1972; testes measured 22 × 12 mm., epididymides were highly convoluted, and seminal vesicles were well developed. Other adult and subadult males collected later during the spring and summer were not in breeding condition. In northwestern Minnesota, Forbes (1966) found no indication of late summer breeding or of two litters per year in either *Tamias striatus* or *Eutamias minimus*, albeit several authors have described two breeding seasons for the eastern chipmunk elsewhere in its range (Condrin, 1936; Yerger, 1955; Smith and Smith, 1972; and Pidduck and Falls, 1973). The only available evidence of summer breeding by eastern chipmunks in northern Minnesota is a specimen (12328) captured in Cass County on 16 August 1973. This adult female purportedly was carrying five embryos in the right uterine horn and four embryos in the left horn.

TABLE 5. Reproductive characteristics of adult female *Tamias striatus* from Cook County, Minnesota.

Date	Reproductive Characteristics
3 July 1971	lactating, 6 placental scars (3L—3R)
20 May 1972	undetermined number of placental scars
20 May 1972	lactating, 5 placental scars (3L—2R)
8 July 1972	6 placental scars; 4 highly pigmented (L), 2 lightly pigmented (1L—1R)
8 July 1972	5 embryos (2L—3R)
28 July 1972	2 placental scars (L)
18 Aug 1972	7 placental scars (4L—3R)

Adult summer molt, as described by Howell (1929) and others, was noted on specimens obtained 22 June, 28 July, and 4 August 1972. Post-subadult molt was seen on two eastern chipmunks collected 17 July and on one each on 10 August, 19 August, and 1 September 1972. Eastern chipmunks in the study area were observed feeding on ripe blueberries, ripe thimbleberries, and seeds of Clinton's lily.

Ectoparasites recovered from *Tamias striatus* include *Hoplopleura erratica* (lice); *Ctenophthalmus pseudagyrtes, Tamiophila grandis, Orchopeas caedens, Megabothris acerbus*, and *M. asio* (fleas); and *Ixodes angustus* (a tick).

Eutamias minimus neglectus (J. A. Allen, 1890)
Least Chipmunk

Specimens examined (46).—Caribou River, 1; Cascade Lake, 2; Cross River, 1; Devil Track River, 1; 21 mi. N, 2½ mi. W Grand Marais, 1; 20 mi. N, 6 mi. W Grand Marais, 2; 17 mi. N, 1 mi. W Grand Marais, 3; 13 mi. N, 3 mi. W Grand Marais, 1; North Shore, W of Grand Marais, 1; Grand Marais, 2; 2 mi. N, 2½ mi. E Grand Portage, 2 (USNM); 1½ mi. N, 2 mi. E Grand Portage, 2 (1 USNM); 14 mi. N, 5 mi. W Hovland, 1; 14 mi. N, 3½ mi. W Hovland, 1; 10 mi. N, 2 mi. E Hovland, 1; 8 mi. N, ½ mi. W Hovland, 2 (USNM); 4½ mi. N, 1 mi. E Hovland, 1; 4 mi. NE Hovland, 1; 1 mi. N, 5 mi. W Hovland, 1; Lewis Island, Lake Saganaga, 2; 16 mi. N, 1½ mi. E Lutsen, 1 (USNM); 15 mi. N, 4½ mi. E Lutsen, 1; 14 mi. N, 2 mi. W Lutsen, 1 (USNM); 13 mi. N, 1 mi.

E Lutsen, 2 (1 USNM); Pigeon River, SW ¼ sec. 20, T. 64 N, R. 6 E, 1; 43 mi. N, 1 mi. E Schroeder, 1; 22 mi. N Schroeder, 1; 21½ mi. N Schroeder, 1; 20½ mi. N Schroeder, 2; 4 mi. N, 2 mi. W Schroeder, 1; 1 mi. N, 1½ mi. E Schroeder, 3 (1 USNM); 15 mi. N, 1½ mi. W Tofte, 1; West Devil Track Lake, 1.

Additional records.—Grand Marais (UMMZ).

The least chipmunk is the smallest sciurid found in northeastern Minnesota and one of the smallest in North America. *Eutamias minimus* superficially resembles the eastern chipmunk, but is considerably smaller and has dorsal stripes that extend to the base of the tail, whereas they fade into the reddish rump patch in *Tamias striatus*. Additionally, *Eutamias* has two upper premolars in each toothrow compared to the single one found in *T. striatus*.

Eutamias was common in recently logged or burned areas, in disturbed habitats around campsites and resorts, and along the rocky shore of Lake Superior. Specimens also were obtained in black spruce, black ash, and balsam fir stands. In general, least chipmunks appeared to occupy earlier successional habitat stages than did eastern chipmunks; the least chipmunk appeared to be completely replaced by the eastern chipmunk in stands of mature pine. Johnson (1922) considered *E. minimus* to be more common than *T. striatus* in Lake County, and Cahn (1937) found it abundant in Quetico Provincial Park.

All adult female *Eutamias minimus* were reproductively active each year, as indicated by placental scars or corpora lutea (Table 6), but no young of the year evinced reproductive activity. Forbes (1966) found no indication of a second annual litter being produced by this chipmunk at Itasca State Park.

The last premolar and the first molar are missing from the left dentary of an adult male obtained on 17 July 1971; the two teeth apparently were never present. Least chipmunks were observed feeding upon ripe blueberries and ripe thimbleberries during the summer of 1972.

Ectoparasites recovered from this species include lice (*Hoplopleura arboricola*), fleas (*Ctenophthalmus pseudagyrtes, Orchopeas caedens, Megabothris acerbus, Megabothris asio, Megabothris quirini,* and *Monophyllus eumolpi*), and mites (*Androlaelaps fahrenholzi*).

TABLE 6. Reproductive characteristics of adult female *Eutamias minimus* from Cook County, Minnesota.

Date of Capture	Reproductive Characteristics
2 July 1967	5 placental scars (2L-3R)
20 June 1972	5 placental scars (4L-1R)
9 July 1972	4 placental scars (L)
27 July 1972	3 corpora albicantia (L)
9 August 1972	7 corpora albicantia (3L-4R)
18 August 1972	4 placental scars (1L-3R)
19 August 1972	3 placental scars; 1 highly pigmented (L), 2 lightly pigmented (1L-1R)

Marmota monax canadensis (Erxleben, 1777)
Woodchuck

Specimens examined (2).—21 mi. N Schroeder, 1; North Shore, West of Grand Marais, 1.

The woodchuck is widely distributed in Cook County; however, it cannot be considered abundant. In addition to the two specimens examined, three sight records were noted during the summers of 1971 and 1972 (8 mi. north and ½ mi. west of Hovland; 10½ mi. north of Lutsen; and 15 mi. north and 1½ mi. west of Tofte).

An adult female taken on 4 July 1972 was lactating and had six highly pigmented placental scars (2L-4R). She was not molting. The second animal, a young of the year obtained in 1879, was molting into its adult pelage. Several specimens of the widespread mite, *Androlaelaps fahrenholzi*, were the only ectoparasites found on the adult.

Sciurus carolinensis hypophaeus Merriam, 1886
Gray Squirrel

Although specimens of gray squirrels are not available from Cook County, individuals are found occasionally in the Coastal Hills area. Local residents near Schroeder and Taconite Harbor reported that gray squirrels were very rare, but occasionally were shot during hunting season. Sight records from Tofte, Lutsen, and Grand Marais were reported to me. Gunderson and Beer (1953) listed a sight record from the county but gave no details. This record probably originated from Gunderson's field notes, which state that a resident reported sighting a gray squirrel near Grand Marais.

Tamiasciurus hudsonicus hudsonicus (Erxleben, 1777)

Red Squirrel

Specimens examined (45).—Mouth of Cascade River, 1; 20 mi. N, 6 mi. W Grand Marais, 2; 17 mi. N, 1 mi. W Grand Marais, 1; 2½ mi. N, 3 mi. E Grand Marais, 1 (USNM); North Shore, W of Grand Marais, 3; Grand Portage, 1; 12 mi. N, 3 mi. W Hovland, 1; 11 mi. N, 2 mi. W Hovland, 1; Otter Lake, 10 mi. N, 1½ mi. W Hovland, 1; 9½ mi. N, 2 mi. W Hovland, 1; 3 mi. N Hovland, 1; ¾ mi. S, 1 mi. W Hovland, 1; 30 mi. N, 2 mi. E Lutsen, 2; 15 mi. N, ½ mi. E Lutsen, 1; 9 mi. N, 3½ mi. W Lutsen, 1; Lutsen, 2 (USNM); 1½ mi. S, 3 mi. W Lutsen, 1; 1 mi. S, 1 mi. W Pigeon River, SW ¼ sec. 20, T. 64 N, R. 6 E, 1; 1½ mi. S, ½ mi. W Pigeon River, NW ¼ sec. 36, T. 64 N, R. 5 E, 1; Islands in Lake Saganaga, 1; 22 mi. N Schroeder, 1; 21½ mi. N Schroeder, 1; 21 mi. N Schroeder, 2; 16½ mi. N, ½ mi. E Schroeder, 1; 4½ mi. N, 1 mi W Schroeder, 1; 4 mi. N, 2 mi. W Schroeder, 1; 3½ mi. W Schroeder, 3 (2 USNM); 15 mi. N, 2 mi. W Tofte, 5; Britton Peak, 1 mi. N, ½ mi. W Tofte, 1; Tofte, 3 (USNM).

The red squirrel is doubtlessly the most abundant and widespread sciurid found in northeastern Minnesota. It was found commonly throughout Cook County during the entire study period, and W. J. Breckenridge's field notes report red squirrels as being common there in 1938 and in 1947. Johnson (1922) considered them widespread but not plentiful in adjacent Lake County; Cahn (1937) noted that *Tamiasciurus hudsonicus* was the only diurnal tree squirrel in Quetico Provincial Park, where it was especially common in jackpine forests.

Only four female red squirrels examined from the county possessed placental scars as evidence of past pregnancy. Dates of capture and location of scars include: 9 August 1966, 2L-2R; 17 July 1971, 2L-3R; 5 July 1972, 1L-2R; and 17 August 1972, 2L-2R. The mean and modal litter size of this small sample was four. No female appeared to have had two litters, and no juveniles were noted in the population after July. Two litters per summer have been reported for red squirrels in many areas (Millar, 1970; and other authors), but this evidently is not the case in northeastern Minnesota. Testes of adult males were large through the first weeks in June, but regressed later in the month and remained small throughout the summer.

Seasonal molt in red squirrels from northeastern Minnesota has been described briefly by Nelson (1945). He found a great deal of individual variation in the date of onset and duration of molt: in general, vernal molt began at the nose and progressed to the tail, whereas autumnal molt began at the base of the tail and proceeded forward. Specimens collected from Cook County on 19 June 1922, 2 and 3 July 1967, 20 and 21 May 1972, and 5 July 1972 were in the process of molting into the summer pelage. The specimen from 21 May had essentially completed the vernal molt except for a small area near the base of the tail. Progression of molt on the squirrel from 20 May was only about one-third of the way down the back. Both were reproductively inactive adult females. Molt into winter pelage, beginning at the rump, was noted on a specimen from 2 September 1966, and on a series of six specimens from 22 September 1972. Red squirrels from 16 April and 28 December 1972 were in winter pelage, whereas a large series from July and August were in summer pelage.

Remains of a red squirrel were found in the stomach of a marten (*Martes americana*) taken on 14 December 1972. A feeding relationship between red squirrels and yellow-bellied sapsuckers on jackpine sap was noted by Hatfield (1937) in Carlton County and by Coulter (1961) at Itasca State Park. The taxonomy of *Tamiasciurus hudsonicus* in the Lake Superior region has been discussed by Nelson (1945) and Kramm *et al.* (1975).

Ectoparasites recovered from red squirrels in Cook County included the following: lice (*Neohaematopinus semifasciatus*), fleas (*Monopsyllus vison* and *Orchopeas caedens*), ticks (*Ixodes angustus* and *I. muris*), and mites (*Androlaelaps fahrenholzi, Haemogamasus ambulans,* and *H. reidi*).

Glaucomys sabrinus sabrinus (Shaw, 1788)

Northern Flying Squirrel

Specimens examined (2).—4 mi. N, 6 mi. E Grand Marais, 1; Islands in Lake Saganaga, 1.

Despite the paucity of voucher specimens, the northern flying squirrel undoubtedly is widely distributed in Cook County. The limited number of specimens probably reflects the difficulty in obtaining flying squirrels. Local residents reported them as common in several areas, especially in the Coastal Hills region near Lake Superior.

Surber's field notes for 1922 state that flying squirrels were especially common near the mouth of the Cascade River, the lower Poplar River, and north of Tofte. Cahn (1937) considered the northern flying squirrel common in Quetico Provincial Park, and Johnson (1922) made similar conclusions for northern Lake County, although neither obtained many documented records.

An adult female trapped in a balsam fir-sugar maple stand on 24 August 1972 evinced no sign of reproductive activity or molt. Fleas (*Orchopeas leucopus* and *Opisodasys pseudarctomys*), lice (*Neohaematopinus sciuropteri*), and mites (*Haemogamasus ambulans*) were recovered from this specimen.

Castor canadensis canadensis Kuhl, 1820
Beaver

Specimen examined (1).—Grand Portage Indian Reservation.

Beaver have played a major role in shaping the post-Columbian history of this area, more so than any other non-human animal. Early exploration and settlement in the county revolved primarily around securing and trading beaver pelts. Some of the abuses and other items of historical interest regarding beaver in northeastern Minnesota and adjacent Ontario were discussed by Cahn (1937), Erickson (1939), and Longley and Moyle (1963).

Castor canadensis occurs throughout Cook County. The single specimen examined is a skull obtained from a trapper on the Grand Portage Indian Reservation. The following localities were sites of active beaver colonies seen during the summer of 1972: 18 mi. north and 5 mi. west of Grand Marais; 9 mi. north and 2½ mi. west of Hovland; 15½ mi. north and 1 mi. east of Lutsen; and 15 mi. north and 3½ mi. east of Lutsen. Byman (1972) frequently found remains of beaver in wolf scats collected in Cook and Lake counties.

Peromyscus maniculatus gracilis (Le Conte, 1855)
Deer Mouse

Specimens examined (299).—Brule Lake, 2; Lower Brule Lake, 2; Caribou River, 2; Cascade Lake, 3 (1 KU); Cascade Lookout, 3 (1 KU); Cascade River, near Eagle Mountain, 1; Mouth of Cascade River, 2 (1 KU); Cross River, 4; Four Mile Lake, 4; 19 mi. N, 4 mi. W Grand Marais, 1; 18 mi. N, 4 mi. E Grand Marais, 4; 17 mi. N, 1 mi. W Grand Marais, 2; 16 mi. N, 2 mi. E Grand Marais, 3; 15 mi. N, 1 mi. E Grand Marais, 2; 13 mi. N, 1 mi. E Grand Marais, 5; Kimball Lake, 8 mi. N, 5 mi. E Grand Marais, 7; 4 mi. N, 11 mi. E Grand Marais, 2; 2 mi. N, 3 mi. E Grand Marais, 1; 1½ mi. N, 1 mi. E Grand Marais, 3; Grand Marais, 8 (7 UMMZ); North Shore, W of Grand Marais, 12; ½ mi. S, 1 mi. W Grand Marais, 2; 2 mi. N, 2½ mi. E Grand Portage, 5; Mt. Maud, 1 mi. N, 4 mi. W Grand Portage, 4; ½ mi. N, 4 mi. W Grand Portage, 1; ½ mi. N, 1 mi. W Grand Portage, 3; Mt. Rose, Grand Portage, 2; Grand Portage, 4; Horseshoe Lake, 1; 14 mi. N, 5 mi. W Hovland, 5; 12 mi. N, 3 mi. W Hovland, 1; Otter Lake, 10 mi. N, 1½ mi. W Hovland, 5; 10 mi. N, 2 mi. E Hovland, 9; 3½ mi. N, 1 mi. W Hovland, 10; 3 mi. N, 1 mi. W Hovland, 8; 3 mi. N Hovland, 1; 2½ mi. N, 5 mi. E Hovland, 2; 2 mi. N, 5 mi. W Hovland, 1; 4 mi. NE Hovland, 2; 2 mi. S, 4 mi. W Hovland, 1; 30 mi. N, 2 mi. E Lutsen, 1; 15½ mi. N, 1 mi. E Lutsen, 1; 9 mi. N, 3½ mi. W Lutsen, 2; 8 mi. N, 1½ mi. W Lutsen, 1; 1½ mi. N, 4¼ mi. W Lutsen, 8; 5 mi. W Lutsen, 1; Onion River, 1½ mi. S, 4½ mi. W Lutsen, 5; 2½ mi. N, 1 mi. E Mineral Center, 3; 2 mi. W Mineral Center, 4; Northern Light Lake, 1; Pigeon River, SW ¼ sec. 20, T. 64 N, R. 6 E, 19; Poplar River, 3; 40 mi. N, 3 mi. E Schroeder, 1; 37 mi. N, 3½ mi. E Schroeder, 9; 22 mi. N Schroeder, 11; 21 mi. N Schroeder, 3; 5 mi. N, 2 mi. E Schroeder, 2; 4½ mi. N, 1 mi. W Schroeder, 2; Temperance River, 1 mi. N, 1 mi. E Schroeder, 1; 1 mi. N, 1½ mi. E Schroeder, 10; 4 mi. W Schroeder, 4; 3½ mi. W Schroeder, 12; 3 mi. W Schroeder, 2; 2 mi. S, 2 mi. W Taconite Harbor, 15; 2½ mi. S, 3 mi. W Taconite Harbor, 2; N of Temperance River, 1; Temperance River, 2; Mouth of Temperance River, 2; 15 mi. N, 1½ mi. W Tofte, 1; 3 mi. N, 1 mi. W Tofte, 1; 2½ mi. N, 1 mi. W Tofte, 2; Britton Peak, 1 mi. N, 1 mi. W Tofte, 3; Carlton Peak, 1 mi. N, 1 mi. W Tofte, 22; W Devil's Track Lake, 2.

The deer mouse, *Peromyscus maniculatus gracilis*, is undoubtedly the most abundant and widespread mammal in Cook County. It was trapped commonly in most habitat types during all seasons of the year. Large cattail, sedge, and sphagnum marshes were the only habitats where *Peromyscus* was conspicuously absent; however, they usually could be collected along the periphery of these marshes. Deer mice were common in the Aspen-Birch community type along the north shore of Lake Superior, especially in areas of habitat disturbance by man and along rocky outcrops. *Peromyscus* appeared to be the most common small mammal at several localities; for example, at Carlton Peak, 1 mi. north and 1 mi. west of Tofte, elevation 1526', 22 *Peromyscus maniculatus* and one *Napaeozapus insignis* were the

only mammals trapped in birch forest on 7 July 1972. Success in trapping deer mice during the winter was highly variable. It appeared as if they were relatively inactive during periods of inclement weather; almost no mice were taken, even in protected areas, during severe snow storms or periods of extremely cold temperatures. Trapping during milder winter conditions generally was productive.

Data on reproduction were obtained from 234 deer mice, trapped during all seasons of the year. Of the 208 individuals collected during this study, 88 were females (42.3%) and 120 were males (57.7%). Reproductive data are available from a total of 92 female deer mice from Cook County; 39 of these had embryos or placental scars. The mean ± S.E. (and range) number of embryos calculated for six pregnant females was 5.2 ± .54 (3-7) (see Table 7). Several others had active corpora lutea, but implanted embryos were not detected.

Thirty-five mice retained placental scars as evidence of past reproductive activity. Of these, 14 had scars that appeared to be of two ages and two pregnant females also possessed placental scars, indicating that two litters per season is not uncommon. Evidence of a second litter during the summer was found in both subadults and adults. No females examined during this study were judged to have had three litters.

The youngest breeding females had not completed molt from the light gray juvenile pelage into the grayish-brown subadult pelage. Breeding appeared to cease in August; no pregnant females were collected in September and few were taken in August, even though large samples were available for both months. Mean testicular lengths and widths for summer-captured, subadult and adult males include: 11.7 × 8.0 mm. (N = 6), June; 7.6 × 4.6 mm. (N = 35), July; and 4.4 × 2.6 mm. (N = 47), August.

All *Peromyscus* captured on 15-16 April 1972 were reproductively active. Testicular length and width of 14 males averaged 12.1 × 7.8 mm. and all had highly convoluted epididymides and well developed seminal vesicles. Seven females trapped during this period appeared to be at the instigation of breeding. All had big, fresh corpora lutea and highly vascularized uteri. Minute, implanted embryos were observed in one, but it could not be determined if the others had mated. A female with near term embryos (5 embs. 12 mm. long) and two others having striated placental scars (evidence of recent

TABLE 7. Characteristics of all reproductively active female *Peromyscus maniculatus gracilis* available from Cook County, Minnesota. If more than one litter was present, the number of placental scars present from the earliest litter is indicated on the following line. A question mark following the number of corpora lutea (or mature follicles) denotes uncertainty in count. Deer mice captured between mid-September and mid-March never evinced reproductive activity.

Date	Embryos	Placental Scars	Corpora Lutea or Mature Follicles
24 March 1973	3L-2R x 4.0 mm.	—	3L-2R
24 March 1973	—	—	3L-3R
24 March 1973	—	—	5L-5R
16 April 1972	—	—	2L-4R
16 April 1972	—	—	2L-3R
16 April 1972	—	—	2L-3R
16 April 1972	—	—	3L-3R
16 April 1972	—	—	3L-4R
16 April 1972	—	—	4L-4R
21 May 1972	—	2L-4R	2L-4R
21 May 1972	3L-2R x 12 mm.	—	3L-2R
21 May 1972	—	2L-3R	2L-3R
1 July 1951	3L-4R x 5.0 mm.	?	?
5 July 1972	—	1L-3R 4L-0R?	3L-3R
6 July 1972	—	2L-2R ?L-?R	4L-2R
6 July 1972	—	2L-4R 2L-4R	3L-3R
8 July 1972	—	4L-1R	4L-1R
9 July 1972	—	4L-0R 1L-5R	2L-3R
9 July 1972	0L-3R x 16 mm.	—	2L-3R
20 July 1972	—	4L-1R 4L-1R	3L-4R
29 July 1972	—	3L-3R 4L-2R	3L-3R
30 July 1967	—	2L-3R	?
1 Aug. 1972	—	3L-2R 4L-1R	3L-2R
2 Aug. 1972	—	3L-4R	3L-4R
9 Aug. 1972	—	2L-0R 2L-2R	3L-1R
10 Aug. 1966	—	2L-3R	?
10 Aug. 1973	—	3L-0R	4L-2R
12 Aug. 1966	—	3L-3R	?
12 Aug. 1966	—	4L-1R	?
16 Aug. 1972	—	3L-2R 2L-1R	3L-2R
16 Aug. 1972	—	3L-2R	3L-4R
16 Aug. 1972	—	2L-2R 4L-0R	5L-4R?
17 Aug. 1972	—	3L-1R 4L-4R	3L-1R
17 Aug. 1972	—	2L-3R	2L-4R
17 Aug. 1972	—	3L-3R	3L-3R?
19 Aug. 1972	—	2L-3R 1L-2R	3L-2R
23 Aug. 1972	—	4L-4R	4L-4R
25 Aug. 1972	—	2L-3R 2L-2R	2L-3R
25 Aug. 1972	—	1L-5R 3L-1R	0L-6R
31 Aug. 1966	3L-3R x 11.0 mm.	—	?
31 Aug. 1972	—	5L-1R	5L-1R
31 Aug. 1972	—	2L-3R	2L-3R
31 Aug. 1972	—	1L-3R	2L-2R
1 Sept. 1972	—	1L-3R	1L-3R
2 Sept. 1966	—	2L-4R	?

parturition) were obtained on 21 May 1972. March 24 was the earliest day on which a pregnant female was trapped in 1973. Other females from that trapping period had enlarged ovarian structures, but their stage of development appeared by gross analysis more like mature follicles than fresh corpora lutea. Uterine development also appeared less than that of recently impregnated animals. Although the data are meager, it appears that breeding began a month earlier in the spring of 1973 than it did in 1972, and that breeding was more synchronous in 1972 than in 1973. It is of interest that the first warm days in the spring of 1972 fell on the 15th and 16th of April when the temperature reached the low 60's, whereas the spring of 1973 was considerably warmer and milder.

No evidence of fall or early- to mid-winter breeding in deer mice was observed. Males captured during these seasons had small testes, small, non-convoluted epididymides, and minute seminal vesicles. Females were not pregnant and showed no indication of recent reproductive effort, i.e., mammae were minute, ovaries appeared to be inactive, and none of the placental scars observed appeared to be recent. All deer mice captured in winter and early spring were judged to be adults on the basis of pelage and size, providing additional evidence of early and complete cessation of breeding. Juvenile mice first appeared in the traps in mid-June. Ten percent of the *Peromyscus* taken in June were either in juvenile pelage or molting from that into the subadult pelage. In July, 47.9 percent were juveniles, whereas only 13.0 percent of the August sample were in this age group. The reduced number of juveniles in August reflects the decreased reproductive effort in late summer. *Peromyscus maniculatus* in juvenile pelage were not trapped between September and May. No deer mice in complete adult pelage were found among specimens collected between early August and late September in Cook County. Apparently all individuals greater than one year of age have died by this time. A few mice trapped in late September were molting into the adult coat, but most appeared to enter winter in subadult pelage.

Ectoparasites recovered from deer mice include: lice (*Hoplopleura hesperomydis*); fleas (*Hystrichopsylla dippiei, Eptedia wenmanni, Ctenophthalmus pseudagyrtes, Orchopeas leucopus, Megabothris quirini, Monopsyllus vison, Monopsyllus wagneri,* and *Peromyscopsylla catatina*); mites (*Eulaelaps stabularis, Androlaelaps fahrenholzi,* and *Haemogamasus ambulans*); chiggers (Trombiculidae); and ticks (*Ixodes angustus*). A subadult *Peromyscus maniculatus* was found in the stomach of a juvenile red fox (*Vulpes vulpes*) on 18 August 1972.

Clethrionomys gapperi gapperi (Vigors, 1830)

Gapper's Red-backed Mouse

Specimens examined (155).—Caribou River, 2; Cascade Lookout, 7; N of Cascade River, 2; Mouth of Cascade River, 2; Echo Lake, 1; Four Mile Lake, 1; 20 mi. N, 6 mi. W Grand Marais, 9; 18 mi. N, 4 mi. E Grand Marais, 2; 17 mi. N, 1 mi. W Grand Marais, 9; 16 mi. N, 2 mi. E Grand Marais, 1; 15½ mi. N, 7 mi. E Grand Marais, 1; 15 mi. N, 1 mi. E Grand Marais, 2; 13 mi. N, 3 mi. W Grand Marais, 1; 13 mi. N, 1 mi. E Grand Marais, 4; Kimball Lake, 8 mi. N, 5 mi. E Grand Marais, 1; 4 mi. N, 6 mi. E Grand Marais, 1; 2½ mi. N, 8½ mi. W Grand Marais, 1; 1½ mi. N, 10 mi. W Grand Marais, 1; North Shore W of Grand Marais, 3; Grand Marais, 1; ½ mi. N, 1 mi. W Grand Portage, 1; Mt. Rose, Grand Portage, 1; Grand Portage, 3; 14 mi. N, 5 mi. W Hovland, 1; Otter Lake, 10 mi. N, 1½ mi. W Hovland, 2; 3½ mi. N, 1 mi. W Hovland, 1; 3 mi. N, 1 mi. W Hovland, 3; 3 mi. N, 1 mi. E Hovland, 2; 3 mi. NE Hovland, 1; ¾ mi. S, 1 mi. W Hovland, 2; 2 mi. S, 4 mi. W Hovland, 1; 30 mi. N, 2 mi. E Lutsen, 7; 15 mi. N, 4½ mi. E Lutsen, 2; 14½ mi. N, 1 mi. W Lutsen, 1; 13 mi. N, 4½ mi. W Lutsen, 1; 9 mi. N, 3½ mi. W Lutsen, 2; 1½ mi. N, 4¼ mi. W Lutsen, 2; 2½ mi. N, 1 mi. E Mineral Center, 1; Pigeon River, SW ¼ sec. 20, T. 64 N, R. 6 E, 8; 43 mi. N, 1 mi. E Schroeder, 3; 40 mi. N, 3 mi. E Schroeder, 1; 39 mi. N, 3½ mi. E Schroeder, 2; 37 mi. N, 3½ mi. E Schroeder, 1; Alton Lake, 23 mi. N, 1 mi. W Schroeder, 2; 22 mi. N Schroeder, 18; 5 mi. N, 2 mi. E Schroeder, 2; 4½ mi. N, 1 mi. W Schroeder, 3; 2 mi. N Schroeder, 1; 1 mi. N, 1½ mi. E Schroeder, 3; Swan Lake, South Brule River, 1; 2 mi. S, 2 mi. W Taconite Harbor, 10; 15 mi. N, 2 mi. W Tofte, 9; 3 mi. N, 1 mi. W Tofte, 1; Britton Peak, 1 mi. N, ½ mi. W Tofte, 2; Tofte, 2.

Additional records.—Grand Marais (UMMZ).

Clethrionomys gapperi is a common and widespread microtine rodent in Cook County. It was trapped most often in the Fir-Birch, Aspen-Birch, Maple-Aspen-Birch, and the Black Spruce community types. *Blarina brevicauda* and *Sorex cinereus* frequently were caught in the same trap line with red-backed mice. Population densities of *C. gapperi* did not appear high at most

localities as only a few specimens usually were taken from a trap line.

Adult red-backed mice in reproductive condition were taken from 21 May through 21 September in 1972. A mean ±S.E. (and range) of 5.2 ± .22 (3-7) embryos was calculated for twenty pregnant females. Fifteen additional females contained placental scars as evidence of previous litters. Placental scars of two age groups were observed in four females. One adult trapped on 31 August 1972 appeared to have scars of three ages. Of the pregnant females, four also had visible placental scars. Apparently two litters per year is not uncommon and there is evidence that some females have three litters. Mean testes length and width (N in parentheses) of subadult and adult male *Clethrionomys* for the spring and summer include: 10.0 × 6.5 mm. (2) in April; 11.8 × 8.2 mm. (5) in May; 12.0 × 8.0 mm. (5) in June; 11.5 × 7.5 mm. (21) in July; 11.8 × 8.2 mm. (15) in August.

Molting adults were trapped on 3 July 1967; 20 May, 21 June, and 3 July 1972; and on 9 August 1973. Individuals molting from the juvenile pelage were trapped on 15 June and 16 and 24 July 1922; 2 July 1951; 3 July 1967; and 5 and 9 July, 31 August, and 1 and 21 September 1972. Ectoparasites recovered from red-backed mice include fleas (*Atyphloceras bishopi, Stenoponia americana, Catallagia borealis, Ctenophthalmus pseudagyrtes, Orchopeas leucopus, Megabothris quirini,* and *Peromyscopsylla catatina*), lice (*Hoplopleura acanthopus*), mites (*Androlaelaps fahrenholzi, Eulaelaps stabularis, Haemogamasus ambulans,* and *H. liponyssoides*), chiggers (Trombiculidae), and ticks (*Ixodes angustus*). This is the first record of *Eulaelaps stabularis* parasitizing *C. gapperi.*

Microtus chrotorrhinus chrotorrhinus (Miller, 1894)

Rock Vole

Specimens examined (2).—17 mi. N, 1 mi. W Grand Marais.

The two specimens of *Microtus chrotorrhinus* from Cook County represent the second and third records of this species in Minnesota (Timm, 1974). Minnesota's first rock vole was collected in 1921 near Burntside Lake in St. Louis County by Vernon Bailey (Swanson, 1945). A specimen from Ely was reported by Swanson to be a rock vole, but later was reidentified as a heather vole, *Phenacomys intermedius* (Handley, 1954). It remains as the single record for that species from the state.

The two specimens of *Microtus chrotorrhinus* were trapped on 9 and 10 August 1973. Details of the habitat were described elsewhere (Timm, 1974), but generally it was a long narrow accumulation of boulders (frost-fracture rock outcrop) supporting dominant vegetation of dry lichens, the most common of which was reindeer moss (*Cladonia*). Balsam fir, black spruce, white-cedar, white pine, aspen, paper birch, mountain maple, prickly rose (*Rosa acicularis*), blueberries (*Vaccinium*), and red raspberries (*Rubus strigosus*) grew among the moss-covered rocks near the edge of the rock stream (see Fig. 3). The adjacent forested area also included thimbleberry (*Rubus parviflorus*), bunchberry (*Cornus canadensis*), Clinton's lily (*Clintonia borealis*), and clubmoss (*Lycopodium*). A lactating female taken on 9 August had seven placental scars of two age groups. The other specimen was a non-breeding, subadult male with testes 4 by 3 mm. Neither animal appeared to be molting.

Ectoparasites were identified as: fleas (*Peromyscopsylla catatina* and *Megabothris quirini*), mites (*Laelaps alaskensis* and *L. kochi*), ticks (*Ixodes angustus*), and chiggers (Trombiculidae). This record represents the first time *Ixodes angustus,* a relatively common tick on small mammals, has been identified as being parasitic on *Microtus chrotorrhinus.* External and selected cranial measurements of the two voles were provided by Timm (1974).

The distribution of these rare voles is typically spotty throughout their range, but it is possible they occur at other localities within the county. Trapping was conducted in all other frost-fracture rock outcrops noted during the study, but no additional rock voles were captured. Most rock outcrops were considerably smaller in size than the one discussed above, and perhaps they do not contain sufficient habitat to sustain populations of this species.

Microtus pennsylvanicus pennsylvanicus (Ord, 1815)

Meadow Vole

Specimens examined (140).—Cascade Lake, 1; Cascade River, near Eagle Mountain, 10; Cross River, 2; Four Mile Lake, 6; 18 mi. N, 4 mi. E Grand Marais, 1; 17 mi. N, 3 mi. W Grand Marais, 2; 15½ mi. N, 6 mi. E Grand Marais, 1; 15 mi. N, 1 mi. E Grand Marais, 1; 13½ mi. N, 4½ mi. W Grand Marais, 5; 6 mi. N, 9 mi. E Grand Marais, 1; 1½ mi. N, 5 mi. W Grand Marais, 1; 6 mi. W Grand Marais, 4; North Shore, W of Grand Marais, 1; 2 mi. N, 4 mi. E Grand Portage, 2; Grand Portage, 8; 1½ mi. S, 2 mi. W Grand Portage, 1; 2 mi. S, 5½ mi. W Grand Portage, 1; 14 mi. N, 3½ mi. W Hovland, 1; 12 mi. N, 3 mi. W Hovland, 1; 11 mi. N, 3 mi. W Hovland, 2; Otter Lake, 10 mi. N, 1½ mi. W Hovland, 1; 4½ mi. N, 1 mi. E Hovland, 3; Islands in Lake Saganaga, 2; 30 mi. N, 2 mi. E Lutsen, 2; 15½ mi. N, 1 mi. E Lutsen, 2; 9 mi. N, 3½ mi. W Lutsen, 1; 8 mi. N, 1½ mi. W Lutsen, 1; 5 mi. W Lutsen, 2; Mineral Center, 2; ½ mi. E Mineral Center, 1; 1 mi. E Mineral Center, 2; Pigeon River, SW ¼ sec. 20, T. 64 N, R. 6 E, 6; Poplar River, 1; 40 mi. N, 3 mi. E Schroeder, 1; 38½ mi. N, 4½ mi. E Schroeder, 2; 37½ mi. N, 4 mi. E Schroeder, 4; 37 mi. N, 7½ mi. E Schroeder, 7; 37 mi. N, 14 mi. E Schroeder, 5; 22 mi. N Schroeder, 1; 21 mi. N Schroeder, 11; 4½ mi. N, 1 mi. W Schroeder, 6; 4 mi. N, 5 mi. W Schroeder, 3; 2 mi. N Schroeder, 1; 1 mi. N, 1½ mi. E Schroeder, 16; 4 mi. W Schroeder, 1; Temperance River, 1; 15 mi. N, 2 mi. W Tofte, 2; Britton Peak, 1 mi. N, ½ mi. W Tofte, 1.

Microtus pennsylvanicus was relatively abundant in northeastern Minnesota during this study. Mesic habitats, especially cattail marshes, sphagnum bogs, and dense stands of grass and sedges around standing water, generally supported high populations of meadow voles. They also were found in drier upland communities, including meadows and grassy road ditches, but they were relatively less abundant in such habitats. *Microtus pennsylvanicus* was never taken in dense upland forests, as was the congeneric *M. chrotorrhinus*. Populations numbers were not estimated precisely, but densities did not appear to approach the 50-60 animals per acre that have been reported by Golley (1961) and others.

Reproductive data are available for 115 individuals, including representatives from all seasons. Of the 104 meadow voles collected during this investigation, 64 were males and 40 were females. During the summer months, all females trapped that were under 24 g. were nulliparous and all those over 24 g. were reproductively active. The mean litter size as judged by embryo counts of 16 pregnant females was 5.25 (range, 4-7) (Table 8). Fifteen individual, non-pregnant females averaged 5.41 placental scars per litter in an estimated 17 litters. Placental scars in three of these females were thought to represent two separate litters and a single, lactating female was believed to have had placental scars of three ages. Three pregnant females also had placental scars. Fifty percent of the females that displayed reproductive activity, trapped on and after 5 July 1972 had produced two litters during the summer as determined by the presence of placental scars and embryos. Evidently two litters per summer is common and some females may produce three litters in Cook County during the breeding season.

No evidence of winter breeding, as has been observed elsewhere (Keller and Krebs, 1970), was found. All *M. pennsylvanicus* trapped during the winter and spring were adults. In 1972 the first pregnant females were captured on 21 May. Juveniles first were noted in early June. Testes, seminal vesicles, and epididymides were not fully developed on adult males collected in mid-April, but their development appeared complete on all adult males trapped after mid-May. Mean testicular measurements (and sample size) for summer caught adult males were: 15.0 × 9.6, (13) in June; 15.2 × 10.1, (13) in July; and 14.5 × 9.1, (8) in August. Reproductive data for all primiparous and multiparous females is summarized in Table 8.

The taxonomy of *Microtus pennsylvanicus* in northeastern Minnesota is poorly understood. Hall and Cockrum (1953) and Hall and Kelson (1959) designated the United States-Canadian border as the boundary between *M. p. drummondii*, the northern subspecies, and *M. p. pennsylvanicus*, the southern subspecies. Early descriptions of these two subspecies are vague; however, *M. p. pennsylvanicus* is considered the larger of the two. Cranial measurements, mean, range, and N, for adult meadow voles from Cook County include: condylobasal length, 25.1, (23.1—27.5), 43; zygomatic breadth, 13.9, (12.4—15.3), 47; interorbital constriction, 3.5, (3.3—3.8), 50; lambdoidal breadth, 11.2, (10.1—12.1), 47; length of nasals, 6.8, (5.9—7.7), 45; length of maxillary toothrow, 6.0, (5.4—6.5), 49. These measurements are

TABLE 8. Characteristics of all reproductively active female *Microtus pennsylvanicus pennsylvanicus* available from Cook County, Minnesota. If more than one litter was present, the number of placental scars present from the earliest litter is indicated on the following line. A question mark following the number of corpora lutea denotes uncertainty in count. Meadow voles captured between September and mid-May evinced no reproductive activity.

Date	Embryos	Placental Scars	Corpora Lutea
21 May 1972	3L-1R x 9.0 mm.	—	4L-1R
21 May 1972	2L-2R x 7.0 mm.	—	2L-2R
22 June 1972	2L-4R x 0.5 mm.	—	2L-4R
22 June 1972	2L-4R x 7.0 mm.	—	2L-4R
22 June 1972	—	3L-3R	3L-3R
23 June 1972	2L-2R x 16.0 mm.	—	?
3 July 1967	3L-3R x ?	—	?
4 July 1972	3L-1R x 6.0 mm.	—	3L-1R
5 July 1972	4L-2R x 23.0 mm.	—	4L-2R
5 July 1972	1L-4R x 9.0 mm.	—	1L-4R
7 July 1972	—	3L-3R	?
9 July 1972	—	3L-3R	3L-3R
17 July 1971	3L-4R x 8.0 mm.	—	?
17 July 1971	2L-2R x 9.0 mm.	—	?
17 July 1971	3L-4R x 6.0 mm.	4L-5R	3L-4R
18 July 1971	—	3L-3R	?
18 July 1971	—	3L-3R	?
18 July 1971	—	4L-1R 1L-?R	?
20 July 1971	3L-3R x 18.0 mm.	—	3L-3R
27 July 1972	—	3L-3R 4L-4R	3L-3R
1 Aug. 1972	3L-2R x 16.0 mm.	—	3L-2R
9 Aug. 1972	—	4L-0R	4L-0R
17 Aug. 1972	—	3L-2R 2L-0R	3L-2R
17 Aug. 1972	—	2L-2R 7L-3R	? total of three litters
18 Aug. 1972	—	2L-3R 2L-4R	?
19 Aug. 1972	—	3L-1R	3L-1R
25 Aug. 1972	2L-2R x 9.0 mm.	3L-1R	1L-3R

about midway between those given by Bailey (1900) for *M. p. drummondii* and *M. p. pennsylvanicus*. It is most likely that meadow voles from Cook County represent an intergradation between the two subspecies.

Maturational molt was found on specimens from 4, 5, 7, and 9 July; 4 and 8 August; and 1 September 1972. Adult molt was seen on voles from 1 July and 9 August 1951, and on 21 May and 22 June 1972.

Ectoparasites recovered from *M. pennsylvanicus* in Cook County include lice (*Hoplopleura acanthopus*), fleas (*Hystrichopsylla dippiei, Ctenophthalmus pseudagyrtes, Orchopeas leucopus, Megabothris asio, M. quirini, Peromyscopsylla catatina,* and *P. hamifera*), ticks (*Ixodes angustus* and *I. muris*), mites (*Eulaelaps stabularis, Androlaelaps fahrenholzi, Haemogamasus ambulans, H. liponyssoides, Laelaps alaskensis, L. kochi,* and Labidophoridae), and chiggers (Trombiculidae).

Ondatra zibethicus zibethicus (Linnaeus, 1766)

Muskrat

Specimen examined (1).—18 mi. N, 5 mi. W Grand Marais.

Ondatra zibethicus was not abundant in northeastern Minnesota during this study. Only a single, road-killed individual was seen, but muskrat "sign" was noted at several localities. Professional trappers indicated that muskrats were found throughout the region but not as plentifully as farther south in the state. Johnson (1922) and Cahn (1937) found them common in adjacent areas; both reported that muskrats often burrow into a bank rather than construct the characteristic "house."

Synaptomys cooperi cooperi Baird, 1858

Southern Bog Lemming

Specimens examined (7).—1½ mi. N, 10 mi. W Grand Marais, 1; Grand Portage, 1; 38½ mi. N, 4½ mi. E Schroeder, 1; 37 mi. N, 7½ mi. E. Schroeder, 2; 21 mi. N Schroeder, 1; 15 mi. N, 2 mi. W Tofte, 1.

The southern bog lemming probably occurs throughout the county, but populations tend to be restricted to specific habitats. Two specimens were trapped in runways through dense grass in a marsh. Other species living in the marsh were *Sorex arcticus, S. cinereus, Blarina brevicauda, Microtus pennsylvanicus,* and *Zapus hudsonius*. *Synaptomys* also was found in association with high populations of *Microtus pennsylvanicus* and *Zapus* in a large bed of *Carex* around a "beaver pond." A single specimen was taken from a subterranean runway in a low, wet area of mixed forest. A southern bog lemming trapped in 1951 near Grand Marais was in a bog of black ash, spruce, balsam fir, birch, and *Lycopodium*.

Three adult males collected on 21-22 June 1972 were in breeding condition (testes 6 × 5, 7 × 4, 8 × 5 mm.; well developed seminal vesicles; and convoluted epididymides). A second young adult male, trapped on 4 August, had testicular measurements of 6 × 4 mm. Neither of the two adult females obtained on 5 July and 22

September 1972 evinced reproductive activity. Molt, apparently into the summer pelage, was visible on an individual taken on 22 June; another was in fresh pelage on 4 August 1972. Two specimens from 21 June, one from 5 July 1972, and another from 5 July 1951 were in worn pelage.

Connor (1959) believed *Carex* to be preferred habitat for *Synaptomys* in New Jersey, but observed densities of no greater than five per acre in prime habitats. He found a mean and modal litter size of three.

Arthropodous ectoparasites found on *Synaptomys cooperi* in Cook County include two fleas, *Ctenophthalmus pseudagyrtes* and *Peromyscopsylla catatina*; three mites, *Haemogamassus ambulans*, *Hirstionyssus isabellinus*, and *Laelaps alaskensis*; and two ticks, *Ixodes angustus* and *I. muris*. These observations constitute new host records for *Haemogamassus ambulans* and *Hirstionyssus isabellinus*.

Rattus norvegicus (Berkenhout, 1769)

Norway Rat

Specimens examined (4).—½ mi. N, 1 mi. W Grand Portage, 3; 1 mi. N, ½ mi. E Lutsen, 1.

Three specimens of the Norway rat were shot at the Grand Portage dump on 20 July 1972. One subadult and one adult were reproductively inactive females; the third was a juvenile male. None was molting. Several other rats were seen in the dump that evening, indicating a high population of *Rattus* there at the time. The rat from near Lutsen was an adult male trapped at a human residence. It appears that this introduced murid is restricted in Cook County to areas of human habitation as no individuals or sign were found in less disturbed situations. In Ontario, Cahn (1937) reported *Rattus norvegicus* from several localities, all closely associated with man.

Zapus hudsonius hudsonius (Zimmerman, 1780)

Meadow Jumping Mouse

Specimens examined (73).—Brule Lake, 1; Cross River, 1; Four Mile Lake, 5; Kimball Lake, 8 mi. N, 5 mi. E Grand Marais, 1; 6 mi. N, 9 mi. E Grand Marais, 1; 4 mi. N, 11 mi. E Grand Marais, 3; 2 mi. N, 3 mi. E Grand Marais, 1; 9½ mi. W Grand Marais, 1; ½ mi. N, 1 mi. W Grand Portage, 3; Grand Portage, 4; 12 mi. N, 3 mi. W Hovland, 2; 10 mi. N, 1 mi. E Hovland, 1; 10 mi. N, 2 mi. E Hovland, 2; 2 mi. N, 5 mi. W Hovland, 1; 4 mi. NE Hovland, 1; ¾ mi. S, 1 mi. W Hovland, 1; 2 mi. S, 4 mi. W Hovland, 1; 15½ mi. N Lutsen, 2; 15½ mi. N, 1 mi. E Lutsen, 1; 14½ mi. N, 1 mi. W Lutsen, 1; 5 mi. W Lutsen, 1; 1 mi. E Mineral Center, 2; Pigeon River, SW ¼ sec. 20, T. 64 N, R. 6 E, 1; 43 mi. N, 1 mi. E Schroeder, 2; 38½ mi. N, 4½ mi. E Schroeder, 1; 37½ mi. N, 4 mi. E. Schroeder, 1; 37 mi. N, 7½ mi. E Schroeder, 1; 37 mi. N, 14 mi. E Schroeder, 1; Alton Lake, 23 mi. N, 1 mi. W Schroeder, 1; 22 mi. N Schroeder, 14; 21 mi. N Schroeder, 6; 20½ mi. N Schroeder, 2; 4½ mi. N, 1 mi. W Schroeder, 1; 4 mi. N, 5 mi. W Schroeder, 2; 1 mi. N, 1½ mi. E Schroeder, 2; 4 mi. W Schroeder, 1.

The meadow jumping mouse was common in a wide variety of habitats throughout the county. Populations of *Zapus* appeared to be high at a few localities but generally the species was not abundant at any one locality. Habitats associated with high populations of meadow jumping mice were usually wet, either marshes or the low-lying areas along streams with sedges, cattails (*Typha*), willows, and grasses being the dominant vegetation. Rom (1940) reported *Zapus hudsonius* from the tall grass around a beaver pond in northeastern Lake County. Preferred habitats in south-central Minnesota were sedge meadows and grassy willow-alder thickets (Quimby, 1951).

Nine adult females collected between 1966 and 1973 were pregnant or had placental scars (see Table 9). A number of adult females collected during the summer were reproductively inactive, but one obtained on 25 August 1972 appeared to have produced two litters that season. A single juvenile was trapped on 9 July 1972, and subadults were obtained on 20 July 1972 and 27 July 1922. Quimby found *Zapus* to have an average of five to six young per litter with a few females producing two litters per year. Bailey (1926) wrote that *Zapus hudsonius intermedius* had only a single litter per year in North Dakota.

Jumping mice undergoing molt were collected on: 5 July 1972; 1 August 1966, 18 August 1966 (3), 19 August 1966 (2), 24 August 1965, and 31 August 1966. Animals collected on 9 August and thereafter were storing fat, presumably for the oncoming winter. Despite extensive collecting efforts, no meadow jumping mice were collected in 1972 after 25 August. Quimby (1951) found some *Zapus* entering hibernation on 17 September where he conducted an extensive ecological study of the species in south-central Minnesota.

TABLE 9. Reproductive characteristics of nine adult female *Zapus hudsonius* collected in Cook County, Minnesota.

Date	Reproductive Characteristics
20 June 1972	5 embs. x 10 mm. (4L-1R)
22 June 1972	6 embs. x 10 mm. (4L-2R)
1 July 1951	5 embs. (1L-4R)
8 July 1972	6 placental scars (4L-2R)
9 July 1972	4 placental scars (1L-3R)
1 Aug. 1966	7 placental scars (4L-3R)
9 Aug. 1972	6 placental scars (3L-3R)
9 Aug. 1972	11 placental scars (6L-5R) (probably two litters represented)
25 Aug. 1972	1 visible placental scar (L)

The following parasites were collected from *Zapus* in Cook County: *Megabothris quirini* (a flea), *Androlaelaps fahrenholzi* and *Haemogamasus liponyssoides* (mites), and Trombiculidae (chiggers). This record represents the first time *H. liponyssoides* has been identified as a parasite of *Zapus hudsonius*. Davis and Ernst (1971) discussed the taxonomic status of jumping mice in the extreme western part of Minnesota.

Napaeozapus insignis frutectanus Jackson, 1919

Woodland Jumping Mouse

Specimens examined (15).—17 mi. N, 1 mi. W Grand Marais, 1; 2 mi. N, 3 mi. E Grand Marais, 1; Lower Brule River, T. 62 N, R. 3 E, 1; 2½ mi. N, 1 mi. E Mineral Center, 1; 22 mi. N Schroeder, 9; 1 mi. N, 1½ mi. E Schroeder, 1; Carlton Peak, 1 mi. N, 1 mi. W Tofte, 1.

Additional records.—90 mi. NE Duluth *in* Cook County (CM).

Although known from Cook County by only 15 specimens, the woodland jumping mouse appears to be distributed in suitable habitat throughout the county. The first specimen of *Napaeozapus insignis* from Minnesota was taken in 1923 along the Lower Brule River, T. 62 N, R. 3 E (Surber, 1923). Three males captured on 1 August 1966, and five males and one female collected on 31 July 1967, were living along Sawbill Creek in a mixed forest of white pine, balsam fir, mountain maple, and white birch. The four specimens obtained in 1972 were trapped in dense growths of thimbleberry. Rom (1940) trapped a single woodland jumping mouse in a poplar-birch-spruce forest near Kekekabic Lake in northeastern Lake County. Woodland jumping mice occur at least as far south in Minnesota as Pine County (Beer, 1953), and as far west as Clearwater County (Clough, 1959).

An adult female captured on 31 July had seven placental scars (4 L, 3 R), but one obtained on 6 July displayed no evidence of reproductive activity. Testicular lengths of ten adult males collected between 7 July and 24 August averaged 5.7 mm. (4-7) in length. Jackson (1972) reported only one litter per year for *Napaeozapus* in Wisconsin. In the central part of the range, Whitaker and Wrigley (1972) found *Napaeozapus* to have breeding peaks in late spring and late summer, with many females producing two litters each year.

Storage of fat was noted first on an adult male captured on 28 July 1972. Adults collected on 6 and 7 July and two from August were molting. Ectoparasites recovered from this species include mites (*Androlaelaps fahrenholzi*) and fleas (*Peromyscopsylla catatina*).

Erethizon dorsatum dorsatum (Linnaeus, 1758)

Porcupine

Specimens examined (2).—Incorrectly specified locality (see below).

Erethizon dorsatum once was extremely abundant across northern Minnesota, but porcupine numbers have been low in the past two decades. Several residents independently drew the correlation between the increase in the fisher population and the decline in numbers of porcupines, concluding that fisher predation was responsible for the low numbers of porcupines. However, it seems unlikely that predation has been the sole causative factor in the demise of porcupine populations.

Evidence of *Erethizon dorsatum* in the county found during this study includes a single pile of old droppings, a quill fragment encased in the mandible of a fisher, and quill fragments embedded in the soft palates of three fishers and a mink. Additionally, a *Lynx rufus* obtained near Grand Marais in 1939 contained ingested porcupine quills according to the data on record with the specimen.

An adult female obtained on 10 April 1955 and her single near-term fetus, both prepared as skin and skull and deposited in the Bell Museum, bear the locality "Grand

Rapids, Cook Co., Minnesota." Apparently this locality is an error as no point within the county is known as Grand Rapids. The specimens may have originated from Grand Marais or Grand Portage in Cook County or the town of Grand Rapids in Itasca County; the origin of these specimens likely will remain unknown. The fetus was 287 mm. long and fully furred, including quills. Habitat selection and movements of porcupines has been studied at the University of Minnesota's Forest Research Center near Cloquet, approximately 60 miles southwest of Cook County (Marshall *et al.*, 1962).

Order Carnivora

Canis latrans thamnos Jackson, 1949

Coyote

Specimen examined (1).—Grand Marais.

Canis latrans is present in Cook County, at least in parts of the southern portion such as along the north shore of Lake Superior, but the status of the species in northeastern Minnesota remains unknown. Several people who have worked in this area agreed that coyotes were uncommon; responses varied from "extremely rare" to "seen once in a while." Johnson (1916) described the coyote as being found throughout the state except the extreme northeastern portion and otherwise excluded them from his discussion of Lake County mammals in 1922 (Johnson, 1922). Cahn (1937) considered them abundant in Quetico Provincial Park, Ontario.

The single specimen from Cook County, an adult female (MMNH 2473), was obtained by Arthur Johnson in January, 1948. It weighed 11.0 kg., and has the following selected cranial measurements: condylobasal length, 181.3 mm.; zygomatic breadth, 98.6 mm.; postorbital constriction, 34.1 mm.; interorbital constriction, 31.9 mm.; length of nasals, 70.1 mm.; and length of maxillary toothrow, 81.4 mm.

Canis lupus lycaon Schreber, 1775

Timber Wolf (Gray Wolf)

Specimens examined (7).—Near Dunn Lake, sec. 28, T. 64 N, R. 4 W, 1; Near Dunn Lake, sec. 36, T. 64 N, R. 3 W, 1; Grand Marais, 1; 3 mi. S, 3 mi. W Grand Portage, 1; Hovland, 1; Poplar River, 1 mi. S, 1½ mi. W Lutsen, 1; 3 mi. W Taconite Harbor, 1.

Additional records.—Approximately 50 mi. N Grand Marais; N of Grand Marais; Grand Marais; E of Gunflint Lake; Northern Cook County [unspecified] (Bell Mus. Documents); Gunflint Lake (east of), Superior National Forest (Goldman, 1944).

The timber wolf (*Canis lupus*) is common throughout Cook County. Van Ballenberghe (1972) calculated a density of one wolf per 9.1 square miles in the Lutsen-Tofte area along the north shore of Lake Superior. This is one of the highest densities yet reported for the species.

The official listing of *Canis lupus* as a rare and endangered species by the United States Department of Interior has intensified the controversy concerning management of wolves. Bounties and predator claims of $50.00 per wolf were being paid routinely in the state until June of 1974. The predator claim was a fee paid to a trapper who had been contracted to remove predators from an area where local residents claimed damage on domestic animals or wildlife. Conservation groups believe that wolves should be completely protected from man, but some sportsmen and farmers argue for less stringent regulations, even including extirpation in extreme cases. The soundest proposal, at least judged biologically, would seem to be an overall management plan in which regulated numbers of wolves could be harvested. The wolf now receives complete protection from man by the Endangered Species Act. Using a broad array of data, Mech (1973*a*) estimated that 271 ± 14 wolves occupied the Superior National Forest in the spring of 1973. This represented a decline from his estimate of 300 ± 15 wolves occupying the forest in the spring of 1972. Roughly one-third of the forest is within the boundaries of Cook County, which also is the area of greatest population density of wolves. From 1950 through 1952 an average of 39 wolves were bountied each year in Cook County. Between 1960 and 1964 that number averaged 52 (Van Ballenberghe *et al.* 1975). Since retraction of the bounty, an estimated two to three dozen wolves were taken each year by trappers and hunters in Cook County. This harvest did not seem to constitute a threat to the population in the state.

Two adult male wolves trapped near Dunn Lake on 4 and 7 March 1938 are represented in the Bell Museum by two com-

plete skeletons and a skin. An adult male trapped at Hovland on 1 March 1947 is in complete winter pelage with dense underfur. It is dark gray, tending towards black, whereas all other wolves examined by me from the county are light gray with some reddish-brown areas intermixed. Occurrence of both black and white color phases in a Great Plains subspecies of wolf (*Canis lupus nubilus*) was discussed by Goldman (1944) and by Mech and Frenzel (1971*c*); *C. l. lycaon* apparently exhibits only more subtle variations of the gray color phase. Mech and Frenzel (1971*c*) reported that, "the race of wolves now occupying northeastern Minnesota does show strong *nubilus* influence." Testes measurements of two winter caught males were 50.8 × 28.5 mm. and 44.5 × 25.4 mm. Weights for three males were 176.4 kg., 167.9 kg., and 145.5 kg.; a single yearling female weighed 59.5 kg.

There has been a substantial amount of research on the timber wolf in northern Minnesota, particularly in Cook, Lake, and St. Louis counties. Johnson (1922), who studied in Lake County, and Cahn (1937) who worked in Quetico Provincial Park, commented that wolves were common during their mammalian faunal studies in these areas. The first field study specifically on timber wolves in this area was that of Olson (1938). Recent studies by Byman (1972), Mech (1970, 1973*a*, and elsewhere), Mech and Frenzel (1971*a*), Seal *et al.* (1975), Stenlund (1955), Van Ballenberghe (1972), Van Ballenberghe and Erickson (1973), and Van Ballenberghe and Mech (1975) have provided valuable information concerning population dynamics, movements, and ecology of *Canis lupus* in Minnesota. A popular account by Stenlund (1974) summarized the history of wolf management in the state.

Vulpes vulpes regalis Merriam, 1900

Red Fox

Specimens examined (6).—Devil Track Lake, 1; Grand Marais, 1; 10 mi. N, 1 mi. E Hovland, 1; 1 mi. S, 2 mi. W Lutsen, 1; 2 mi. S, 3 mi. W Lutsen, 1; Cook County [no specific locality], 1.

Red foxes were common throughout Cook County during the study. The specimen from 10 mi. north and 1 mi. east of Hovland was a subadult male (weight 3 kg. and testes 20 × 8 mm.) obtained on 18 August 1972. Stomach contents included the partially digested remains of a *Sorex cinereus*, a subadult *Zapus hudsonius*, a subadult *Peromyscus maniculatus*, and a dragonfly (Odonata). Specimens listed above with reference to Lutsen were found dead on the road. Specimens from Devil Track Lake and Grand Marais are skulls obtained from local trappers; the specimen with no specific locality is represented only by a skin. In addition to the specimens examined, red foxes were seen several times during the summer of 1972, including one observation of an adult and at least four pups (18 mi. north and 2 mi. west of Grand Marais).

Earlier students found *Vulpes vulpes* common in the Superior National Forest (Surber, 1932), northern Lake County (Johnson, 1922), and Quetico Provincial Park (Cahn, 1937). Field notes by W. J. Breckenridge and T. Surber indicate that both the cross and the silver-black color phases of red foxes commonly are seen in this area.

Urocyon cinereoargenteus ocythous Bangs, 1899

Gray Fox

Specimen examined (1).—Gunflint Lake.

The gray fox is a recent addition to the mammalian fauna of Cook County, where it is less abundant than the well-established red fox. Originally restricted to the deciduous forest of southeastern Minnesota, gray foxes have been expanding their range northward in the state. This expansion can be tracked chronologically. Johnson (1916) found *Urocyon cinereoargenteus* only in southeastern Minnesota. Bailey (1929) recorded only one specimen from Sherburne County, taken in 1927. Surber (1932) noted a range expansion from southern Pine County into Carlton County in the 1920's, and Swanson (1945) reported Becker, southern St. Louis, and Wadena counties as forming the northern limit for the species in Minnesota. Cahn (1921) and Johnson (1922) do not include *Urocyon* in their mammalian faunal accounts of Itasca and Lake counties. Unpublished field notes written by W. J. Breckenridge state that the gray fox had not yet reached Cook County by 1938, whereas his notes from 1947 provide two records for

the county. The first (MMNH 2331—a skin only), referenced from Gunflint Lake, was taken on 24 November 1945. The second, from Tofte, was not preserved or precisely dated. The third gray fox known from the county was trapped in January of 1953 in T. 62 N, R. 3 E [ca. 3 miles west of Hovland] (M. Stenlund pers. com. to A. Erickson, 16 March 1953).

Rabbits, mice (*Peromyscus* and *Microtus*), and vegetation were found to be the primary food items for *Urocyon* in south-central Minnesota (Hatfield, 1939). Collectively, these items comprised over 56% of the total stomach contents.

Ursus americanus americanus Pallas, 1780

Black Bear

Specimens examined (3).—2½ mi. N, 5 mi. E Hovland, 1; Grand Marais, 1; 3½ mi. W Schroeder, 1.

Additional record.—17 mi. N, 1 mi. E Grand Marais (Aldous, 1937).

Ursus americanus, the only bear found in Cook County in recent history, is common throughout northeastern Minnesota. Black bears often were encountered around garbage dumps and camp sites where they foraged. All dumps in the county apparently are visited regularly by bears. The largest number observed by me at any one time was 12, seen at the Tofte dump on 10 August 1972. This included a large adult female and four young-of-the-year. In June of 1958 a sow and four cubs were photographed at the same dump (Minneapolis Sunday Tribune, 24 August 1958 pp. 4-5 in Magazine Section). The modal litter size for black bears in this region is thought to be three (L. L. Rogers, pers. com.).

The three specimens examined are represented only by skulls. Two were acquired from carcasses of adult black bears shot as nuisances (male from 3½ mi. west of Schroeder; female from 2½ mi. north and 5 mi. east of Hovland). The specimen from Grand Marais is an adult male obtained in 1880.

Ursus americanus has been the subject of relatively more study than most mammals of this area. Aldous (1937) and Morse (1937) discussed hibernation and breeding of black bears in northeastern Minnesota. A summary of black bear biology in the state was presented by Kinsey (1965) and Rogers (pers. com.) has conducted an autecological study of bears in adjacent Lake County, where he concentrated on movements and social structure.

Procyon lotor hirtus Nelson and Goldman, 1930

Raccoon

The raccoon evidently is uncommon in Cook County. Records for the county include a reported sighting near Lutsen "several years ago" and two males captured during a separate study in traps set for timber wolves (V. Van Ballenberghe, pers. com.). The first, taken in sec. 22, T. 61 N, R. 2 W on 27 July 1970, weighed about 7 kg. The second was trapped in sec. 8, T. 60 N, R. 4 W on 7 August 1970. Most local trappers questioned had not taken or heard of raccoons being taken in the area. Cahn (1937) did not mention raccoons as being found in Quetico Provincial Park, but Peterson (1966) and Simkin (1966) reported a few records from western Ontario. No specimen of *Procyon lotor* from northeastern Minnesota has ever been preserved insofar as I could determine.

Martes americana americana (Turton, 1806)

Marten

Specimens examined (4).—Grand Marais Area [no specific locality], 2; 1½ mi. N Mineral Center, 1; ½ mi. S, ¼ mi. W Pigeon River, NW ¼ sec. 29, T. 64 N, R. 6 E, 1.

Martens were once numerous throughout northern Minnesota (Swanson, 1945). By the early 1900's extensive trapping and destruction of forests had reduced their range in the state to the least accessible areas near the Canadian boundary. Johnson (1922) found no evidence that they persisted in northern Lake County. By 1937 Cahn considered them extirpated from the Quetico Provincial Park area of Ontario. From the 1920's to 1953 there were only a few unverified trappers' reports of martens having been collected or of tracks having been seen in Minnesota, and all of these were in the vicinity of the Canadian boundary. On 29 November 1953 a *Mares americana* was trapped near the North Arm of Burntside Lake (T. 64 N, R. 13 W) in St. Louis County (Stenlund, 1954). Gunderson (1965) reported the two specimens from the Grand Marais

area, which had been collected during the winter of 1961, and a fourth specimen that had been trapped on 1 December 1963 near Farm Lake in Lake County.

The marten from Pigeon River was trapped on 14 December 1972 in a mink set baited with fish heads. It was a female young-of-the-year with no gross evidence of embryos. Remains of two short-tailed shrews (*Blarina brevicauda*) and a red squirrel (*Tamiasciurus hudsonicus*) with badly worn cheek teeth were recovered from the stomach and intestinal tract. The marten from Mineral Center was a male young-of-the-year trapped by a professional trapper in October of 1972. It is represented only by the skull. The trapper indicated that he had received $35.00 from a fur buyer for the skin. He also spoke of a pine marten taken the previous winter (1971-72) near Mineral Center. He believed it to be the first one obtained in the area for at least twenty-five years. A young-of-the-year male *Martes americana* having testes 8 × 4 mm. was trapped 8 mi. south and 3 mi. east of Babbitt, St. Louis County, on 4 December 1972. Both martens from Cook County and the one from St. Louis County were in fresh winter pelage. Measurements of the only available cranial materials preserved from Minnesota are provided in Table 11. Unfortunately, the two specimens from near Grand Marais are represented only by skins.

There have been numerous sightings of martens by local residents in northeastern Minnesota since 1971. These include one at 2½ mi. north and 2 mi. west of Grand Marais in the early spring of 1972 and one at McFarland Lake during the winter of 1972-73. These two probably are valid, but insufficient background information is available for the others to evaluate their validity. Although actually or nearly extirpated from the state, the marten has made a remarkable comeback in recent years as indicated by the increased number of sightings and of specimens collected. However, it still must be considered as rare in the state and in need of complete protection.

Martes pennanti pennanti (Erxleben, 1777)
Fisher

Specimens examined (20).—10 mi. N Grand Marais, 1; Near Grand Marais, 2; Grand Marais, 1; 8 mi. W Grand Marais, 1; Grand Portage Indian Reservation, 10; McFarland Lake, 15 mi. N, 3 mi. W Hovland, 1; ½ mi. S, 1½ mi. W Lutsen, 1; 1½ mi. S, 3 mi. W Lutsen, 1; 1 mi. E Mineral Center, 1; Taconite Harbor, 1.

Additional records.—Grand Marais; 11 mi. N, 3 mi. W Lutsen (A. Johnson pers. com. to H. L. Gunderson, 5 March 1948).

Martes pennanti is a common carnivore throughout Cook County. Trapping pressure and habitat destruction during the late 1800's and the first half of this century greatly reduced the number of fishers in Minnesota and elsewhere. During the last twenty-five years they have made a strong comeback in the northeastern corner of the state, where they now are considered a nuisance by some trappers. Surber (1932) stated that fishers were becoming scarce in northern Minnesota, and Cahn (1937) regarded the species as "extremely rare" in Quetico Provincial Park, Ontario. Their increase in numbers in northern Minnesota has been documented by Balser and Longley (1966).

Twenty fishers from Cook County and a few specimens from adjacent Lake County were examined during this study. Additionally, a sight record was made at a place 6 miles north and 1 mile west of Tofte on 20 May 1973. The carcasses of ten males and six females were obtained from trappers during the 1972-73 trapping season. Following the criteria set forth by Wright and Coulter (1967), nine (five males and four females) were judged to be young-of-the-year and the other seven (two males and five females) were adults. An adult female killed on 6 March 1973 contained a single embryo 44 mm. long, whereas young-of-the-year females did not appear to be pregnant. Testes measurements for an adult male killed on 18 February 1968, were 22 mm. in length; those of one taken on 26 December 1972 were 22 × 18 mm. A road-killed juvenile male found on 7 July 1972 had complete milk dentition with only the emerging tips of the first premolars (both uppers and lowers) visible in the jaws.

An albino male *Martes pennanti* (MMNH 5024) was trapped 10 miles north of Grand Marais on 13 October 1960. A second albino fisher was obtained near Grand Marais during the 1973-74 trapping season, but unfortunately this individual could not be obtained. Approximate percentage of occurrence of food species in the stomachs

TABLE 10. Stomach contents of six *Martes pennanti* from Cook County, Minnesota.

Specimen Number	Sex	Date	Food Species	Percentage by Volume
12233	♂	early February 1973	*Odocoileus virginianus* (White-tailed deer)	50%
			Blarina brevicauda (Short-tailed shrew)	25%
			Condylura cristata (Star-nosed mole)	12.5%
			Accipiter striatus (Sharp-shinned hawk)	12.5%
12235	♀	6 March 1973	*Lepus americanus* (Snowshoe hare)	100%
12240	♂	Fall 1973	*Tamiasciurus hudsonicus* (Red squirrel)	100%
12241	♂	Fall 1973	*Odocoileus virginianus*	33.3%
			Blarina brevicauda	33.3%
			Bonasa umbellus (Ruffed grouse)	33.3%
12242	♂	Fall 1973	*Odocoileus virginianus*	100%
12390	♂	10 October 1969	*Bonasa umbellus*	100%

of six fall and winter trapped fishers is shown in Table 10. The high incidence of insectivores (*Blarina brevicauda* and *Condylura cristata*) is of interest because other studies have found that insectivores comprise only a minor portion of the fisher's diet. White-tailed deer and ruffed grouse probably were consumed as carrion.

Mustela erminea bangsi Hall, 1945

Short-tailed Weasel (Ermine)

Specimens examined (16).—Cascade Lake [= Big Cascade Lake], 2; 15 mi. N, 1 mi. E Grand Marais, 1; 2 mi. N, 4 mi. E Grand Marais, 1; North Shore, W of Grand Marais, 2; 6 mi. W Grand Marais, 1; Grand Marais, 2 (UMMZ); 2 mi. S, 1 mi. W Grand Portage, 1; 4 mi. N, 1 mi. E Hovand, 1; ¾ mi. S, 1 mi. W Hovland, 1; 2 mi. S, 4 mi. W Hovland, 1; 1 mi. E Mineral Center, 1; ½ mi. S, ¼ mi. W Pigeon River, NW ¼ sec. 29, T. 64 N, R. 6 E, 1; Tofte, 1.

Additional record.—Grand Marais (Hall, 1951).

The short-tailed weasel is without a doubt the most abundant carnivore in northeastern Minnesota and probably is the most abundant carnivore throughout most of the state. It was collected in a variety of habitats including cat-tail marshes; aspen, balsam fir, and white spruce forests; open meadows; and in low lying white-cedar swamps. *Mustela erminea* probably occurs within all natural habitat types within the county. Weasels of this species were common in Lake County (Johnson, 1922), Sherburne County (Bailey, 1929), across the northern tier of counties in Minnesta (Aldous and Manweiler, 1942), and in Quetico Provincial Park (Cahn, 1937). Aldous and Manweiler (1942) discussed the winter food habits of short-tailed weasels in Lake of the Woods and St. Louis counties.

None of the female *Mustela erminea* collected displayed evidence of previous reproductive activity. Testicular measurements of adult males include: 9 mm., 11 August 1966; 5 mm., 11 August 1966; 8 × 4 mm., 4 August 1972; 5 × 4 mm., 1 September 1972; and 7 × 4 mm., 12 December 1972. Short-tailed weasels in July and August had complete summer pelage whereas one from 12 December 1972 was in complete winter pelage. A male young-of-the-year obtained on 1 September 1972 was just beginning molt into the winter pelage, albeit three others respectively from 1 September 1966, and 14 and 16 September 1921 had not begun the autumnal molt. Dental abnormalities noted for adult *Mustela erminea* include an adult male with pl missing from the left dentary, an adult female with pl missing from both dentaries, and an adult male with an aberrant incisor on the left dentary. This tooth, i3, erupted slightly anterior and labial to the canine. It is noticeably larger than a normal incisor but smaller than the canine. The aberrant incisor apparently pressured the canine during growth in such a way that it is posterior in placement to the corresponding right canine. A large indentation is formed in the maxillary and premaxillary bones where the influxed canine rests when the jaw is articulated. This malformity apparently had little or no effect on the weasel's hunting ability as the animal was in excellent condition when captured and the mandibles articulate in an apparently normal manner with the cranium.

TABLE 11. Cranial measurements (individual or mean and range) for five species of mustelids from northern and central Minnesota. All specimens are from Cook County unless specified otherwise.

Catalog Number or N and Sex		Condylobasal Length	Zygomatic Breadth	Postorbital Constriction	Mastoidal Breadth	Length of Maxillary Toothrow
			Martes americana americana			
			1½ mi. N Mineral Center			
12168	♂	82.5	42.3	17.2	35.5	30.1
			½ mi. S, ¼ mi. W Pigeon River, NW ¼ sec. 29, T. 64 N, R. 6 E			
12169	♀	75.0	40.6	17.3	32.6	28.3
			8 mi. S, 3 mi. E Babbit, St. Louis County			
12170	♂	79.2	41.2	17.4	33.9	29.2
			Near Ely, S of Farm Lake, *in* Lake County			
5963	♂	77.7	41.2	17.7	33.9	29.2
			Martes pennanti pennanti			
5	♀♀	99.9(98.2-102.8)	55.7(54.2-57.6)	20.1(19.2-21.1)	46.3(45.9-46.6)	38.2(37.2-39.6)
9	♂♂	113.7(106.0-121.9)	65.4(59.0-80.7)	21.5(17.5-25.3)	53.9(49.4-57.9)	44.8(40.6-47.9)
			Mustela erminea bangsi			
4	♀♀	31.3(31.1-31.4)	17.0(16.9-17.1)	9.0(8.8-9.1)	15.8(15.5-16.1)	11.0(10.5-11.5)
6	♂♂	37.6(36.1-40.0)	21.8(20.1-23.0)	10.9(10.8-11.0)	19.2(18.1-20.7)	13.3(12.3-13.9)
			Mustela vison			
			Cook County			
8	♂♂	63.5(60.2-66.6)	36.4(34.6-38.9)	12.9(11.2-13.8)	32.3(30.3-33.8)	20.8(19.8-21.7)
3	♀♀	59.2(57.9-60.3)	32.9(32.3-33.4)	11.2(10.4-12.3)	28.8(28.4-29.3)	19.2(19.2-19.3)
			St. Louis County			
7	♂♂	67.8(65.2-70.1)	38.6(35.6-40.3)	12.7(10.4-13.4)	34.7(33.0-36.2)	22.3(21.5-22.7)
2	♀♀	60.4(59.9-61.0)	33.2(32.7-33.8)	12.1(11.8-12.4)	29.1(29.0-29.2)	19.2(19.1-19.3)
			Anoka County			
6	♂♂	69.8(66.9-72.1)	40.8(36.8-43.4)	14.0(12.0-14.9)	35.8(32.9-37.1)	22.8(21.9-23.3)
8	♀♀	61.0(58.5-62.8)	34.6(33.6-35.7)	12.7(12.1-14.0)	30.1(29.9-31.6)	19.5(18.8-20.4)
			Lontra canadensis canadensis			
			St. Louis County			
3	♀♀	104.7(101.5-109.1)	66.0(64.7-67.3)	20.7(17.9-22.4)	62.6(60.2-65.1)	35.8(33.6-37.3)

Short-tailed weasels from Cook County represent an intergradation between *M. erminea bangsi*, a large midwestern race, and *M. erminea cicognanii*, a smaller subspecies found throughout sotheastern Canada and northeastern United States. All short-tailed weasels from Minnesota were assigned to *M. erminea bangsi* by Hall (1951); however, Hall and Kelson (1959) included Cook County within the range of *M. erminea cicognanii*. Selected measurements (see Table 11) are intermediate between corresponding measurements for *M. erminea bangsi* and *M. erminea cicognanii* as described by Hall (1951), but average slightly closer to those of the larger *M. erminea bangsi*. Therefore, short-tailed weasels from Cook County are assigned to that subspecies.

Eleven of twelve skulls examined from the county contained obvious damage from the parasitic sinus nematode, *Skrjabingylus nasicola*. The lesions produced by *Skrjabingylus* varied from minute to complete deterioration of the supraorbital process. *Megabothris asio*, a common flea on small mammals, was the only ectoparasite recovered from *Mustela erminea*.

Mustela nivalis rixosa (Bangs, 1896)

Least Weasel (Weasel)

There are no verified records of the least weasel in northeastern Minnesota; however, it undoubtedly is present there. In his field notes from the Lake Saganaga area written in 1937, Breckenridge reported that profes-

sional trappers indicated "that the large Long-tailed Weasel was taken frequently here and that the Least Weasel also occurred in varying numbers. The Short-tailed is the commonest." Swanson and Fryklund (1935) described a population eruption of this species in northwestern Minnesota.

Mustela vison lacustris (Preble, 1902)

Mink

Specimens examined (12).—Within 14 mi. radius N and W of Grand Marais, 7; Grand Portage, 1; Grand Portage Indian Reservation, 3; 4 mi. N, 6½ mi. E Lutsen, 1.

Mustela vison is one of the most abundant carnivores found in northeastern Minnesota, being second in abundance only to the short-tailed weasel, and is the most common fur-bearer trapped each winter. In addition to the twelve specimens obtained from trappers, mink were seen twice during the summer of 1972; once at a place 19 mi. north and 3 mi. west of Grand Marais, and at a place 1 mi. north and ½ mi. east of Lutsen. Mink were found to be common also in northern Lake County (Johnson, 1922) and in Ontario (Cahn, 1937).

The mink from this region have been assigned to the northern subspecies, *Mustela vison lacustris*, although until the present study they have not been examined critically. Hollister (1913) characterized *M. vison lacustris* as being larger and darker than the more southern race, *M. vison letifera*, which he described from Elk River, Minnesota. *Mustela vison vison*, smallest of the American mink, was listed originally as being found from central Ontario south to Lake Superior and east. The problems of geographic variation in this species and our lack of knowledge of this subject were pointed out by Hollister (1913) and Peterson (1966).

On separate occasions, two individuals (a game warden and a professional trapper) who had no professional training in mammalogy but who had a great deal of field experience with furbearers, volunteered the information that mink from this region were much smaller than those found in the southern part of the state. Their observations were substantiated later by examination of three series of mink skulls, the first from the study area, the second from St. Louis County (west and south of the study area), and the third from Anoka County in south-central Minnesota. All individuals measured had been obtained in November or December. Cranial measurements of the series from Cook County are considerably smaller than those from Anoka County; measurements of the series from St. Louis County are intermediate in size between those of the northern and southern samples (Table 11).

It appears that mink in northeastern Minnesota may best be referred to the eastern subspecies, *Mustela vison vison*. The cranial measurements from the Cook County series agree closely with those of that subspecies (from Hollister, 1913), whereas Hollister's sample from south-central Minnesota (Elk River and Fort Snelling) agree closely to the Anoka County series; his measurements of *Mustela vison lacustris* are considerably larger than any of the Minnesota specimens. I reserve assigning the mink from Cook County unequivocally to *M. vison vison* until specimens to the east of this study area are examined.

Gulo gulo luscus (Linnaeus, 1758)

Wolverine

The wolverine undoubtedly occurred in Cook County in recent history; however, there exists a paucity of information concerning this mustelid in Minnesota and no records are available for the county. Johnson (1923) reported that in 1918 a fur buyer purchased a wolverine skin thought to be from the northern portion of either Lake or St. Louis County. Peterson (1966) recorded a specimen taken in 1955 in Ontario, just north of Cook County. Records of wolverines in Minnesota were summarized by Swanson (1945) and Birney (1974).

Mephitis mephitis hudsonica Richards, 1829

Striped Skunk

Specimens examined (2).—2 mi. N, 4 mi. E Grand Marais, 1; 1 mi. S, 2½ mi. W Grand Marais, 1.

Mephitis mephitis is represented from Cook County by two adults of unknown sex found on U.S. Highway 61 near the north shore of Lake Superior. A few sight records were reported by local residents and a trapper mentioned having trapped one

"some years ago" along East Bearskin Lake (approximately 20 mi. north and 3 mi. east of Grand Marais). Johnson (1922) reported a female taken in northeastern Lake County in 1912. This species is not common in the county.

Lontra canadensis canadensis (Schreder, 1776)

River Otter

This large, semi-aquatic mustelid was originally common throughout Minnesota, but trapping greatly reduced its numbers. Johnson (1922) considered river otters uncommon in Lake County, but in 1937 Cahn thought they were increasing in numbers in adjacent Ontario. In apparent response to a carefully regulated trapping season in the state, otters have increased in numbers and are again common in northeastern Minnesota. No river otter was collected during the course of this study, but sight records were made on two separate occasions. Three *Lontra canadensis* were seen crossing a road at approximately 10½ mi. north and 6 mi. west of Schroeder, and several individuals were seen on the Pigeon River (SW ¼ sec. 20, T. 64 N, R. 6 E). The two conservation officers in the county tagged respectively, 22 and 53 river otters during the 1972 and 1973 trapping seasons (Longley, pers. com.). However, these figures do not represent the exact harvest of river otters in the county during these years because some of those tagged actually were trapped in eastern Lake County and none of those trapped on the Grand Portage Indian Reservation was tagged.

Use of the generic name *Lontra* follows van Zyll de Jong's (1972) recent revision of New World river otters. He examined only four specimens from Minnesota, all from the southern portion of the state. He assigned these to the western subspecies, *Lontra canadensis pacifica*, but he assigned specimens from the Thunder Bay District of Ontario to the eastern subspecies, *L. c. canadensis*; otters in Cook County thus are assigned to the nominate subspecies on the basis of geography.

Lynx canadensis canadensis Kerr, 1792

Lynx

Specimens examined (6).—Grand Portage Indian Reservation, 4; 2 mi. N Mineral Center, 1; 18 mi. N, 2 mi. W Schroeder, 1.

Additional records.—Near Grand Marais: Sec. 23, T. 61 N, R. 1 W (Bell Museum Documents).

Lynx canadensis was abundant in Cook County and throughout northeastern Minnesota during this study. Mech (1973*b*) attributed the density peak in northern Minnesota during the years 1972 and 1973 to dispersal from high populations in adjacent portions of Canada. The extreme fluctuations in numbers of this species are well documented, although poorly understood. Long term records kept by the Hudson Bay Company indicate that lynx population densities fluctuate or "cycle" on an approximate ten year basis (Keith, 1963).

A professional trapper on the Grand Portage Indian Reservation noted that the first lynx trapped in his area for several years was taken in the winter of 1971-72, and that he already had trapped five lynx in the 1972-73 season by the 28th of December 1972. Numerous records of lynx were reported from the county during 1972 and early 1973. By fall of 1973 a decline in the population was suggested by the few lynx being reported by trappers and the scarcity of sightings. Unpublished records in the Bell Museum indicate that lynx were abundant in northern Minnesota in the early 1960's; the Museum obtained one in 1960, one in 1961, and 18 during the winter of 1962-63. Additional records are available for the early 1950's, but none was obtained from 1954 through 1959 nor from 1964 through 1971.

The six *L. canadensis* examined from the county, five males and one female, are all adults obtained during the winter of 1972-73. The female possessed two corpora albicantia in each ovary in January 1973. Only one distinct placental scar was present. A male obtained in October of 1972 weighed 12.0 kg., and was molting into the winter pelage. Contents of four stomachs included the following foods: *Lepus americanus* (100% of contents of two stomachs), *Odocoileus virginianus* (100% of contents of a single stomach), and *L. americanus* and traces of raven (*Corvus corax*) (one stomach). Selected cranial measurements, including mean, range, and N, of the female followed by those for the males are: greatest length of skull, —; 128.3 mm., (122.0—133.2), 4; zygomatic breadth, 85.0 mm.; 88.3 mm., (86.5—91.5), 5; least interorbital constriction, 27.3 mm.; 28.2 mm., (27.0—29.6), 5;

mastoidal breadth, —; 56.4 mm., (54.3—58.5), 2; length of maxillary toothrow, 39.4 mm.; 42.1 mm., (39.8—43.3), 5. In addition to the six specimens examined, a sight record was noted during the summer of 1972 at a place 18½ mi. north and 2 mi. west of Grand Marais.

The taxonomic position of the New World lynx is not well understood. Rausch (1953) and Kurtén and Rausch (1959) discussed the relationship between the New World lynx, *Lynx canadensis*, and the Old World lynx, *Lynx lynx*, and suggested that they may be conspecific. If this proves true, then *canadensis* would be reduced to a subspecies of the Holarctic species *Lynx lynx*. *Lynx canadensis* is recognized here as a distinct species until a complete revision of this group sheds more light on the problem. Many European workers, including Ellerman and Morrison-Scott (1951), do not recognize the genus *Lynx* for this group of felids, but rather feel they are congeneric with cats of the genus *Felis*.

Lynx rufus superiorensis Peterson and Downing, 1952

Bobcat

Specimens examined (3).—N of Grand Marais along Gunflint Trail, 2; Tofte, 1.

Lynx rufus probably was not found in the coniferous forest zone of northern Minnesota before settlement of the state by European man. Habitat manipulation by man undoubtedly has led to northward range expansion of this species (de Vos, 1964; Peterson, 1966). Surber (1932) considered southern Lake and St. Louis counties as the northern limit of bobcats in the state. W. J. Breckenridge's field notes for the winter of 1936-37 state that several bobcats were collected in the Grand Marais area, but Cahn (1937) found them extremely rare in Quetico Provincial Park, Ontario. Rollings (1945) thought the bobcat had expanded its range since 1900 to include all of northeastern Minnesota.

The two specimens from Grand Marais were obtained by C. T. Rollings as part of his Master's degree research on food habits of bobcats. One of these, a young-of-the-year trapped on 24 November 1939, was undergoing replacement of the deciduous dentition. The lacteal and the permanent upper canines are roughly equal in size, each being 11-12 mm. in length. DP 3 is still present although P 3 is visible; P 4 has replaced DP 4 but is not fully erupted. The lacteal canines have been lost from the mandible, where the permanent set was erupting. The deciduous lower premolars remain in place, with no sign of the permanent premolars (see also Rollings, 1945). The second specimen from Grand Marais is an adult of unknown sex, probably a male based on size. A young male from Tofte, obtained on 21 January 1958, has complete adult dentition, although P 3 and P 4 are not fully erupted. Saunders (1964) has shown that the permanent canines of *Lynx canadensis* erupt at five to six months of age.

Rollings (1945) found snowshoe hares, white-tailed deer (both carrion and freshly killed), and porcupines to provide the main diet of bobcats in the northeastern and north-central parts of the state. One specimen from Grand Marais contained porcupine quills in the stomach, according to data with the specimen. In a separate study, *Lepus americanus* was found to be the main food of bobcats in northern Minnesota (Petraborg and Gunvalson, 1962).

Order Artiodactyla

Odocoileus virginianus borealis (Miller, 1900)

White-tailed Deer

Specimens examined (6).—Schroeder.

White-tailed deer were found throughout Cook County in 1972, but they could not be considered abundant. All available evidence indicates that *Odocoileus virginianus* did not occur in Cook County until the late 1800's. Heavy logging and forest fires removed much of the dense coniferous forest, and subsequent growth of deciduous vegetation allowed this species to increase its range to cover all of the state by the early 1900's. Karns (1967) documented the rapid increase of deer in northeastern Minnesota from 1900 through the 1930's. Petraborg and Burcalow (1965) thought deer had become common throughout northeastern Minnesota by 1920. The peak density of Minnesota's deer herd was reached during the 1930's. Since that time there has been a continuing decline in the population, which

is a predictable result of natural deterioration of the range resulting from succession (Karns, 1967; Petraborg and Burcalow, 1965).

Six *O. virginianus* were examined after having been killed by cars near Schroeder between 1 and 15 April 1972. Each of four adult females carried a single, near-term fetus. The skull of one female was saved. White-tailed deer occasionally were observed during the summers of 1972 and 1973, but they were not common. Several winter deer yards are located along the north shore of Lake Superior (Erickson *et al.*, 1961). This area has less snowfall because of the moderating effect of the lake on the local climate. The annual migration of *O. virginianus* to these yards tends to concentrate deer where human density is highest in the county, resulting in increased mortality of deer from both cars and dogs. Herds of 15 or more frequently are seen along Highway 61 during the winter, particularly in areas where they are fed by humans.

Byman (1972) found white-tailed deer, especially young of the year, to be the principal food item of *Canis lupus* throughout the year. He concluded that wolf predation may limit the deer population in northeastern Minnesota. An analysis of age and state of health of deer killed by wolves during winter months showed that individuals older than the population average and debilitated and abnormal deer often fall prey to wolves (Mech *et al.*, 1971*a*).

For information on management and numbers of deer in this area consult Burcalow and Marshall (1958), Erickson *et al.* (1961), Fashingbauer and Moyle (1963), Petraborg and Burcalow (1965), and Wetzel (1972).

Alces alces andersoni Peterson, 1950

Moose

Specimen examined (1).—Grand Marais.
Additional record.—Temperance River (Peterson, 1952).

The moose, a circumpolar cervid, is the largest mammal in Cook County. Moose were considered common in the area by all residents questioned. There is some question as to the distribution of *Alces alces* in northeastern Minnesota prior to settlement of the area by European man. Idstrom (1965) thought they were completely replaced by caribou in Cook and Lake counties, whereas other authors concluded they had been present in low numbers throughout this area (Johnson, 1916; Surber, 1932; Peek, 1971). It is certain that moose are more numerous in the county now than they were before logging began in the late 1800's. Surber (1945) noted several extreme fluctuations in moose populations in Cook County between 1922 and 1943.

Twenty-five moose were taken by hunters in Cook County in 1971, during the first hunting season on moose held in Minnesota in several decades. Although hunting statistics for Cook County alone were not available for the 1972 season, a total of 159 moose was registered from Cook and Lake counties (W. H. Longley, pers. com.). The single specimen of *Alces alces* examined from the county, represented only by a skull, is that of an adult bull obtained in 1938 by Carl Meyer. Five moose were observed during the summers of 1971 and 1972: 3 mi. north and 1 mi. west of Hovland; 15 mi. north and 3 mi. east of Lutsen; 15 mi. north and 4½ mi. east of Lutsen; 2 mi. west of Mineral Center; and 37 mi. north and 14 mi. east of Schroeder.

Natural history and management of moose in this area were studied by Surber (1940), Peterson (1953), Karns (1967), Peek (1971; 1974), and Van Ballenberghe and Peek (1971). Densities of 2-5 moose per square mile were reported in the Isabella area (Lake County) by Peek (1971). The dynamics of moose aggregations were studied by Peek *et al.*, (1974). Byman (1972) found *Alces* to be a primary food item of wolves in this area.

Rangifer tarandus sylvestris (Richardson, 1829)

Caribou

Specimen examined (1).—Tuscarora Lake.

Caribou were once common throughout much of northern Minnesota, but have been extirpated from the state by man. Surber (1932) reported that they had been common in the greater part of Cook County until 1885. Breckenridge (1949) stated that the caribou was present along the North Shore in 1890 and disappeared soon afterwards,

but occasional individuals were noted as late as 1913 (Fashingbauer, 1965). Johnson (1922) reported a sight record from the Sawbill Lake area in 1917, and a herd of about 20 animals was observed along Gunflint Lake from 1916 through 1925 (Hatton, 1919; Peck, 1928). One of the last sightings near the North Shore was that of a single individual seen near Hovland in 1924 (Anonymous, 1924).

The specimen from Tuscarora Lake (T. 64 N, R. 4-5 W) is a partial antler that was donated to the museum by Mr. Charles Ott, a former state conservation officer. It had been gnawed on by rodents before being found during the winter of 1935-1936, but date of the animal's death is unknown.

Species of Unverified Occurrence

Sorex fumeus fumeus (Miller, 1895)

Smoky Shrew

Although there are no records of *Sorex fumeus* from Minnesota, it is conceivable that the species may be found in the extreme northeastern corner of the state. Specimens from several localities in the Thunder Bay District of Ontario denote the western and southwestern documented localities of record for the smoky shrew (Anderson, 1946; Prince, 1941).

Microsorex hoyi hoyi (Baird, 1857)

Pygmy Shrew

Occurrence of pygmy shrews has not been documented within the borders of Cook County, but they undoubtedly live there. Specimens have been recorded from Ely, St. Louis County (Cahn, 1937); Itasca State Park, Clearwater County (Quimby, 1943); and Quetico Provincial Park, Ontario (Cahn, 1937). Although Rom (1940) reported three specimens of a small shrew obtained near Kekekabic Lake in northeastern Lake County as *Microsorex hoyi*, it is doubtful they represented that species (Heaney and Birney, 1975). It is most likely that his specimens were *Sorex cinereus*, which is extremely abundant and superficially resembles the pygmy shrew.

Sylvilagus floridanus mearnsi (J. A. Allen, 1894)

Eastern Cottontail

No indication was found that *Sylvilagus floridanus* occurs or ever did occur within the borders of Cook County. The eastern cottontail was reported for Cook County by Gunderson and Beer (1953) on the strength of a sight record; however, examination of their files used in preparation of *The Mammals of Minnesota* revealed that this record was hearsay and that they doubted its validity at the time. Nevertheless, it was published as an authentic sighting. Additional records have been noted for Duluth (Swanson, 1945) and elsewhere in St. Louis County (Breckenridge, unpubl.). It is possible the eastern cottontail may be found in Cook County in the future, especially the southwestern portion, but it is doubtful they exist there now.

Lepus europeaus hybridus Desmarest, 1822

European Hare

The European hare first was introduced into Ontario in 1912 as a game animal. Subsequent introductions aided in the rapid expansion of the range of *Lepus europeaus* within the province (Reynolds, 1955). Allin (1950) recorded introductions of European hares during the 1940's at localities only 40 miles northeast of the United States-Canadian border near the present city of Thunder Bay in the District of Thunder Bay, Ontario. European hares apparently did not survive along the north and west shore of Lake Superior as none has been seen in the area since 1949 (Dean and de Vos, 1965). There are no specimens of *L. europeaus* known from Minnesota.

Sciurus niger rufiventer E. Geoffroy St.-Hilaire, 1803

Fox Squirrel

No evidence of the occurrence of *Sciurus niger* in Cook County was uncovered during this study When questioned, residents were certain that this squirrel does not occur in the area at present, and they doubted that it ever occurred there. Gunderson and Beer (1953) reported a sight record of a fox squirrel for the county, but gave no further details. Hall and Kelson (1959) subsequently reported it as a northeastern record for S. *n. rufiventer*. A specimen from one mile south of Barnum, Carlton County (MMNH 3708), represents the northeasternmost locality of verified occurrence of fox squirrels in Minnesota.

Phenacomys intermedius celatus Merriam, 1889

Heather Vole

The single specimen of a heather vole from Minnesota was obtained by Shaler Aldous in 1940. Swanson (1945) and Gunderson and Beer (1953) reported this specimen as a rock vole, *Microtus chrotorrhinus*, but Handley (1954) reidentified it as *Phenacomys intermedius*. The locality of the specimen's origin is uncertain; the label and first published citation of the record denote Ely [St. Louis County] as the locality of capture. However, Aldous' field notes indicate that it was obtained at the Lake States Experimental Forest in Lake County. It is not unlikely that heather voles occur within the borders of Cook County, perhaps in populations of restricted size within discontinuous areas of suitable habitat. Numerous collectors have spent a great deal of time searching for this species in Minnesota without success. If this species is present in the state, its populations must be small and isolated.

Mus musculus Linnaeus, 1758

House Mouse

No records of this introduced murid are available from northeastern Minnesota, but, notwithstanding extensive efforts made to obtain house mice by trapping dumps and other habitats thought to be suitable, it probably occurs there. Johnson (1922) made no mention of this species in his discussions of rodents from neighboring Lake County. Peterson (1966) mapped several localities of record for *Mus musculus* along Lake Superior in Ontario and Cahn (1937) described the species as common in Quetico Provincial Park.

Myocastor coypus bonariensis (E. Geoffroy St.-Hilaire, 1805)

Nutria

The nutria, an aquatic caviomorph rodent intermediate in size between beavers and muskrats, was introduced from South America and has been raised for its fur in this country and in Canada. Individuals that have escaped or have been released occasionally are found living outside of captivity, but it is unlikely that they could survive the harsh winters and become permanently established as far north as Cook County. Feral *Myocastor* have been reported in Lake of the Woods County, Minnesota (Gunderson, 1955), and in the District of Thunder Bay, Ontario (Allin, 1955).

Mustela frenata spadix (Bangs, 1896)

Long-tailed Weasel

The only records of the long-tailed weasel in Cook County are in the field notes of W. J. Breckenridge. He wrote that long-tailed weasels were taken frequently in 1937 in the Lake Saganaga area of the northwestern corner of the county. This may be the sight record reported by Gunderson and Beer (1953). The nearest verified records in Minnesota are from St. Louis County. Johnson (1922) did not mention long-tailed weasels in Lake County and Cahn (1937) reported the species as extremely uncommon, but present in Quetico Provincial Park.

Felis concolor Kerr, 1792

Mountain Lion

It is questionable whether or not *Felis concolor* has ever lived in Cook County. A skull obtained by E. T. Seton from the Duluth area in the early 1900's represents the northeastern most and possibly the last verified record of a mountain lion in Minnesota. Hall and Kelson (1959) cited two records from Ontario, but these were only unsupported sight records. Numerous sightings of mountain lions have been reported from northern Minnesota, Manitoba, and Ontario (Bue and Stenlund, 1952, 1953; Dear, 1955; Thomson, 1974); unfortunately none of these is supported by tangible documentation. A specimen of *Felis concolor* was obtained recently in Manitoba (Nero, 1974). It is possible that mountain lions are in Minnesota, either as occasional transients or as residents in low numbers. For example, several persons, including at least one experienced field biologist, working at the University of Minnesota's Itasca Field Biology Station in Clearwater County reported sighting a mountain lion on several occasions during the summer of 1972. Nevertheless, documentation is lacking, most sightings were made at night, and the probability seems high that the animals observed were not *Felis concolor*.

Cervus elaphus canadensis Erxleben, 1777

Wapiti or Elk

There is some question as to whether or not elk were ever a part of the fauna of extreme northeastern Minnesota. No early literature records make specific reference to this species in the area, although Johnson (1916) described the elk as ranging through out the state. On the other hand, Murie (1951) did not include northeastern Minnesota in his estimate of the pre-Columbian distribution of elk. Cahn (1937) had two separate records of antlers found just north of the United States border in Ontario, and Murie (1951) cited a single record from the central part of that province.

DISCUSSION

Analysis of Parasite Fauna

Parasitic arthropods were found on 20 species of small mammals in Cook County. The groups of arthropods included Anoplura (sucking lice), Siphonaptera (fleas), Acari (mites, chiggers, and ticks). Host-parasite records are presented for 23 species of fleas, 11 species of mites, 6 species of sucking lice, and 3 species of ticks.

Mites and chiggers were found parasitizing 18 species of small mammals (Table 12). Mites are usually associated with a single taxon of hosts; however, some may be found on a wide range of hosts (e.g., *Androlaelaps fahrenholzi*). During this study, seven species of mites were recorded from Minnesota for the first time: *Myonyssus jamesoni, Eulaelaps stabularis, Haemogamasus reidi, Hirstionyssus isabellinus, Hirstionyssus talpae, Laelaps alaskensis,* and *Laelaps kochi.* This large number of new state records reflects the lack of attention that mites have received from collectors in this area. Also, new host records are reported for six species of mites as follows: *Androlaelaps fahrenholzi, Eulaelaps stabularis,* and *Hirstionyssus talpae* parasitizing *Condylura cristata; Eulaelaps stabularis* parasitizing *Clethrionomys gapperi*; *Haemogamasus ambulans* and *Hirstionyssus isabellinus* on *Synaptomys cooperi*; and *Haemogamasus liponyssoides* on *Zapus hudsonius.*

Of the three species of ticks found parasitizing small mammals in Cook County (Table 13), two species (*Ixodes angustus* and *I. muris*) were found commonly on a variety of hosts, whereas, the third (*Haemaphysalis leporispalustris*) is a rabbit tick. *Ixodes angustus* was identified as being parasitic on *Microtus chrotorrhinus* for the first time.

Twenty-three species of fleas were found associated with 18 species of mammalian hosts in Cook County (Table 14). Fleas are extremely mobile parasites and are found often on a wide variety of hosts, although they usually require specific hosts to complete their life cycle. Four species of fleas are reported from Minnesota for the first time: *Stenoponia americana, Atyphloceras bishopi, Tamiophila grandis, Nearctopsylla genalis,* and *Peromyscopsylla hamifera.* A single specimen of *Ctenocephalides felis,* the common cat flea, is known from the county. This flea is found commonly on domestic cats and dogs, and occasionally on wild carnivores. *Ctenocephalides canis,* the common dog flea, is to be expected also in this area although none was obtained.

Six species of sucking lice were found on seven species of hosts (Table 15). In general, the Anoplura are host-specific; however, *Hoplopleura acanthopus* is found on several species of microtine rodents. During this study, it was found commonly on both *Clethrionomys gapperi* and *Microtus pennsylvanicus.*

In examining the entire ectoparasite fauna of a mammalian community, three primary and two secondary categories of parasites can be identified: 1) taxa-specific parasites, including a) species-specific parasites (e.g., Anoplura) and b) parasites associated with higher taxa (e.g., *Orchopeas caedens,* a flea found on squirrels [Sciuridae]; 2) habitat-specific parasites, found on unrelated hosts that occupy similar habitats (e.g., *Ctenophthalmus pseudagyrtes*); and 3) cosmopolitan parasites found on diverse taxa and in a wide variety of habitats (e.g., *Androlaelaps fahrenholzi*).

The hypothesis that the natural classification of certain groups of parasites parallels that of their hosts was proposed first by H. Fahrenholz in the late 1800's. Fahrenholz drew his conclusions concerning phylogenetic parallelism of parasites and hosts while working on feather-mites (Acarina),

TABLE 12. Mites and chiggers found on some mammals from Cook County, Minnesota.

HOSTS \ PARASITES	*Spinturnix americanus*	*Myonyssus jamesoni*	*Eulaelaps stabularis*	*Androlaelaps fahrenholzi*	*Haemogamasus ambulans*	*Haemogamasus liponyssoides*	*Haemogamasus reidi*	*Hirstionyssus isabellinus*	*Hirstionyssus talpae*	*Laelaps alaskensis*	*Laelaps kochi*	Trombiculidae	Labidophoridae
Sorex arcticus						X							
Sorex cinereus				X									
Sorex palustris					X								
Blarina brevicauda		X	X	X	X	X				X			
Condylura cristata			X	X	X				X				
Myotis lucifugus	X											X	
Tamias striatus				X							X		
Eutamias minimus				X									
Marmota monax				X									
Tamiasciurus hudsonicus				X	X		X						
Glaucomys sabrinus					X								
Peromyscus maniculatus			X	X	X							X	
Clethrionomys gapperi			X	X	X	X						X	
Microtus chrotorrhinus										X	X		
Microtus pennsylvanicus			X	X	X	X				X	X	X	X
Synaptomys cooperi					X			X		X			
Zapus hudsonius				X		X						X	
Napaeozapus insignis				X								X	

but later hypothesized that it should be valid for both the sucking lice (Anoplura) and the chewing lice (Mallophaga). Eichler (1948) later proposed the term "Fahrenholz's Rule" for this hypothesis and coined the following definition: "In groups of permanent parasites the classification of the parasites usually corresponds directly with the natural relationships of the hosts." This work has remained unknown to most vertebrate taxonomists and, more surprisingly, to taxonomists working with the various groups of parasitic invertebrates despite the fact they have been utilizing and expanding on the original idea put forth by Fahrenholz.

At the basis of the theory is the assumption that at some point in the evolutionary history of host and parasite the parasite should enter a close association with the ancestral host after which both would evolve and speciate together. Thus speciation and specializations in the host would be paralleled by those of its parasites.

Although numerous individuals have discussed utilizing the classification of various groups of ectoparasites as a taxonomic tool in the classification of their vertebrate hosts (see Clay, 1970; Ferris, 1951; Hopkins, 1949; Jameson and Dusbábek, 1971; Rothschild and Clay, 1957; and others), little progress has been made. Two notable exceptions exist: Machado-Allison (1967) examined the parasitic bat mites of the family Spinturnicidae (Acarina: Mesostigmata) and proposed that the vampire bats (three monotypic genera: *Desmodus, Diaemus,* and *Diphylla*) were more closely re-

TABLE 13. Ticks (Ixodidae) found on some mammals from Cook County, Minnesota.

HOSTS \ PARASITES	*Ixodes angustus*	*Ixodes muris*	*Haemaphysalis leporispalustris*
Sorex arcticus	X	X	
Sorex palustris	X		
Blarina brevicauda	X		
Condylura cristata	X		
Lepus americanus			X
Tamias striatus	X		
Tamiasciurus hudsonicus	X	X	
Peromyscus maniculatus	X		
Clethrionomys gapperi	X		
Microtus chrotorrhinus	X		
Microtus pennsylvanicus	X	X	
Synaptomys cooperi	X	X	

lated to the New World leaf-nosed bats (family Phyllostomatidae) than had been recognized previously and suggested that the vampire bat family (Desmodontidae) be reduced to a subfamily of Phyllostomatidae. Subsequent systematic studies of the relationships between the two taxa of bats have supported this conclusion and the family Desmodontidae was reduced to a subfamily of the Phyllostomatidae (Forman, *et al.*, 1968). Machado-Allison (1967) also proposed that the Chilonycterinae, recognized as a subfamily of the Phyllostomatidae, be elevated to familial status on the basis that its mites were sufficiently distinct from all other spinturnicid mites found on phyllostomatids. Smith (1972) later monographed these bats and elevated the group to familial status for which he resurrected the name Mormoopidae.

Wenzel *et al.* (1966) examined the streblid batflies of Central American bats and drew several conclusions concerning chiropteran taxonomy. Independent of Machado-Allison, they proposed that the Chilonycterinae be ranked as a family rather than a subfamily of the Phyllostomatidae, and that the desmodontids are most closely related to the subfamily Phyllostomatinae of the Phyllostomatidae. They also discussed several other points in the taxonomy of the order Chiroptera that have yet to be investigated by mammalogists. Thus, through thorough examination of two separate groups of ectoparasites, two separate investigations drew similar conclusions and shed considerable light on the relationships between different mammalian taxa.

I felt it would be interesting to expand on this idea and examine the ectoparasitic fauna of a mammalian community to see what general relationships, if any, existed between the parasites and their hosts. Hosts and parasites obtained during this study proved ideal for such a comparison because the taxonomy of both groups is reasonably well understood and not unduly complex in this region. Additionally, large numbers of both hosts and parasites were obtained, yet extreme care was taken to avoid contamination. Principles that come to light here may be applicable to other such groups where the relationships are not well understood.

Parasitic Siphonaptera, Anoplura, Mesostigmata, and Ixodidae are included in the following analysis; Prostigmata (fur mites) were excluded because field collecting procedure did not adequately sample the group.

A two-dimensional phenogram of the hosts based entirely on their ectoparasites was generated using an agglomerative clustering program as outlined by Orloci (1967). This clustering technique uses within-group sum of squares as the agglomeration criterion. Agglomeration is carried out in successive cycles such that within-group sums of squares are minimized and the differences between groups are maximized at each clustering cycle. The program compares the entire set of data points for each species to the entire set for the next species. The host parameter utilized was Sorensen's (1948) similarity coefficient, representing the similarity of the parasite fauna between two hosts (see Fig. 6). Sorensen's similarity coefficient was calculated by the formula $S=\frac{2C}{A+B}$. Similarity (S) is equal to twice the number of ectoparasitic species in common (C) between two mammalian hosts di-

TABLE 14. Fleas (Siphonaptera) found on some mammals from Cook County, Minnesota. The asterisks indicate species of fleas from the county in the Entomology collection at the University of Minnesota, not obtained during this study.

HOSTS \ PARASITES	*Cediopsylla simplex**	*Ctenocephalides felis**	*Atyphloceras bishopi*	*Hystrichopsylla dippiei*	*Stenoponia americana*	*Catallagia borealis*	*Epitedia wenmanni*	*Tamiophila grandis*	*Ctenophthalmus pseudagyrtes*	*Corrodopsylla curvata*	*Nearctopsylla genalis*	*Opisodasys pseudarctomys*	*Orchopeas oaedens*	*Orchopeas leucopus*	*Megabothris acerbus*	*Megabothris asio*	*Megabothris quirini*	*Monopsyllus eumolpi*	*Monopsyllus vison*	*Monopsyllus wagneri*	*Peromyscopsylla catatina*	*Peromyscopsylla hamifera*	*Myodopsylla insignis*
Sorex arcticus										X													
Sorex cinereus											X												
Sorex palustris										X													
Blarina brevicauda							X		X	X	X					X							
Myotis lucifugus																							X
Lepus americanus	X							X									X						
Tamias striatus								X	X				X		X	X							
Eutamias minimus									X				X		X	X	X	X					
Tamiasciurus hudsonicus													X						X				
Glaucomys sabrinus												X	X										
Peromyscus maniculatus				X			X		X					X			X		X	X	X		
Clethrionomys gapperi			X		X	X			X					X			X				X		
Microtus chrotorrhinus																	X				X		
Microtus pennsylvanicus				X					X					X		X	X				X	X	
Synaptomys cooperi									X							X					X		
Zapus hudsonius																	X						
Napaeozapus insignis																					X		
Mustela erminea																X							
Host unknown		X																					

TABLE 15. Lice (Anoplura) found on some mammals from Cook County, Minnesota.

HOSTS \ PARASITES	*Hoplopleura acanthopus*	*Hoplopleura arboricola*	*Hoplopleura erratica*	*Hoplopleura hesperomydis*	*Neohaematopinus sciuropteri*	*Neohaematopinus semifasciatus*
Tamias striatus			X			
Eutamias minimus		X				
Tamiasciurus hudsonicus						X
Glaucomys sabrinus					X	
Peromyscus maniculatus				X		
Clethrionomys gapperi	X					
Microtus pennsylvanicus	X					

vided by the sum of the number of ectoparasitic species found on the first host (A) and the second host (B). The final analysis included 15 species of mammals: *Sorex arcticus, S. palustris, Blarina brevicauda, Condylura cristata, Tamias striatus, Eutamias minimus, Tamiasciurus hudsonicus, Glaucomys sabrinus, Peromyscus maniculatus, Clethrionomys gapperi, Microtus chrotorrhinus, M. pennsylvanicus, Synaptomys cooperi, Zapus hudsonius,* and *Napaeozapus insignis.* Parasites were also obtained from four species (*Sorex cinereus, Myotis lucifugus, Lepus americanus,* and *Mustela erminea*) not included here because preliminary analysis demonstrated that extremely small sample sizes of parasites, especially if the parasites are cosmopolitan, provide inconclusive results. *Myotis lucifugus* had no parasitic species in common with other hosts.

The phenogram (Fig. 7) demonstrates several interesting points and suggests areas for future research. It is by no means a replication of a phenogram that mammalogists would construct based on our current understanding of the taxonomic relationships of these species. Nevertheless, examination of the phenogram reveals that the species appear to be grouped into two types of categories that correspond to distance on the phenogram. Clustering at the .35 level and below closely approximates a taxonomic grouping. The two members of the genus *Sorex* are clustered; *Blarina brevicauda* and *Condylura cristata,* two insectivores, are clustered; *Clethrionomys gapperi* and *Microtus pennsylvanicus,* two microtine rodents, are clustered and these clustered closely to *Peromyscus maniculatus* (all are members of the family Cricetidae); and the two members of the family Zapodidae, *Zapus hudsonius* and *Napaeozapus insignis,* are clustered together as are the two chipmunks, *Tamias striatus* and *Eutamias minimus.* The *Microtus chrotorrhinus-Synaptomys cooperi* cluster reflects two phenomena. First, they are closely related microtine rodents and occupy similar habitats, hence have similar parasites, but furthermore only extremely small samples of both were obtained. This nonrepresentative sample of parasites, plus the overall similarity of parasites, accounts for the grouping of these two as a separate unit apart from the other microtine rodents. This grouping as well as a preliminary analysis including the four mammalian species in which only a few parasites were obtained indicates that the technique is dependent upon having a representative sample of parasites. Obtaining only one or two parasitic species from some hosts when it is known that a larger sample of hosts would increase this number, while other hosts are represented by 10+ parasitic species, does not give an accurate picture of the similarity of the ectoparasite fauna. Similarly, it is not necessary to have obtained all parasites present on a host species, although the closer this is approached the greater will be the accuracy of the technique. The grouping of *Tamiasciurus hudsonicus* with the cricetid rodents and the insectivores reflects a high proportion of habitat specific parasites on these species, although clustering at this level and above is not indicative of close similarity.

The phenogram also demonstrates the similarity of the ectoparasite fauna found in association with a mammalian community. The clustered groups found between 0 and .35 indicate that taxa-specific parasites tend to dominate the ectoparasite fauna on small mammals in northeastern Minnesota; this trend probably prevails for other areas as well. However, taxa-specific ectoparasites are only one component of the parasite

	Sorex palustris	Blarina brevicauda	Condylura cristata	Tamias striatus	Eutamias minimus	Tamiasciurus hudsonicus	Glaucomys sabrinus	Peromyscus maniculatus	Clethrionomys gapperi	Microtus chrotorrhinus	Microtus pennsylvanicus	Synaptomys cooperi	Zapus hudsonius	Napaeozapus insignis
Sorex arcticus	.57	.38	.22	.15	0.0	.33	0.0	.12	.23	.22	.30	.33	.14	0.0
Sorex palustris		.40	.50	.08	0.0	.36	.29	.25	.25	.25	.21	.36	0.0	0.0
Blarina brevicauda			.50	.38	.30	.30	.06	.48	.48	.24	.57	.50	.27	.14
Condylura cristata				.29	.15	.31	.22	.44	.44	.20	.38	.31	.25	.29
Tamias striatus					.59	.35	.15	.27	.27	.29	.40	.35	.17	.18
Eutamias minimus						.25	.17	.29	.29	.15	.25	.13	.36	.20
Tamiasciurus hudsonicus							.33	.38	.38	.15	.33	.38	.18	.20
Glaucomys sabrinus								.12	.12	0.0	.10	.17	0.0	0.0
Peromyscus maniculatus									.63	.33	.62	.38	.25	.27
Clethrionomys gapperi										.33	.69	.38	.38	.27
Microtus chrotorrhinus											.48	.46	.25	.29
Microtus pennsylvanicus												.58	.32	.22
Synaptomys cooperi													0.0	.10
Zapus hudsonius														.40
Napaeozapus insignis														

FIGURE 6. Sorensen similarity coefficients comparing the ectoparasite faunas of 15 species of small mammals from Cook County, Minnesota.

load, and conclusions based on the parasite fauna must take this into consideration.

In this analysis Sorensen's similarity coefficient was utilized as an absolute value. Several other indices are available and their use in this technique should be considered as should standardization of the data. Weighing taxa of highly host specific categories would produce greater resolution. Similarly, species that are habitat specific could be utilized in comparisons of communities.

As a taxonomic tool, this technique probably will prove more useful in examining the relationships between a single taxa of hosts over its geographic range or in analysis of taxa that exemplify great diversity within a limited area (e.g., heteromyid rodents in the southwestern U.S.) than in comparing a diverse group of taxa as was done here.

Examination of an entire fauna of ectoparasites may prove to be a useful tool for ecologists in determinations of similarities and differences between hosts or communities.

Comments on Zoogeography

Fifty-nine species of mammals are known or believed to occur in Cook County, Minnesota. Four of these are adventive. Thus, the native mammalian fauna of the county consists of 55 species of verified or possible occurrence. These can be divided into three groups on the basis of habitat preference and presumed common zoogeo-

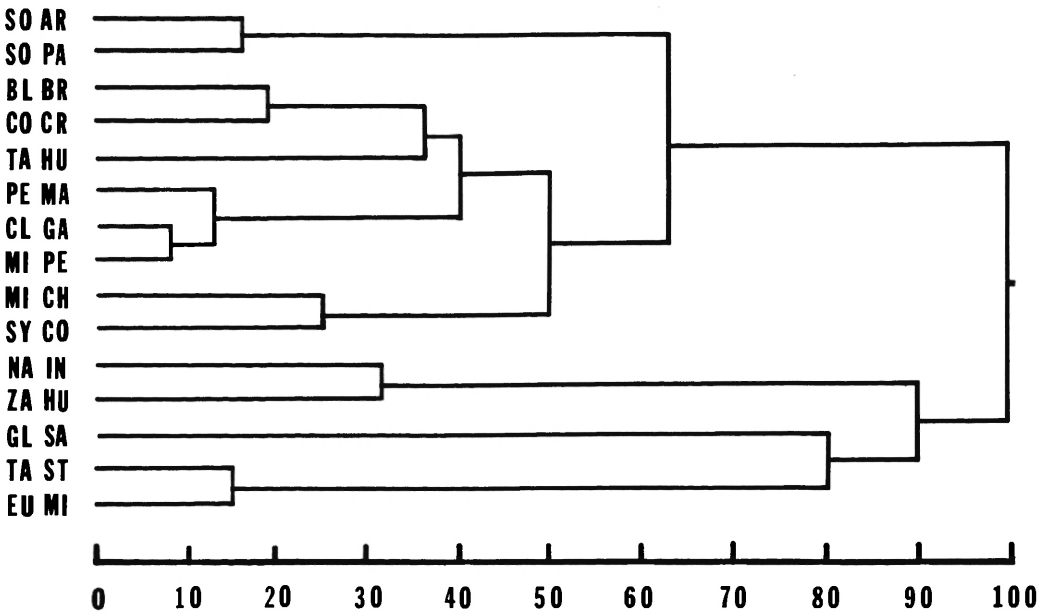

FIGURE 7. Optimal agglomeration phenogram generated from similarity coefficients. Distance on the ordinate is average within-group dispersion as a percent of the total. The following codes represent the mammalian species shown in parentheses: SO AR (*Sorex arcticus*), SO PA (*Sorex palustris*), BL BR (*Blarina brevicauda*), CO CR (*Condylura cristata*), TA HU (*Tamiasciurus hudsonicus*), PE MA (*Peromyscus maniculatus*), CL GA (*Clethrionomys gapperi*), MI PE (*Microtus pennsylvanicus*), MI CH (*Microtus chrotorrhinus*), SY CO (*Synaptomys cooperi*), NA IN (*Napaeozapus insignis*), ZA HU (*Zapus hudsonius*), GL SA (*Glaucomys sabrinus*), TA ST (*Tamias striatus*), EU MI (*Eutamias minimus*).

graphic affinities as proposed by Hoffmann and Jones (1970). Included are coniferous or boreal forest species, deciduous forest species, and species of widespread occurrence. Adventive species form a fourth, ecologically heterogeneous group.

Coniferous forest species.—Species associated primarily with the coniferous forests are generally restricted to the northern third of North America and the coniferous forest zones that extend down the Appalachian, Rocky, Cascade, and Sierra Nevada mountain ranges. This group of 25 species comprises the largest single mammalian faunal unit in the county. Included are: *Sorex arcticus, S. cinereus, S. fumeus, S. palustris, Microsorex hoyi, Condylura cristata, Lepus americanus, Eutamias minimus, Tamiasciurus hudsonicus, Glaucomys sabrinus, Clethrionomys gapperi, Phenacomys intermedius, Microtus chrotorrhinus, M. pennsylvanicus, Synaptomys cooperi, Zapus hudsonius, Napaeozapus insignis, Martes americana, M. pennanti, Mustela erminea, M. nivalis, Gulo gulo, Lynx canadensis, Alces alces,* and *Rangifer tarandus.* Most of these species are common in Cook County at the present time or probably were common in recent history. The paucity of information concerning *Microsorex, Phenacomys,* and *Gulo* in Minnesota handicaps interpretation of their present status. Wolverines most assuredly have lived within the county during the past century, but no documentation of this exists, although they have been reported from adjacent areas both to the west and north. *Microsorex* probably lives within the county at present; specimens have been collected from St. Louis County to the west and Quetico Provincial Park to the north. *Phenacomys* is known from Minnesota by only one specimen, which was trapped near Ely, St. Louis County. Five coniferous forest species, *Mustela erminea, M. nivalis, Gulo gulo, Alces alces,* and *Rangifer tarandus,* are of Holarctic distribution and several other species have closely related Palearctic counterparts.

Deciduous forest species.—Deciduous forest species, which generally are distributed throughout eastern North America, comprise the smallest of the three faunal associations. Nine species in Cook County

are considered to be of deciduous forest affinity: *Blarina brevicauda, Myotis keenii, Lasiurus borealis, Sylvilagus floridanus, Tamias striatus, Marmota monax, Sciurus carolinensis,* S. *niger,* and *Urocyon cinereoargenteus.* Two of these, *Sciurus carolinensis* and *Urocyon cinereoargenteus,* are recent (within the past few decades), apparently natural additions to the mammalian fauna of Cook County. Four species (*Lasiurus borealis, Marmota monax, Sciurus carolinensis,* and *Urocyon cinereoargenteus*) are not common in the county and the records of *Sylvilagus floridanus* and *Sciurus niger* are questionable (see accounts of species). Of the deciduous forest species, only *B. brevicauda, M. keenii,* and *T. striatus* are common in Cook County.

Widespread species.—Species of widespread occurrence are not restricted to any particular habitat type, but generally are found throughout much of North America. Twenty-one mammalian species are included in this category from Cook County as follows: *Myotis lucifugus, Lasionycteris noctivagans, Eptesicus fuscus, Lasiurus cinereus, Castor canadensis, Peromyscus maniculatus, Ondatra zibethicus, Erethizon dorsatum, Canis latrans, C. lupus, Vulpes vulpes, Ursus americanus, Procyon lotor, Mustela frenata, M. vison, Mephitis mephitis, Lontra canadensis, Felis concolor, Lynx rufus, Cervus elaphus,* and *Odocoileus virginianus.* Four species, *Canis latrans, Procyon lotor, Lynx rufus,* and *Odocoileus virginianus,* recently have extended their ranges to include Cook County, and three others, *Mustela frenata, Felis concolor,* and *Cervus elaphus,* are lacking documentary records from the county (see species accounts and the following discussion). Most species in this widespread group are common in the county, at least at certain times.

Introduced species.—Lepus europaeus, Rattus norvegicus, Mus musculus, and *Myocastor coypus* have been introduced by man and thus are not native to North America. *L. europaeus* and *M. coypus* probably are not established in Cook County at the present time. The two murids, *Rattus* and *Mus,* have spread throughout much of North America since 1492. Norway rats were found living as commensals with man in Cook County and house mice almost surely are resident there today, although this is unverified.

In summary, 46 of the 55 native mammals of verified or possible occurrence in Cook County, Minnesota, have coniferous forest and widespread affinities. The 25 coniferous forest species comprise 46 percent of the native mammalian fauna, 21 widespread species comprise 38 percent, and the nine deciduous forest species account for the remaining 16 percent.

Discussion.—Mammalian distributions are in dynamic equilibrium with the environment, and although they may appear so at any given time, they are not static entities. Most mammals are highly mobile and opportunistic, capable of expanding their ranges into suitable habitats as conditions favorable to their living requirements are met. Changes in the environment continuously alter habitats; this allows colonization by some species and concomitant reduction of suitable habitat for others.

Pleistocene glaciers, which persisted in northeastern Minnesota until 9,000-10,000 years BP, played a major role in determining the topography and vegetation of Cook County. Some mammals of coniferous and widespread affinity already were in the area before retreat of the glaciers. However, the retreating ice and subsequent revegetation allowed several species to immigrate into the area from the south. Fluctuating margins of glaciers are known to be one causative agent in isolating mammalian populations, especially those characterized by low mobility or narrow habitat requirements. Relictual populations of *Microtus chrotorrhinus* in Cook County apparently became isolated there as a result of such fluctuations.

Forest fires played a major role in shaping the vegetational patterns of northeastern Minnesota long before the arrival of European man. Periodic fires burned huge sections of the forest, destroying some community types while creating conditions for earlier seral stages. Heinselman (1969; 1973*a*) and Swain (1973) have described and quantified fires and their effects on the forest community in northeastern Minnesota during the last 1,000 years. They estimated that each area burnt an average of every 70-80 years over the past millennium, and concluded that fire has had a positive effect on the long-term stability of the area by increasing diversity of vegetational types. The importance of forest fires in the

ecosystem, with special reference to this area, has been discussed recently by Wright (1974), Wright and Heinselman (1973), and Heinselman (1973*b*). By increasing vegetational and community diversity, fire undoubtedly has been instrumental in the diversification of the mammalian fauna of Cook County. Differential abilities of small mammals to recolonize after fire was recently investigated in this area by Krefting and Ahlgren (1974).

Impact of Man's Activities

The search for furs, especially beaver, led to early exploration and settlement in northeastern Minnesota. By the late 1600's, several French explorers (e.g., Pierre Esprit Radisson, Sieur des Groseilliers, Sieur Du Luth, and Jacques De Noyon) had visited the region. Since 1731, when Sieur de la Vérendrye established a series of trading posts with the Indians throughout the region, man's exploitation of the fauna has been severe. Pigeon River took its name from the huge flocks of passenger pigeons that nested there. Today, of course, the species is extinct. Only two of the original mammalian inhabitants (*Gulo gulo* and *Rangifer tarandus*) have been extirpated from Cook County, and although their ranges have been reduced considerably, both are still plentiful in other areas. Furbearers were overexploited during the 19th century, but proper management during this century has led to significant increases in their numbers, especially during the past 25 years. Beaver, mink, fisher, and otter are again common throughout the region and the marten is becoming more numerous. In fact, allowing an annual harvest of fishers is now in order to utilize most efficiently those animals that are captured accidentally in traps set for other fur-bearers. With proper management, successful harvests during a carefully monitored annual trapping season should not jeopardize the substantial breeding populations of fishers in northeastern Minnesota. The marten, however, remains in need of complete protection.

Extensive logging began in northeastern Minnesota in the late 1800's. Red and white pine were the most desired trees, but spruce, cedar, and tamarack also were taken. Unlike forest fires, logging of pine stands removed the seed sources, and these species failed to regenerate in many areas (Heinselman, 1969). Aspen, birch, and fir reforested such areas and for several years provided excellent habitat for pioneer-stage species, including some species (e.g., white-tailed deer) that were able to expand their ranges to include Cook County.

Other human disturbances of the environment, such as creating roads and grassy road ditches through the forest, provided corridors for immigration of certain prairie species. For example, Franklin's ground squirrels (*Spermophilus franklinii*) and thirteen-lined ground squirrels (*S. tridecemlineatus*), recently have extended their range into the Duluth area (Robins, 1971; Gunderson and Beer, 1953), but apparently have yet to reach Cook County.

Of the 48 species of mammals known to occur in Cook County, Minnesota, at least six (*Sciurus carolinensis, Canis latrans, Urocyon cinereoargenteus, Procyon lotor, Lynx rufus, Odocoileus virginianus,* and possibly *Lasiurus borealis*) are there as a result of recent expansion of their ranges; one species (*Rattus norvegicus*) was introduced by man; and two species (*Gulo gulo* and *Rangifer tarandus*) have been extirpated recently. The recent arrivals in Cook County are of deciduous forest or widespread affinities and the abilities of most to co-exist with man are well known. The two extirpated species are of coniferous forest affinity and both are known to be largely unable to co-exist with man and intolerant of human-related disturbances to the environment. Nevertheless, the overall effect of man's activities on the post-Columbian mammalian fauna of Cook County has been to increase diversity at the expense of two species.

There is no indication that the native small mammals of the region are threatened currently by man. Most insectivores, bats, rodents, and small carnivores are found throughout the entire region wherever suitable habitat exists. Habitat destruction in small areas (e.g., such as resorts or communities) does not pose a threat to the continued existence in the state, or even Cook County specifically, for most species, although local populations may be decimated. The rock vole (*Microtus chrotorrhinus*) and the heather vole (*Phenacomys intermedius*) are exceptions to this generalization. Despite considerable col-

lecting in the area by numerous individuals, only a single, small population of rock voles is now known to exist in the state of Minnesota, and the status of the heather vole is unknown; if present, they probably occur only in small, localized areas. Any disturbance by man of the limited natural habitat available to these voles would pose a definite threat to the continued existence of the species in the state.

As the population of *Homo sapiens* in the area increases, the continued harmonious co-existence of some elements of the native mammalian fauna and man appears unlikely. A predictable change in the faunal elements would be to increase the number of species of widespread and deciduous forest affinity and to decrease the number of coniferous forest species. If sufficient areas are left unchanged for wildlife habitat, it is likely that man's activities will not endanger the populations of most insectivores, bats, rodents, and small carnivores in the county. However, the impact of an appreciable increase in the human population or of a major change in land usage could be considerable and the consequences should be considered seriously before such action is taken.

ACKNOWLEDGMENTS

This study was made possible by a grant from the W/M Foundation. I am grateful for this support and for the continued interest Wallace C. Dayton has shown for this project. The Department of Ecology and Behavioral Biology at the University of Minnesota also provided support in the form of research and teaching assistantships.

The local council of the Grand Portage Indian Reservation granted permission for field investigations on Indian land within the county's borders. William H. Longley of the Department of Natural Resources was helpful in supplying harvest records on fur-bearers and big game. Daniel C. Ross, Conservation Officer from Schroeder, William Peterson, Area Game Manager from Grand Marais, Lloyd Scherer of Lutsen, William Heigler of Taconite Harbor, and John Hart of Grand Portage donated numerous carcasses of fur-bearers and shared with me their knowledge of the local fauna. John Peshek of Blaine, Minnesota, assisted in several aspects of the field work; his efforts are appreciated.

Several of my colleagues in the Bell Museum of Natural History at the University of Minnesota assisted in criticizing my ideas and in giving needed technical advice. I am grateful to Donna Day Baird, Steven H. Fritts, Lawrence R. Heaney, Richard P. Lampe, and Jeanette A. Thomas. Lawrence R. Heaney's assistance in collecting specimens and in examining mammals from Cook County housed in the American Museum of Natural History and the Carnegie Museum is appreciated. John Jarosz provided records of carnivores captured in Cook County and prepared by him for use in exhibits.

Clyde J. Jones and Don E. Wilson, National Museum of Natural History; Robert S. Hoffmann, Museum of Natural History, The University of Kansas; and Emmet T. Hooper, Museum of Zoology, The University of Michigan, allowed me to examine specimens from Minnesota in their respective collections.

I am grateful to Allen H. Benton, Henry J. Griffiths, James E. Keirans, Ke Chung Kim, and Nixon Wilson for identification of parasites. Ronald A. Hellenthal wrote the computer program utilized in the analysis of parasite data. Carol Gobar and Linda Forcier typed copies of the manuscript.

I would like to thank David M. Armstrong of the University of Colorado, Boulder, and Evan B. Hazard, Bemidji State College, Bemidji, Minnesota, for their critical review of the manuscript.

My graduate committee included: Elmer C. Birney, Robert C. Bright, Magnus Olson, and Harrison B. Tordoff. Each offered valuable criticisms of the manuscript. I acknowledge my advisor, Elmer C. Birney, for his needed criticisms of my ideas and use of the English language, and for his continued assistance throughout this project.

LITERATURE CITED

Aldous, C. M. 1936. Food habits of Lepus americanus phaeonotus. Jour. Mammalogy, Vol. 17:175-176.

——. 1937. Notes on the life history of the snowshoe hare. Jour. Mammalogy, Vol. 18:46-57.

——. 1947. Some forest-wildlife problems in the Lake States. U.S. Forest Service, Lake States Forest Exp. Sta., No. 6, 11 p.

Aldous, S. E. 1937. A hibernating black bear with cubs. Jour. Mammalogy, Vol. 18: 466-468.

Aldous, S. E., and J. Manweiler. 1942. The winter food habits of the short-tailed weasel in northern Minnesota. Jour. Mammalogy, Vol. 23:250-255.

Allin, A. E. 1942. Bats hibernating in the District of Thunder Bay, Ontario. Canadian Field-Nat., Vol. 56:90-91.

——. 1950. European hare introduced into the District of Thunder Bay, Ontario. Canadian Field-Nat., Vol. 64:122-124.

——. 1955. Nutria, *Myocastor coypus*, in Thunder Bay District, Ontario. Canadian Field-Nat., Vol. 69:25-26.

Ames, A. E. 1873. Mammalia of Minnesota. Bull. Minnesota Acad. Sci., Vol. 1:68-71.

Anderson, R. M. 1946. Catalogue of Canadian Recent Mammals. Bull. Nat. Mus. Canada, Vol. 102:v + 1-238.

Anonymous. 1924. Caribou on North Shore. Fins, Feathers and Fur, Vol. 37:169.

Bailey, B. 1929. Mammals of Sherburne County, Minnesota. Jour. Mammalogy, Vol. 10:153-164.

Bailey, V. 1900. Revision of American voles of the genus Microtus. N. Amer. Fauna, No. 17:1-88.

——. 1926. A biological survey of North Dakota. N. Amer. Fauna, No. 49:vi + 1-226.

Balser, D. S., and W. H. Longley. 1966. Increase of the fisher in Minnesota. Jour. Mammalogy, Vol. 47:547-550.

Banfield, A. W. F. 1974. The mammals of Canada. Univ. Toronto Press, Toronto, xxv + 438.

Beer, J. R. 1953. Two new locality records for mammals in Minnesota. Jour. Mammalogy, Vol. 34:384-385.

——. 1955. Survival and movements of banded big brown bats. Jour. Mammalogy, Vol. 36:242-248.

Beer, J. R., and A. G. Richards. 1956. Hibernation of the big brown bat. Jour. Mammalogy, Vol. 37:31-41.

Birney, E. C. 1974. Twentieth century records of wolverine in Minnesota. Loon, Vol. 46:78-81.

Bole, B. P., Jr., and P. N. Moulthrop. 1942. The Ohio recent mammal collection in the Cleveland Museum of Natural History. Sci. Publs. Cleveland Mus. Nat. Hist., Vol. 5:83-181.

Breckenridge, W. J. 1949. A century of Minnesota wild life. Minnesota Hist., Vol. 30:123-134.

Brown, L. N. 1970. Population dynamics of the western jumping mouse (*Zapus princeps*) during a four year study. Jour. Mammalogy, Vol. 51:651-658.

Bue, G. T., and M. H. Stenlund. 1952. Are there mountain lions in Minnesota? Conserv. Volunteer, Vol. 15(89):32-37.

Bue, G. T., and M. H. Stenlund. 1953. Recent records of the mountain lion, *Felis concolor*, in Minnesota. Jour. Mammalogy, Vol. 34:390-391.

Burcalow, D. W., and W. H. Marshall. 1958. Deer numbers, kill, and recreational use on an intensively managed forest. Jour. Wildl. Manage., Vol. 22:141-148.

Burt, W. H. 1969. Mammals of the Great Lakes Region. Univ. Michigan Press, Ann Arbor. xv + 246 p.

Byman, D. 1972. Food habits and internal parasites of the timber wolf in northeastern Minnesota. Unpubl. M.S. Thesis, Univ. Minnesota, Minneapolis, v + 74 p.

Cahn, A. R. 1921. The Mammals of Itasca County, Minnesota. Jour. Mammalogy, Vol. 2:68-74.

——. 1937. The mammals of Quetico Provincial Park of Ontario. Jour. Mammalogy, Vol. 18:19-30.

Choate, J. R. 1970. Systematics and zoogeography of Middle American shrews of

the genus Cryptotis. Univ. Kansas Publ., Mus. Nat. Hist., Vol. 19:195-317.

Clay, T. 1970. The Amblycera (Phthiraptera: Insecta). Bull. British Mus. (Nat. Hist.) Ent., Vol. 25:75-98.

Clough, G. C. 1959. Extension of range of the woodland jumping mouse. Jour. Mammalogy, Vol. 40:449.

Conaway, C. H. 1952. Life history of the water shrew (*Sorex palustris navigator*). Amer. Midl. Nat., Vol. 48:219-248.

Condrin, J. M. 1936. Observations on the seasonal and reproductive activities of the eastern chipmunk. Jour. Mammalogy, Vol. 17:231-234.

Connor, P. F. 1959. The bog lemming *Synaptomys cooperi* in southern New Jersey. Biol. Ser., Michigan State Univ., Vol. 1:161-248.

Coulter, J. C. 1961. An investigation of possible commensalism in red squirrels, yellow-bellied sapsuckers, and hummingbirds at the Lake Itasca Biological Station. Proc. Minnesota Acad. Sci., Vol. 29:272-274.

Cox, W. T. 1936. Snowshoe rabbit migration, tick infestation, and weather cycles. Jour. Mammalogy, Vol. 17:216-221.

Davis, D. E., and J. T. Emlen, Jr. 1948. The placental scar as a measure of fertilty in rats. Jour. Wildl. Manage., Vol. 12:162-166.

Davis, W. H., and C. H. Ernst. 1971. The taxonomic status of Zapus in northwestern Minnesota. Amer. Midl. Nat., Vol. 85:265-267.

Dean, P. B., and A. de Vos. 1965. The spread and present status of the European hare, *Lepus europaeus hybridus* (Desmarest), in North America. Canadian Field-Nat., Vol. 79:38-48.

Dear, L. S. 1955. Cougar or mountain lion reported in northwestern Ontario. Canadian Field-Nat., Vol. 69:26.

de Vos, A. 1964. Range changes of mammals in the Great Lakes region. Amer. Midl. Nat., Vol. 71:210-231.

Eadie, W. R., and W. J. Hamilton, Jr. 1956. Notes on reproduction in the star-nosed mole. Jour. Mammalogy, Vol. 37: 223-231.

Eichler, W. 1948. Some rules in ectoparasitism. Ann. Mag. Nat. Hist., Vol. 1:588-598.

Ellerman, J. R., and T. C. S. Morrison-Scott. 1951. Checklist of Palaearctic and Indian mammals, 1758 to 1946. British Museum (Nat. Hist.), London, 810 p.

Erickson, A. B. 1939. Beaver populations in Pine County, Minnesota. Jour. Mammalogy, Vol. 20:195-201.

Erickson, A. B., V. E. Gunvalson, M. H. Stenlund, D. W. Burcalow, and L. H. Blankenship. 1961. The white-tailed deer of Minnesota. Tech. Bull., Minnesota Dept. Conserv., No. 5: 1-64.

Evans, C. A. 1934. Hibernating bats in Minnesota. Jour. Mammalogy, Vol. 15:240-241.

Fashingbauer, B. A. 1965. The woodland caribou in Minnesota. P. 133-166 *in* Moyle, J. B., *Editor*, Big game in Minnesota. Tech. Bull. Minnesota Dept. Conserv., No. 9:1-231.

Fashingbauer, B. A., and J. B. Moyle. 1963. Nutritive value of red-osier dogwood and mountain maple as deer browse. Proc. Minnesota Acad. Sci., Vol. 31:73-77.

Ferris, G. F. 1951. The sucking lice. Mem. Pacific Coast Ent. Soc., Vol. 1. ix + 1-320.

Forbes, R. B. 1966. Studies of the biology of Minnesotan chipmunks. Amer. Midl. Nat., Vol. 76:290-308.

Forman, G. L., R. J. Baker, and J. D. Gerber. 1968. Comments on the systematic status of vampire bats (Family Desmodontidae). Syst. Zool., Vol. 17:417-425.

Goehring, H. H. 1954. *Pipistrellus subflavus obscurus, Myotis keenii,* and *Eptesicus fuscus fuscus* hibernating in a storm sewer in central Minnesota. Jour. Mammalogy, Vol. 35:434-435.

_____. 1971. Big brown bat survives sub-zero temperature. Jour. Mammalogy, Vol. 52:832-833.

_____. 1972. Twenty-year study of *Eptesicus fuscus* in Minnesota. Jour. Mammalogy, Vol. 53:201-207.

Goldman, E. A. 1944. Classification of wolves. P. 389-636 *in* The wolves of

North America. Young, S. P., an E. A. Goldman. Amer. Wildl. Inst., Washington, D. C. 636 p.

Golley, F. B. 1961. Interaction of natility, mortality and movement during one annual cycle in a Microtus population. Amer. Midl. Nat., Vol. 66:152-159.

Grant, U. S. 1899. The geology of Cook County. Minnesota Geol. and Nat. Hist. Surv., No. 4:313-345.

Grout, F. F., R. P. Sharp, and G. M. Schwartz. 1959. The geology of Cook County, Minnesota. Bull. Minnesota Geol. Surv., No. 39:xvi + 163.

Gunderson, H. L. 1955. Nutria, *Myocastor coypus*, in Minnesota. Jour. Mammalogy, Vol. 36:465.

_____. 1965. Marten records for Minnesota. Jour. Mammalogy, Vol. 46:688.

Gunderson, H. L., and J. R. Beer. 1953. The mammals of Minnesota. Occas. Papers, Minnesota Mus. Nat. Hist., Univ. Minnesota, No. 6:xii + 190.

Hall, E. R. 1946. Mammals of Nevada. Univ. California Press, Berkeley, xi + 710 p.

_____. 1951. American weasels. Univ. Kanas Publ., Mus. Nat. Hist., Vol. 4:1-466.

Hall, E. R., and E. L. Cockrum. 1953. A synopsis of the North American microtine rodents. Univ. Kansas Publ., Mus. Nat. Hist., Vol. 5:373-498.

Hall, E. R., and K. R. Kelson. 1959. The mammals of North America. Ronald Press Co., New York, 2 vols. 1:xxx + 1-546 + 79; 2:viii + 547-1083 + 79.

Hamilton, W. J., Jr. 1943. The mammals of eastern United States. Comstock Publ. Co., Inc., Ithaca, New York, 432 p.

Handley, C. O., Jr. 1954. *Phenacomys* in Minnesota. Jour. Mammalogy, Vol. 35: 260.

Hatfield, D. M. 1937. Notes on Minnesota squirrels. Jour. Mammalogy, Vol. 18: 242-243.

_____. 1939. Winter food habits of foxes in Minnesota. Jour. Mammalogy, Vol. 20: 202-206.

Hatton, J. H. 1919. District forester's report on game. Fins, Feathers and Fur, No. 17:12-14.

Heaney, L. R., and E. C. Birney. 1975. Comments on the distribution and natural history of some mammals in Minnesota. Canadian Field-Nat., Vol. 89:29-34.

Heinselman, M. L. 1969. Diary of the canoe country's landscape. Naturalist, Vol. 20 (1):2-31.

_____. 1973*a*. Fire in the virgin forests of the boundary waters canoe area, Minnesota. Quaternary Res., Vol. 3:329-382.

_____. 1973*b*. Restoring fire to the canoe country. Naturalist, Vol. 24(4):21-31.

Herrick, C. L. 1892. The mammals of Minnesota. . . . Bull. Geo. and Nat. Hist. Surv. Minnesota, No. 7:1-299.

Hoffmann, R. S., and J. K. Jones, Jr. 1970. Influence of late-glacial and post-glacial events on the distribution of Recent mammals on the Northern Great Plains. P. 355-394 *in* Dort, W., Jr., and J. K. Jones, Jr., *Editors*, Pleistocene and Recent environments of the central Great Plains. Spec. Publ. Dept. Geol., Univ. Kansas, No. 3:1-433.

Hollister, N. 1913. A synopsis of the American minks. Proc. U.S. Nat. Mus., Vol. 44:471-480.

Hopkins, G. H. E. 1949. Some factors which have modified the phylogenetic relationship between parasite and host in the Mallophaga. Proc. Linnean Soc. London, Session 161:37-39.

Hovde, M. R. 1941. Climate of Minnesota. *in* Climate and Man. Yearbook of Agr., Washington, D.C.

Howell, A. H. 1929. Revision of the American chipmunks (genera Tamias and Eutamias). N. Amer. Fauna, No. 52:1-157.

Idstrom, J. M. 1965. The moose in Minnesota. P. 57-98 *in* Moyle, J. B., *Editor*, Big game in Minnesota. Tech. Bull. Minnesota Dept. Conserv., No. 9:1-231.

Jackson, H. H. T. 1928. A taxonomic review of the American long-tailed shrews (genera Sorex and Microsorex). N. Amer. Fauna, No. 51:vi + 238.

_____. 1972. Mammals of Wisconsin. Univ. Wisconsin Press, Madison. 504 p.

Jameson, E. W., Jr., and F. Dusbábek. 1971. Comments on the myobiid mite genus

Protomyobia. Jour. Med. Ent., Vol. 8: 33-36.

Johnson, C. E. 1916. A brief descriptive list of Minnesota mammals. Fins, Feathers and Fur, No. 8:1-8.

_____. 1922. Notes on the mammals of northern Lake County, Minnesota. Jour. Mammalogy, Vol. 3:33-39.

_____. 1923. A recent report of the wolverine in Minnesota. Jour. Mammalogy, Vol. 4:54-55.

Johnson, M.S. 1930. Common injurious mammals of Minnesota. Bull. Univ. Minnesota Agr. Exp. Sta., No. 259:1-67.

Jones, J. K., Jr., D. C. Carter, and H. H. Genoways. 1973. Checklist of North American mammals north of Mexico. Occas. Papers Mus., Texas Tech Univ., No. 12:1-14.

Karns, P. D. 1967. The moose in northeastern Minnesota. Jour. Minnesota Acad. Sci., Vol. 34:114-116.

Keith, L. B. 1963. Wildlife's ten-year cycle. Univ. Wisconsin Press, Madison, xvi + 201 p.

Keller, B. L., and C. J. Krebs. 1970. *Microtus* population biology; III. Reproductive changes in fluctuating populations of *M. ochrogaster* and *M. pennsylvanicus* in southern Indiana, 1965-67. Ecol. Monogr., Vol. 40:263-294.

Kinsey, C. 1965. The black bear in Minnesota. P. 179-210 *in* Moyle, J. B., *Editor*, Big game in Minnesota. Tech. Bull. Minnesota Dept. Conserv., 9:1-231.

Kramm, K. R., D. E. Maki, and J. M. Glime. 1975. Variation within and among populations of red squirrel in the Lake Superior region. Jour. Mammalogy, Vol. 56:258-262.

Krefting, L. W., and C. E. Ahlgren. 1974. Small mammals and vegetation changes after fire in a mixed conifer-hardwood forest. Ecology, Vol. 55:1391-1398.

Küchler, A. W. 1964. Potential natural vegetation of the conterminous United States. Spec. Publ., Amer. Geogr. Soc., No. 36:v + 1-39 + map + 116 plates.

Kurtén, B., and R. Rausch. 1959. Biometric comparisons between North American and European mammals. Acta Arctica, Fasc. 11:5-44.

Longly, W. H., and J. B. Moyle. 1963. The beaver in Minnesota. Tech. Bull., Minnesota Dept. Conserv., No. 6:1-87.

Machado-Allison, C. E. 1967. The systematic position of the bats *Desmodus* and *Chilonycteris*, based on host-parasite relationships (Mammalia; Chiroptera). Proc. Biol. Soc. Washington, Vol. 80: 223-226.

Marshall, W. H., G. W. Gullion, and R. G. Schwab. 1962. Early summer activities of porcupines as determined by radiopositioning techniques. Jour. Wildl. Manage., Vol. 26:75-79.

McMiller, P. R. 1947. Principal soil regions of Minnesota. Bull. Univ. Minnesota Agr. Exp. Sta., No. 392:1-48.

Mech, L. D. 1970. The wolf: the ecology and behavior of an endangered species. Nat. Hist. Press, Garden City, New York, xxii + 384 p.

_____. 1973*a*. Wolf numbers in the Superior National Forest of Minnesota. N. Cent. Forest Exp. Sta., St. Paul, Minnesota, No. 97:1-10.

_____. 1973*b*. Canadian lynx invasion of Minnesota. Biol. Conserv., Vol. 5:151-152.

Mech, L. D., and L. D. Frenzel, Jr. (*Editors*). 1971*a*. Ecological studies of the timber wolf in northeastern Minnesota. N. Cent. Forest Exp. Sta., St. Paul, Minnesota, No. 52:1-62.

_____. 1971*b*. An analysis of the age, sex, and condition of deer killed by wolves in northeastern Minnesota. P. 35-51 *in* Mech, L. D., and L. D. Frenzel, Jr., *Editors*, Ecological studies of the timber wolf in northeastern Minnesota. N. Cent. Forest Exp. Sta., St. Paul, Minnesota, No. 52:1-62.

_____. 1971*c*. The possible occurrence of the Great Plains wolf in northeastern Minnesota. P. 60-62 *in* Mech, L. D., and L. D. Frenzel, Jr., *Editors*, Ecological studies of the timber wolf in northeastern Minnesota. N. Cent. Forest Exp. Sta., St. Paul, Minnesota, No. 52:1-62.

Millar, J. S. 1970. The breeding season and reproductive cycle of the western red squirrel. Canadian Jour. Zool., Vol. 48: 471-473.

Morse, M. A. 1937. Hibernation and breeding of the black bear. Jour. Mammalogy, Vol. 18:460-465.

Murie, O. J. 1951. The elk of North America. Stackpole Co., and Wild. Manage. Inst., Harrisburg, Pennsylvania. 376 p.

Nelson, B. A. 1945. The spring molt of the northern red squirrel in Minnesota. Jour. Mammalogy, Vol. 26:397-400.

Nero, R. W. 1974. Cougars in Manitoba. Blue Jay, Vol. 32:55-56.

Ohmann, L. F., and R. R. Ream. 1971. Wilderness ecology: virgin plant communities of the Boundary Waters Canoe Area. N. Cent. Forest. Exp. Sta., St. Paul, Minnesota, No. 63:1-55.

Olson, S. F. 1938. Organization and range of the pack. Ecology, Vol. 19:168-170.

Orloci, L. 1967. An agglomerative method for classification of plant communities. Jour. Ecol., Vol. 55:193-206.

Orr, L. W. 1930. An unusual chipmunk nest. Jour. Mammalogy, Vol. 11:315.

Pearson, O. P. 1944. Reproduction in the shrew (Blarina brevicauda Say). Amer. Jour. Anat., Vol. 75:39-93.

Peck, A. S. 1928. Game increase reported in Superior Forest. Fins, Feathers, and Fur, No. 56:29, 38.

Peek, J. M. 1971. Moose habitat selection and relationships to forest management in northeastern Minnesota. Unpubl. Ph.D. Dissertation, Univ. Minnesota, St. Paul. xi + 250 p.

———. 1974. Initial response of moose to a forest fire in northeastern Minnesota. Amer. Midl. Nat., Vol. 91:435-438.

Peek, J. M., R. E. LeResche, and D. R. Stevens. 1974. Dynamics of moose aggregations in Alaska, Minnesota, and Montana. Jour. Mammalogy, Vol. 55: 126-137.

Peterson, R. L. 1952. A review of the living representatives of the genus Alces. Contrib. Royal Ontario Mus. Zool. and Palaeo., Vol. 34:1-30.

———. 1953. Studies of the food habits and habitat of moose in Ontario. Contrib. Royal Ontario Mus. Zool. and Palaeo., Vol. 36:1-49.

———. 1966. The mammals of Eastern Canada. Oxford Univ. Press, Toronto, xxxii + 465 p.

Petraborg, W. H., and D. W. Burcalow. 1965. The white-tailed deer in Minnesota. P. 11-48 *in* Moyle, J. B., *Editor*, Big game in Minnesota. Tech. Bull. Minnesota Dept. Conserv., No. 9:1-231.

Petraborg, W. H., and V. E. Gunvalson. 1962. Observations on bobcat mortality and bobcat predation on deer. Jour. Mammalogy, Vol. 43:430-431.

Pidduck, E. R., and J. B. Falls. 1973. Reproduction and emergence of juveniles in *Tamias striatus* (Rodentia: Sciuridae) at two localities in Ontario, Canada. Jour. Mammalogy, Vol. 54:693-707.

Prince, L. A. 1941. Geographic range extensions of the smoky shrew (*Sorex fumeus*) in Ontario and Quebec. Canadian Field-Nat., Vol. 55:103.

Quimby, D. 1943. Notes on the long-tailed shrews in Minnesota. Jour. Mammalogy, Vol. 24:261-262.

———. 1951. The life history and ecology of the jumping mouse, *Zapus hudsonius*. Ecol. Monogr., Vol. 21:61-95.

Rausch, R. 1953. On the status of some Arctic mammals. Arctic, Vol. 6:91-148.

Reynolds, J. K. 1955. Distribution and populations of the European hare in southern Ontario. Canadian Field-Nat., Vol. 69:14-20.

Robins, J. D. 1971. Movement of Franklin's ground squirrel into northeastern Minnesota. Jour. Minnesota Acad. Sci., Vol. 37:30-31.

Rogers, L. L. 1970. Black bear of Minnesota. Naturalist, Vol. 21(4):42-47.

———. 1972. Movement patterns and social organization of black bears in northeastern Minnesota. Bull. Ecol. Soc. Amer., Vol. 53(2):21.

———. 1974. Shedding of foot pads by black bears during denning. Jour. Mammalogy, Vol. 55:672-674.

Rollings, C. T. 1945. Habits, foods, and parasites of the bobcat in Minnesota. Jour. Wildl. Manage., Vol. 9:131-145.

Rom, W. N. 1940. Small mammals of northeastern Lake County, Minnesota. Flicker, Vol. 12:29-32.

Rongstad, O. J., and J. R. Tester. 1971. Behavior and maternal relations of young snowshoe hares. Jour. Wildl. Manage., Vol. 35:338-346.

Rothschild, M., and T. Clay. 1957. Fleas, flukes and cuckoos: A study of bird parasites. The Macmillan Company, New York, xiv + 305.

Rysgaard, G. N. 1942. A study of the cave bats of Minnesota with especial reference to the large brown bat, Eptesicus fuscus fuscus (Beauvois). Amer. Midl. Nat., Vol. 28:245-267.

Saunders, J. K., Jr. 1964. Physical characteristics of the Newfoundland lynx. Jour. Mammalogy, Vol. 45:36-47.

Seal, U. S., L. D. Mech, and V. Van Ballenberghe. 1975. Blood analyses of wolf pups and their ecological and metabolic interpretation. Jour. Mammalogy, Vol. 56:64-75.

Seton, E. T. 1909. Life-histories of northern animals . . . The mammals of Manitoba. . . . Charles Scribner's Sons, New York, Vol. 1: xxx + 1-673.

Sharp, R. P. 1953. Glacial features of Cook County, Minnesota. Amer. Jour. Sci., Vol. 251:855-883.

Simkin, D. W. 1966. Extralimital occurrences of raccoons in Ontario. Canadian Field-Nat., Vol. 80:144-146.

Smith, L. C., and D. A. Smith. 1972. Reproductive biology, breeding seasons, and growth of eastern chipmunks, *Tamias striatus* (Rodentia: Sciuridae) in Canada. Canadian Jour. Zool., Vol. 50:1069-1085.

Smith, J. D. 1972. Systematics of the chiropteran family Mormoopidae. Misc. Publ. Mus. Nat. Hist., Univ. Kansas, No. 56: 1-132.

Sorensen, T. 1948. A method of establishing groups of equal amplitude in plant sociology based on similarity of species content. . . . K. Danske Vidensk. Selsk., Vol. 5:1-34.

Stenlund, M. H. 1954. Pine marten returns to Minnesota. Conserv. Volunteer, Vol. 17(97):40-43.

———. 1955. A field study of the timber wolf (*Canis lupus*) on the Superior National Forest, Minnesota. Tech. Bull., Minnesota Dept. Conserv., No. 4:1-55.

———. 1974. Trials of the timber wolf. Minnesota Volunteer, Vol. 37:50-61.

Surber, T. 1923. The occurrence of the woodland jumping mouse in Minnesota. Fins, Feathers and Fur, No. 35:106.

———. 1932. The mammals of Minnesota. Minnesota Dept. Conserv., St. Paul, 84 p.

———. 1940. Minnesota moose—then and now. Conserv. Volunteer, Vol. 1(1):41-44.

Swain, A. M. 1973. A history of fire and vegetation in northeastern Minnesota as recorded in lake sediments. Quaternary Res., Vol. 3:383-396.

Swanson, G. 1945. A systematic catalog of the mammals of Minnesota. P. 52-105 *in* The mammals of Minnesota. Swanson, G., T. Surber, and T. S. Roberts, *Editors*, Tech. Bull., Minnesota Dept. Conserv., No. 2:1-108.

Swanson, G., and C. Evans. 1936. The hibernation of certain bats in southern Minnesota. Jour. Mammalogy, Vol. 17: 39-43.

Swanson, G., and P. O. Fryklund. 1935. The least weasel in Minnesota and its fluctuation in numbers. Amer. Midl. Nat., Vol. 16:120-126.

Thomson, S. C. 1974. Sight record of a cougar in northern Ontario. Canadian Field-Nat., Vol. 88:87.

Timm, R. M. 1974. Rediscovery of the rock vole (*Microtus chrotorrhinus*) in Minnesota. Canadian Field-Nat., Vol. 88:82.

Upham, W. 1920. Minnesota geographic names: Their origin and historic significance. Minnesota Hist. Soc., St. Paul, Vol. 17:vii + 1-735.

Van Ballenberghe, V. 1972. Ecology, movements and population characteristics of timber wolves in northeastern Minnesota. Unpubl. Ph.D. Dissertation, Univ. Minnesota, St. Paul, iv + 90 p.

Van Ballenberghe, V., and A. W. Erickson. 1973. A wolf pack kills another wolf. Amer. Midl. Nat., Vol. 90:490-493.

Van Ballenberghe, V., A. W. Erickson, and D. Byman. 1975. Ecology of the timber wolf in northeastern Minnesota. Wildlife Monogr., No. 43:1-43.

Van Ballenberghe, V., and J. M. Peek. 1971. Radiotelemetry studies of moose in northeastern Minnesota. Jour. Wildl. Manage., Vol. 35:63-71.

Van Ballenberghe, V., and L. D. Mech. 1975. Weights, growth, and survival of timber wolf pups in Minnesota. Jour. Mammalogy, Vol. 56:44-63.

van Zyll de Jong, C. G. 1972. A systematic review of the Nearctic and Neotropical river otters (genus *Lutra*, Mustelidae, Carnivora). Life Sci. Contrib., Royal Ontario Mus., No. 80:1-104.

Weaver, J. E., and F. E. Clements. 1938. Plant Ecology. McGraw-Hill Book Company, Inc., New York, xxii + 601 p.

Webb, W. L. 1937. Notes on the sex ratio of the snowshoe rabbit. Jour. Mammalogy, Vol. 18:343-347.

Wenzel, R. L., V. J. Tipton, and A. Kiewlick. 1966. The streblid batflies of Panama (Diptera Calypterae: Streblidae). P. 405-675 *in* Wenzel, R. L., and V. J. Tipton, *Editors*, Ectoparasites of Panama. Field Mus. Nat. Hist., Chicago, xii + 861 p.

Wetzel, J. F. 1972. Winter food habits and habitat preferences of deer in northeastern Minnesota. Unpubl. M.S. Thesis, Univ. Minnesota, St. Paul, ix + 106 p.

Whitaker, J. O., Jr., and D. D. Pascal, Jr. 1971. External parasites of arctic shrews (*Sorex arcticus*) taken in Minnesota. Jour. Mammalogy, Vol. 52:202.

Whitaker, J. O., Jr., and L. L. Schmeltz. 1973. Food and external parasites of *Sorex palustris* and food of *Sorex cinereus* from St. Louis County, Minnesota. Jour. Mammalogy, Vol. 54:283-285.

Whitaker, J. O., Jr., and R. E. Wrigley. 1972. *Napaeozapus insignis*. Mammalian Species, No. 14:1-6.

Wright, H. E., Jr. 1974. Landscape development, forest fires, and wilderness management. Science, Vol. 186:487-495.

Wright, H. E., Jr., and M. L. Heinselman. 1973. The ecological role of fire in natural conifer forests of western and northern North America—Introduction. Quaternary Res., Vol. 3:319-328.

Wright, H. E., Jr., and R. V. Ruhe. 1965. Glaciation of Minnesota and Iowa. P. 29-41 *in* Wright, H. E., Jr., and D. G. Frey, *Editors*, The Quaternary of the United States. Princeton University Press, Princeton, New Jersey, x + 922 p.

Wright, P. L., and M. W. Coulter. 1967. Reproduction and growth in Maine fishers. Jour. Wildl. Manage., Vol. 31:70-87.

Yerger, R. W. 1955. Life history notes on the eastern chipmunk, Tamias striatus lysteri (Richardson), in Central New York. Amer. Midl. Nat., Vol. 53:312-323.

Occasional Papers of the Bell Museum of Natural History

No. 1. 1916 ..... Out of Print
Roberts, T. S. The winter bird-life of Minnesota. Being an annotated list of birds that have been found within the state of Minnesota during the winter months. 20 p.

No. 2. 1926 ..... Out of Print
Roberts, T. S. The winter bird-life of Minnesota. P. 5-10.
Roberts, T. S. The migration of Minnesota birds. P. 11-16.
Roberts, T. S. March and April bird-lore in Minnesota. P. 17-22.
Roberts, T. S. May bird-lore in Minnesota. P. 23-28.
Four radio talks broadcasted in the University of Minnesota program over Station WCCO in Minneapolis, 1926.

No. 3. 1930 ..... $.50
Roberts, T. S. Some changes in the distribution of certain Minnesota birds in the last fifty years. P. 9-14.
Kilgore, William. Breeding of the Connecticut Warbler (*Oporornis agilis*), with special reference to Minnesota. P. 15-28.
Breckenridge, W. J. Breeding of Nelson's Sparrow *(Ammospiza nelsonii)* with special reference to Minnesota. P. 29-38.
Breckenridge, W.J. A hybrid Passerina *(Passerina cyanea + Passerina amoena).* P. 39-40.

No. 4. 1950 ..... Out of Print
Gunderson, H. L. A study of some small mammal populations at Cedar Creek Forest, Anoka County, Minnesota. 49 p.

No. 5. 1952 ..... Out of Print
Olson, S. T., and W. H. Marshall. The Common Loon in Minnesota. 77 p.

No. 6. 1953 ..... Out of Print
Gunderson, H. L., and J. R. Beer. The mammals of Minnesota. 190 p.

No. 7. 1957 ..... Out of Print
Underhill, J. C. The distribution of Minnesota minnows and darters in relation to Pleistocene glaciation. 45 p.

No. 8. 1961 ..... Out of Print
Tester, J. R., and W. H. Marshall. A study of certain plant and animal interrelations on a native prairie in Northwestern Minnesota. 51 p.

No. 9. 1963 ..... $.75
Dickerman, R. W. The song sparrows of the Mexican Plateau. 79 p.

No. 10. 1971 ..... $2.00
Phillips, G. L., and J. C. Underhill. Distribution and variation of the Catostomidae of Minnesota. 45 p.

No. 11. 1972 ..... $1.40
Eddy, S., R. C. Tasker, and J. C. Underhill. Fishes of the Red River, Rainy River, and Lake of the Woods, Minnesota, with comments of the distribution of species in the Nelson River Drainage. 24 p.

No. 12. 1973 ..... $1.50
Moore, J. W. A catalog of the flora of Cedar Creek Natural History Area, Anoka and Isanti counties, Minnesota. 28 p.

No. 13. 1974 ..... $1.25
Birney, E. C., J. B. Bowles, R. M. Timm, and S. L. Williams. Mammalian distributional records in Yucatán and Quintana Roo, with comments on reproduction, structure, and status of peninsular populations. 25 p.

No. 14. 1975 ..... $3.00
Timm, R. M. Distribution, natural history, and parasites of mammals of Cook County, Minnesota. 56 p.