FOOD HABITS OF MINK IN THE
TURTLE MOUNTAIN AREA
OF MANITOBA

A Thesis

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Abstract.-The food habits of mink in the Turtle Mountain area of southern Manitoba were studied in both grassland and parkland habitats. Scats were collected during the summer and carcasses utilised for obtaining winter data. Feeding experiments were conducted in the laboratory on two mink captured in the study area.

Seasonal variation in prey taken by mink was evident. A high percentage occurrence of mammals was recorded during the winter and a slight increase noted in the spring. Utilisation decreased in the early summer followed by an increase in the early autumn. Percentage occurrence of Crustaceans was low during the winter and increased to a maximum in August. Maximum percent occurrence of birds was in the early fall. Insects varied in 1966 but increased from May to August in 1967.

The number of prey taken by mink was large. Potential mammals utilised were 57%, birds 33%, fish 80%. Comparison of mammalian prey in grassland and parkland habitats showed that of a potential 13 species available 6 (1966) and 7 (1967) species were utilised. Thirteen potential species were available in the parkland habitat and 9 were utilised both years. The principal prey class was mammals and auxillary prey classes were birds and fish. Frogs, insects, and crustaceans formed a minor portion of the diet. The principal mammalian species taken by mink was the muskrat Ondatra zibethica. Anseriformes and Ralliformes were the most important orders of birds utilised. Catostomids and Cyprinids were the most important families of fish taken as food by mink. A relationship existed between mammals and the remaining prey classes of food. An increase in mammals was associated with a decrease in the other prey classes and vice versa. A similar relationship was present between muskrats and Microtus, Peromyscus, and shrews.

The feeding habits of mink were related to availability rather than preference for a particular prey item. Results of laboratory feeding experiments showed that mink ate mammals, birds and fish in approximately the same quantities but showed a dislike for frogs.

Introduction

This study was initiated to determine the feeding habits of mink on a year round basis, as far as possible. To this end, two hypotheses will be examined:

1. mink have a wide range of prey species.
2. prey species change with season of the year.

Four points were selected for examination to provide information related to these hypotheses and the study in general. These points included determination of the following:

1. prey species taken by minks as a source of food.
2. specific methods of ingested prey identification.
3. seasonal variation in prey species taken as food by mink.
4. information on mink scat identification, daily food requirements, appearance of food items after digestion, and food preferences.

Most feeding habit studies on mink were done either during the winter or the summer period. Results failed to show whether changes in feeding habits were gradual or abrupt. Furthermore, the prey species taken were not related to season of the year, habitat, prey availability, or environmental factors.

Little detailed information was published on methods or techniques utilised in gut and fecal analysis of mink. Although reference collections are valuable as identification tools, specific identification methods would provide a better foundation upon which to base accurate identification of ingested prey remains.

Material from the field and laboratory was examined both macroscopically and microscopically. Summer material consisted of scats and winter material was obtained from carcasses donated by trappers. Feeding experiments were conducted in the laboratory on two mink captured in the vicinity of the study area.

DEFINITION OF TERMS

1. Availability - the presence of a potential prey species within the study area and therefore capable of being utilised as food by mink.

2. Abundance - presence of a prey species in numbers greater than are present at a time during the year when population numbers are minimal i.e. prey numbers are greater after reproduction.

3. Vulnerability- the inability of a prey species to adequately defend itself from predation by mink.

4. Percent frequency of occurrence - the number of identified prey expressed as a percent of the total number of items found in the gut and / or fecal analysis. Scott(1941) tested the following methods of expressing results on fecal analysis of the red fox: frequency of occurrence, dry weight, and volumetric. The frequency of occurrence method provided the most reliable interpretation of the relative quantities of foods consumed. This method tends to overestimate larger food items and underestimate smaller food items. Dry weight and volumetric methods both proved to be reliable and accurate, but were very time consuming. In addition, both methods can only be used for major food items as it is difficult to determine the volume and / or dry weight of a few hairs.

REVIEW OF THE LITERATURE

Little information has been published on the life history of mink despite the economic value of wild mink pelts. Food habit studies generally lack specific identification methods and information on seasonal variation of prey taken. A summary of the life history and food habits of the mink follows.

LIFE HISTORY OF THE MINK

Taxonomy and Occurrence

Mink, included in the genus *Mustela* L. are classified under the subgenus *Lutreola* Wagner. The predominant North American species is *Mustela vison* Gray, with 14 subspecies listed by Hall and Kelson (1959). The subspecies investigated herein is *M. v. lacustris* Preble, with a range extending from western Ontario, through Manitoba, Saskatchewan excepting the southwest corner of the province, eastern Alberta, and the southern fringe of the North West Territories. The southern boundary of the range lies just south of the International boundary (Fig. 1.).

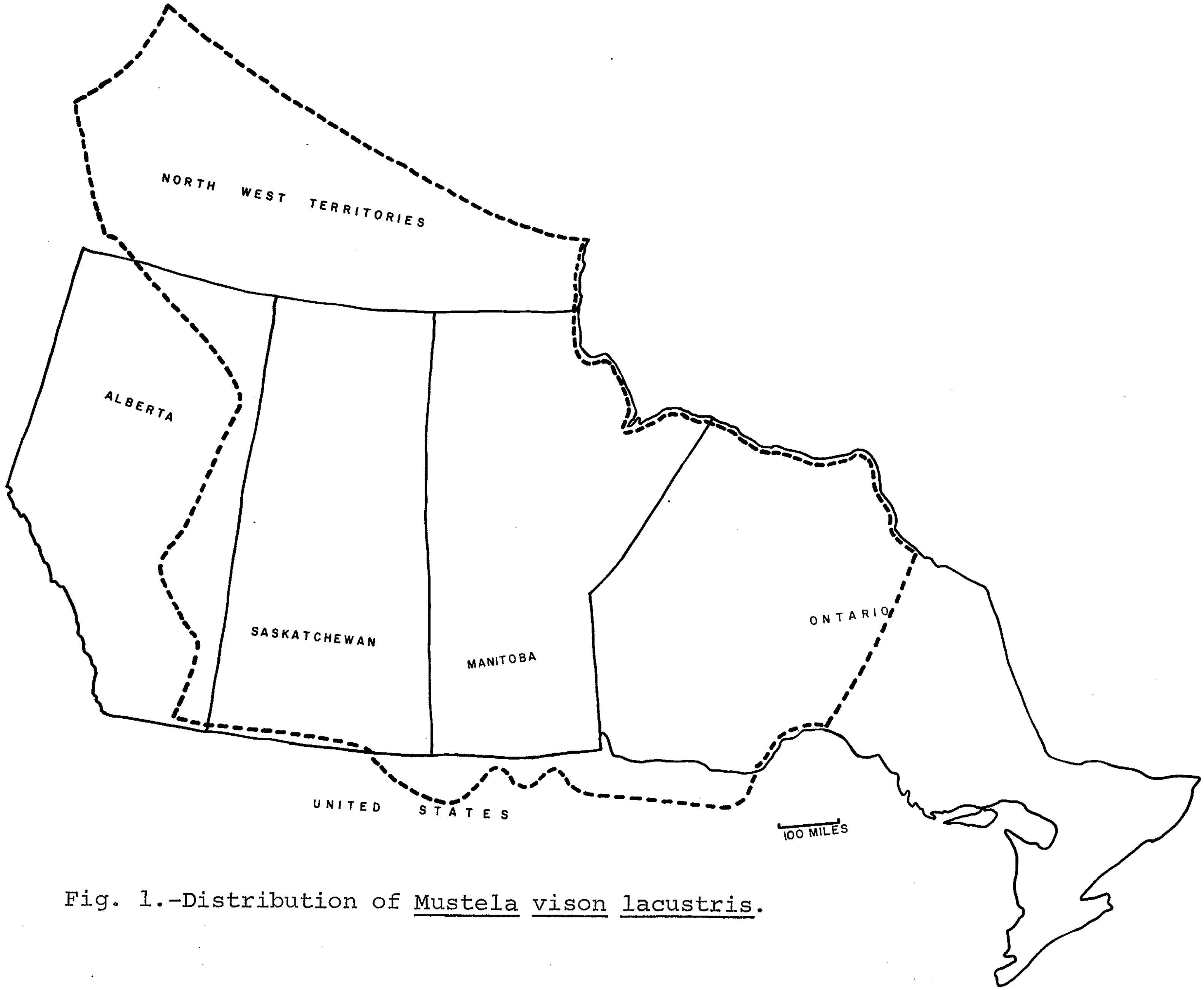

Fig. 1.-Distribution of <u>Mustela vison lacustris</u>.

Size

Considerable variability in the size of mink has been reported. Average weights for male Alaska mink, _Mustela vision ingens_ Osgood, were 1037 g. and females were 616g. (Burns 1964). Maximum weights for this subspecies were greater than 2000 g. for males and 1000 g. for females. Waller (1962) gave average weights of 1055 g. for males and 574 g. for females of _Mustela vison letifera_ Hollister in Iowa.

Both Bailey (1929) and Waller (1962) reported almost identical total body lengths of _Mustela vison letifera_ Hollister (Table 1). Errington (1936) claimed that mink from lakes were longer than those from rivers. His measurements were based on pelts whereas those of Bailey and Waller were based on carcass length.

A summary of the weights and the lengths of mink is given in Table 1.

Pelage

In prime winter condition mink are usually dark brown in color. Irregular white patches occur under the chin, throat, or belly. Guard hairs have a flat expanded

Table 1. A summary of sex ratio, weight, length, and litter size of *Mustela vison*.

Designation	Sex Ratio Male:Female	Weight (g.) Male	Weight (g.) Female	Length (cms.) (Total Body) Male	Length (cms.) (Total Body) Female	Litter Size	Authority
M. vison Grey	56:44			91.4+ 85.4++	81.3 71.1		Errington (1936)
M. v. letifera Hollister		1100	726	61.5	51.6		Bailey (1929)
M. vison Grey		1055	574				McCabe (1949)
M. v. ingens Osgood	59:41 & 67:33	1037	616				Burns (1964)
M. v. letifera Hollister		1055	574	61.7	50.4		Waller (1962)
M. vison Grey	56:44	1150	600			4.0	Mitchill (1961)
M. v. lacustris Preble	60:40						Urban (1968)
M. vison Grey	56:44* 47:53						Apelgren (1941)
M. vison Grey						4.48	Enders (1952)

* Single kit litters
\+ Pelt lengths from lakes
++ Pelt lengths from rivers

portion or shield and are 1.8-2.5 cm. long. The underfur is thick, wavy, and 1.0-1.5 cm long. The black-tipped tail is one quarter to one third of the total body length.

Behavior

Adult mink are usually solitary except during mating. Ritcey and Edwards (1956) noted that two mink interchanged their respective areas of greatest activity in order to avoid one another. Mitchell (1961) noted an exception to intraspecific isolation. He observed that juvenile males often invade areas inhabited by other mink. Waller (1962) also noted a juvenile male which invaded the den of an adult female.

Mink habitat reflects the semi-aquatic and terrestrial habits of the species. Preferred habitat is a shoreline with good vegetation cover. Marshall (1936) described the preferred vegetation cover as "brushy" or "sedge" type.

Dens are located under excavated tree roots (Schnell 1964, Marshall 1936), in the sides of beaver lodges and muskrat houses (Errington 1943), and in the banks of creeks and rivers (Marshall 1936). Burrows are composed of several tunnels with expanded areas or "rooms"

(Schnell 1964) and usually have one or more entrances. During the winter mink often burrow beneath the snow.

Home Range

A distinct difference exists between home range of male and female mink: females are more restricted in their movements. Marshall (1936) using the measurement of the hind track in fresh snow found the home range ("territory") of females never exceeded 20 acres while that of males was much larger but could not be measured accurately. Marshall's methods were criticized by Sealander (1944) who claimed that male and female mink tracks could not be differentiated accurately. Mitchell (1961) measured home range of mink with the following results: females 19.3-50.4 acres: male movement did not exceed three miles in diameter. He also reported home range overlap between juvenile and adult males, but none between adult males.

Reproduction

Reproduction of mink was reviewed by Enders (1952). A short period of increased activity occurs prior to copulation, and courtship may or may not occur.

Copulation takes place between late February and early April: ovulation and fertilization occur 48-52 hours after copulation. Implantation is delayed and results in a gestation period ranging from 40-75 days. The young are weaned at about five weeks and leave the den at six to eight weeks.

Promiscuity was noted during the breeding season (Enders 1952, Marshall 1936). Reports of superfetation (Cavan 1944, Rick 1946) stemmed from results of promiscuous behavior and led to confusion of single litter size. Young born a few days apart were considered as a single litter. It is now considered that these are separate litters resulting from two separate sexual acts. Enders (1952) found an average of 4.48 kits per litter and Mitchell (1961) reported an average of 4.0 kits per litter.

Reports on sex ratio vary (Table 1). Errington (1936) and Mitchell (1961) reported male: female ratios of 56:44. Although Apelgren (1941) also found a 56:44 ratio, this was based on litters containing a single kit. He claimed that in large litters males declined to 47 percent. As previously noted average litter size is four kits. It is doubtful that a sex ratio for wild mink based on litters of single kits would be accurate. It is also improbable that sex ratios based on trapping records are accurate because more males tend to be trapped probably due to their greater area of movement as compared to females.

FOOD HABITS

Most studies of mink food habits were carried out in winter (Dearborn 1932, Hamilton 1936, 1940, 1959, Sealander 1943, Guilday 1949, Wilson 1954, Korschgen 1958, Burns 1964). Some investigations were supplemented by collections of scats during the summer. The majority of workers utilized stomach and intestinal contents of carcasses obtained either from trappers or from research trapping programs.

A summary of winter foods of mink is presented in Table 2. The delineation of major food classes varies with investigator. Several authors reported mammals as the main winter food (Dearborn 1932, Guilday 1949, Hamilton 1936, Sealander 1943, Waller 1962). Fish were reported as the most important prey item by Hamilton (1959), Wilson (1954), and Burns (1964).

Amphibians (frogs in particular) were classed in

Table 2. Mink prey groups taken during fall and winter expressed as percent frequency of occurrence.

Authority	Mammals	Birds	Fish	Amphibia	Insects	Crayfish	Arthropods	Snails	Isopods
Dearborn (1932)	55.63	5.70	18.35	8.55	2.27	7.91			
Guilday (1949)	41.38	3.12	19.54	0.78	9.37	14.06			
Hamilton (1959)	33.20	2.70	34.10	21.9	6.8	14.1			
Hamilton (1936)	54.13		18.82	2.36	7.06	16.47			
Korschgen (1958)		5.9	30.9	25.5					
Sealander (1943)	70s 64I	13s 6I	11s 16I	23s 10I	--- 3I	6s 18I			
Wilson (1954)	34G 71St	18G 30St	61G 13St				30G 17St		
Waller (1962)	49.6	48.0	5.7	9.8	2.8	2.8			
Burns (1964)	17G 10St	--- 2St	43G 37St					14G 19St	6G 12St

Table 2 (continued)

Authority	Reptiles	Carrion	Spiders	Molluscs	Vegetation
Dearborn (1932)	1.59				
Guilday (1949)			8.60		
Hamilton (1959)	1.4			1.6	
Hamilton (1936)					1.18
Korschgen (1958)	0.3		2.7		1.9
Sealander (1943)	2S 1I				
Wilson (1954)					
Waller (1962)					
Burns (1964)					20G 19St

S- Stomach
I- Intestine
St- Scat
G- Gut

various categories according to their prominence in mink diets. Korschgen (1958) considered frogs the most important single prey group. Waller (1962) noted extensive feeding on frogs and Hamilton (1959) considered them as a major item in mink diet. Sealander (1943) suggested that frogs act as food buffers during muskrat scarcity. Gerell (1967) considered frogs an important food item when feeding habits of mink changed in the late spring and autumn. Several authors reported frogs as an insignificant part of the mink diet (Wilson 1954, Hamilton 1936, 1940, Dearborn 1932).

Crayfish are the most important crustacean found in mink diets. Although they are an auxillary food item, several investigators found that crayfish made up a significant portion of the mink diet (Guilday 1949, Hamilton 1936, 1959). Sealander (1943) claimed that the presence of crayfish remains in both the stomach and intestine suggested differential digestion rates of hard and soft parts. Snails, isopods, insects, reptiles, spiders and molluscs are also present but form a small part of the diet. Hamilton (1959) and Korschgen (1958) did not consider vegetation a source of food because it probably was ingested inadvertently with animal prey.

The principal prey species varied in the winter. Several authors reported muskrat as the primary mammalian species ingested (Sealander 1943, Dearborn 1932, Hamilton 1940, Burns 1964, Waller 1962). Errington (1943, 1954, 1963 (Ch. 16) discussed in detail various aspects of muskrat predation by mink eg. vulnerability of muskrats to mink during low water periods and winter; affect of epizootics in muskrat populations; affect of drought and overpopulation. Sealander (1943) and Hamilton (1959) both reported that male mink consumed more muskrats than the smaller females and the former author suggested "the size of a mink may determine the size of its prey". Hamilton (1959) confirmed this observation. Wilson (1954) suggested that mink tend to avoid strenuous conflict with muskrats. As a result muskrats were a minor food item in his study.

Other principal mammals ingested by mink included mice (Guilday 1949, Hamilton 1936), Microtus (Hamilton 1959), and Peromyscus (Wilson 1954). Wilson (op. cit.) attributed high Peromyscus predation to the previously mentioned fact that mink tend to avoid strenuous conflict with muskrats. Hamilton (op. cit.) attributed low muskrat predation and high Microtus predation to absence of large numbers of muskrats.

Summer foods of mink were predominantly mammals (Table 3). Burns (1964) found that voles were taken in the largest numbers while Hamilton (1940) found that muskrats were the main food item. Dearborn (1932) determined that crayfish provided the bulk of the summer diet. Other prey groups i.e. birds, fish, amphibia, insects varied in percent occurrence and were generally considered auxillary food groups.

Data from year round studies on feeding habits of mink are limited. Seasonal trends in prey species were reported by both Waller (1962) and Gerell (1967). Waller's results from Iowa marshes indicated mammals occurred at uniform frequencies of about 50 percent except in spring when mammals declined to 35 percent. This decline was associated with a high incidence of avian species (70 percent). Birds declined in summer but became progressively more frequent during fall and winter. Cold blooded vertebrates and invertebrates were more seasonal, with utilization mostly during the warmer months.

Table 3. Mink prey groups taken during the summer expressed as percent fequency of occurrence. All results are from scat analysis.

Authority	Mammals	Birds	Fish	Amphibia	Insects	Crayfish	Snails	Isopods	Reptiles	Veg.
Burns (1964)	94	31	19		9		31	3		38
Waller (1962)	50.2	32.2	14.9	22.8	12.5	22.3			1.3	
Dearborn (1932)	19.64*	0.89	2.87	5.75	2.02	68.22			0.61	
Hamilton (1940)	approx 54	9.66	41.0	5.66			0.33		1.00	

* percent volume

Gerell's (1967) results from Sweden showed a marked seasonal variation in prey species taken by mink. He noted that greatest changes in feeding habits occurred at the end of spring and in the autumn. Crayfish occurred most frequently in the summer and fish were consumed preferentially in winter and spring. Consumption of frogs was most frequent when feeding habits changed. Birds were taken predominantly during migration and breeding season. Rodents were a variable food source. Differences between habitats with regard to food habits of mink were most marked in summer. He also claimed that increased number of prey species available resulted in more varied food habits. Dearborn (1932 p.15) stated that his results "reflect the food habits of the various animals for the entire year or for their period of activity, and not merely for the two and a half months during which the collections were made". He further stated "This report........is not partial in a seasonal sense". This is in direct opposition to the results published by both Waller (1962) and Gerell (1967). According to the above statements Dearborn inferred that no seasonal variation in prey species occurred *i.e.* crayfish remained at a high percent volume from early spring until late fall. Both Waller and Gerell showed that this is not likely.

INGESTED PREY IDENTIFICATION

Few workers have published methods of identification of ingested prey remains. Waller (1962) mentioned the use of reference collections. Both Wilson (1954) and Sealander (1943) used hair, feathers, bones, teeth, and scales, but gave no specific characteristics of these parts.

Several keys were published for the identification of mammalian hairs (Mathiak 1938, Stains 1958, Mayer 1952). These keys were based on hairs which had not undergone mastication, digestion, or weathering and were therefore unsatisfactory for hair identification in most food habit studies.

Day (1965) published a key for the identification of ingested remains of small mammals and birds of Britain. Hair identification was based on scale pattern, medulla pattern, and transverse sections. Feather identification was based on the structural variations to the down barbules of coverts. Potential mammalian prey included in the key were identified to genus and potential avian prey were identified to order. The characteristics utilised by Day (*op*. *cit*.) were identifiable although mastication and digestion had occurred.

METHODS

STUDY AREA

Turtle Mountain Provincial Park is located in south-western Manitoba adjacent to the International Boundary (Fig. 2) and was selected as a study site on the basis of trapping records that indicated a large well established mink population. The area had many lakes and was transected by many streams that create shoreline habitat with adequate vegetation cover suitable to mink. A wide variety of potential prey species were present. Farmland adjacent to the northern boundary of the park was also included in the study, as mink were present and a comparison of the feeding habits between much of the two habitats was possible.

Physiography

Turtle Mountain, herein called the "parkland" area, is a relief feature situated on the Manitoba escarpment. This area extends 40 miles in an east-west direction and 8-10 miles north-south. It is pre-glacial in origin and is composed of sandstone, shale, and lignite covered by a thick layer of glacial drift (Johnston 1934, Wickenden 1945). The parkland is about 2200 feet above

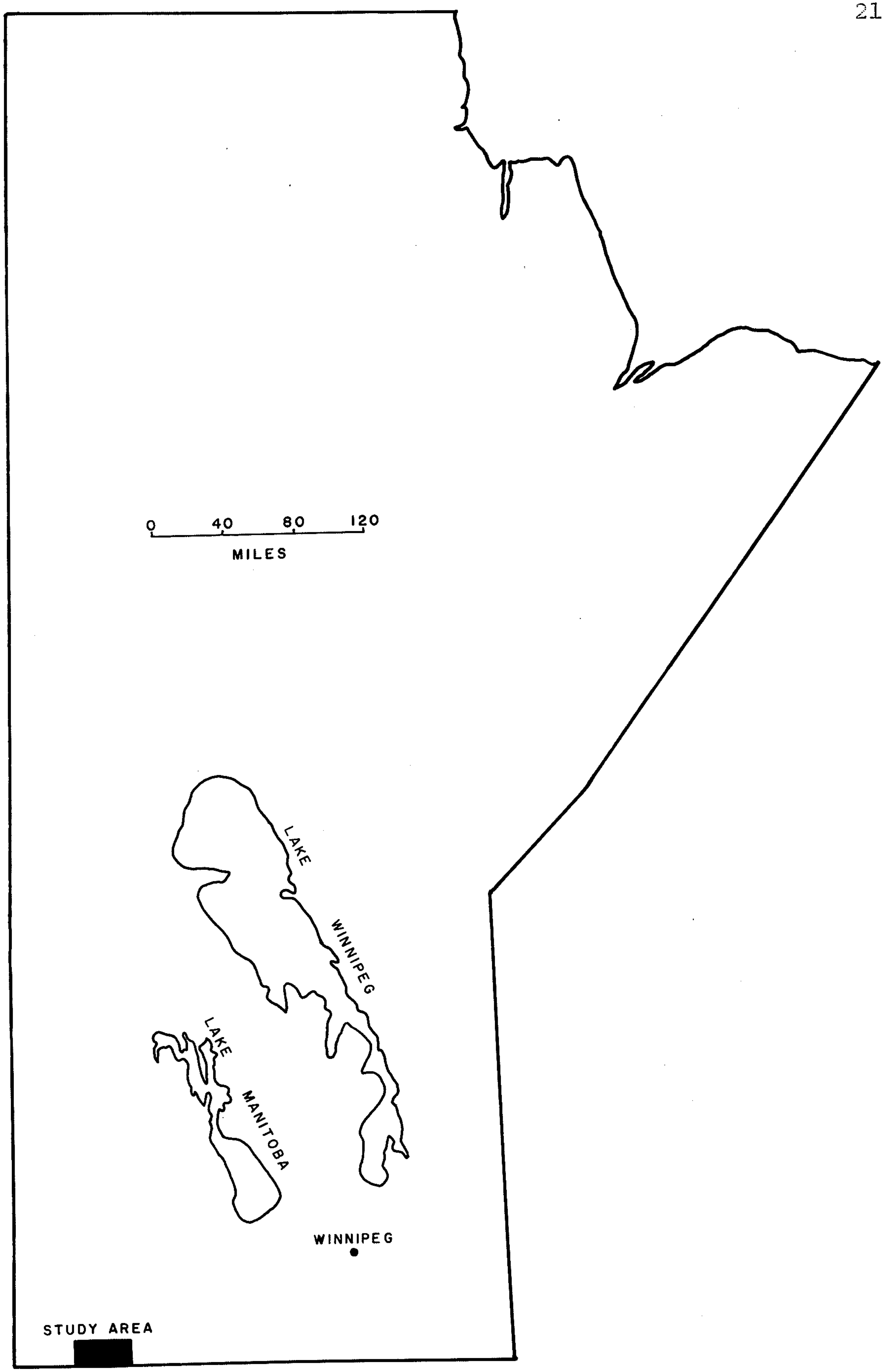

Fig. 2-Map of Manitoba showing the study area.

above sea level while that of the adjacent farmland herein called the "grassland" area is about 1700 feet above sea level. The surface terrain in the parkland is rough and hilly and the grassland area is flat with several streams dissecting its topography.

The parkland vegetation is mainly a bur oak-aspen community (Bird 1961). Aspen (Populus tremuloides Michx) predominate while bur oak (Quercus macrocarpa Michx) scattered throughout the aspen stands. The undergrowth is dense and littered with deadfall. The grassland area is mostly under cultivation but some grassland community is present. Bird (1961) described this area as an Agropyron-Stipa-Bouteloua grassland with Poa the dominant lowland grass. Willow (Salix) is present along water edges at both the high and low alatitudes.

The parkland area contains many lakes and ponds. All water bodies are shallow and shoreline vegetation is dense. Drainage streams run north from the mountain and are usually slow running or dry except during the spring run off. Throughout the summer creek banks become laden with dense vegetation cover of willows and shrubs. A detailed prey availability list is presented in Appendix C, however a summary of species (taken from Soper 1945) is appropriate. Throughout the parkland several small mammls such as snowshoe hares (Lepus americanus Erxleben), beaver (Castor canadensis Kuhl), muskrat (Ondatra zibethica (L.)), red squirrels (Tamiasciuris hudsonicus (Erxleben)) are present. Common mammals about the forest edge are the red-backed voles (Clethrionomys gapperi (Bailey)), the chipmunks (Eutamias minimus (Allen)), Franklin's ground squirrels (Citellus franklinii (Sabine)), and the skunk (Mephitis mephitis (Richardson)). Larger mammals are represented by Virginia white-tailed deer (Odocoileus virginianus Goldman and Kellogg), coyotes (Canis latrans Say), and red foxes (Vulpes fulva Merriam).

Birds occur throughout the parkland and particularly around the forest edge. Game birds (Galliformes) are present in the forested areas and in open areas within the forest. The many lakes and ponds are frequented by aquatic birds represented Anseriformes, Ciconiformes, and Colymbiformes. The water-land ecotone is inhabited by waders (Charadriformes) and shorebirds (Gruiformes). Non-aquatic birds are numerous and occupy most niches within the parkland habitat.

Some of the more numerous

orders are the Passeriformes, Strigiformes, Falconiformes, and Picifomres.

Lakes and ponds contain both native and introduced species of fish. Native species include northern pike (*Esox lucius* L.), pickerel (*Stizostedion vitreum* Mitchell), shiners (*Notropis* sp), sticklebacks (*Gasterostidae*) and mud minnows (*Umbra limi* Kirtland). An introduced species the rainbow trout (*Salmo gairdneri* Richardson), is also present.

Cold blooded vertebrates and invertebrates are numberous and found throughout the forest area. They include various species of frogs, crayfish, insects and snakes.

The mammal component of the grassland community is varied. Several species that occur in the forest are also present in the grassland *i.e.* deer, coyotes, foxes, species exclusive to grassland communites are mostly small mammals. The white-footed mouse (*Peromyscus maniculatus bairdii* Hay & Kennicott) and voles (*Microtus pennsylvanicus* subspp. and *Microtus ochrogaster* Wagner) are present in ungrazed grassland. The thirteen-striped ground squirrel (*Citellus tridecem lineatus* Mitchill) inhabits the longer grass areas. Richardson's ground squirrel (Citellus richardsonii Sabine) is present on knolls, gravel ridges, and overgrazed areas. The white-tailed jack rabbit (Lepus townsendii Bachman) ranges throughout the grass- and and the pocket gopher (Thomomys talpoides subspp.) is also present throughout the grassland community but spends most of its life underground.

Avian species are numerous and varied. Birds particular to grassland habitat include many passerines, ducks and sharptailed grouse. Although birds of prey such as owls and hawks live in the forest area, their hunt for prey is conducted over the grassland. Snakes, frogs, insects, and snails are also present in the grassland habitat.

COLLECTION OF FIELD MATERIAL

Scat collection

The study area was divided into eight arbitrary subdivisions (Fig. 3) and several collecting sites selected in each subdivision. Sites included bridges, dry rocky creek bottoms, culverts, beaver lodges and dams, muskrat houses, and rocky shorelines. All collecting sites were adjacent

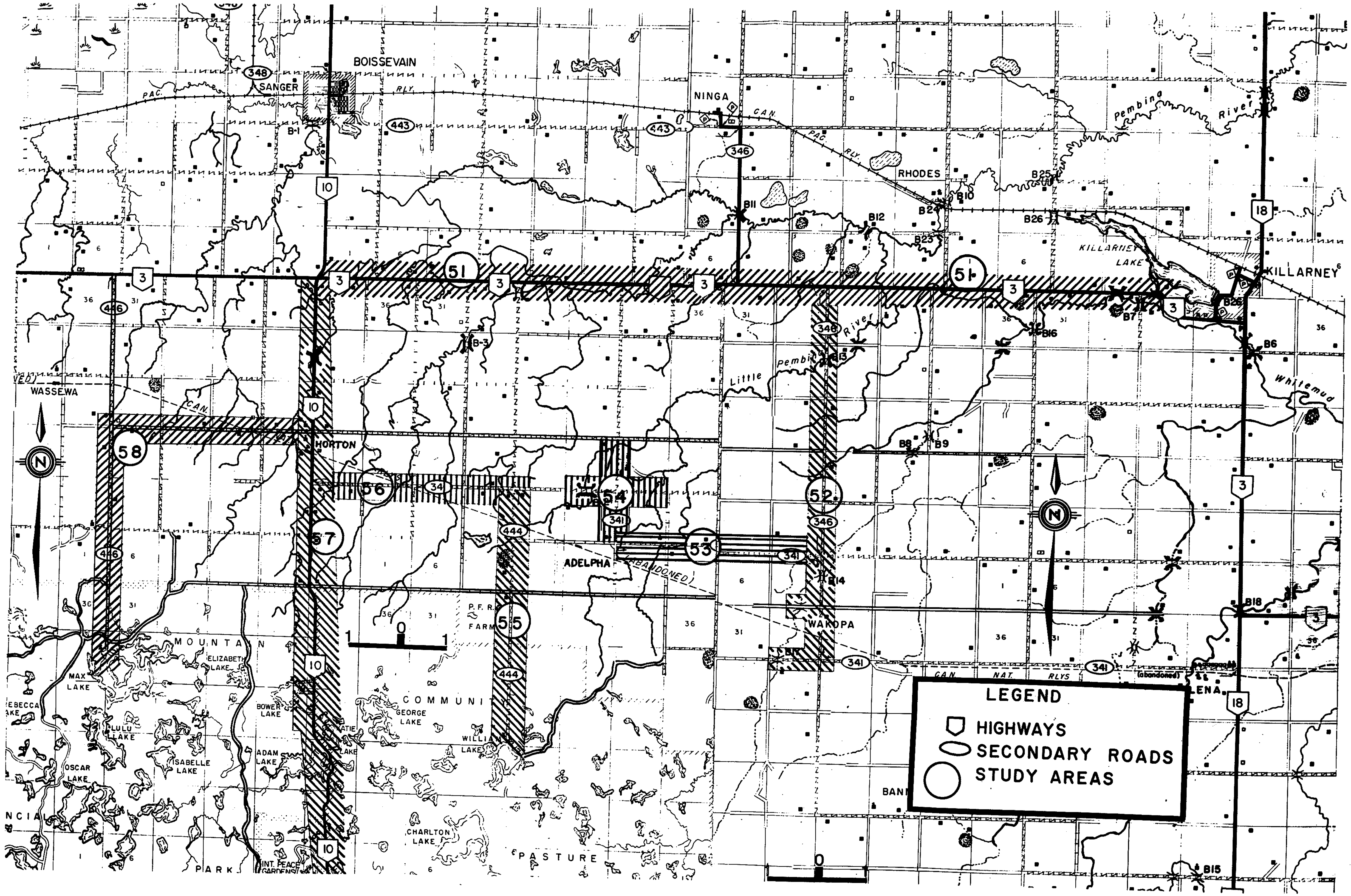

Fig. 3.-Map of the study area showing the roads along which scats were collected.

to main trunk highways or secondary roads. Except for July, scats were collected monthly from May to September in 1966 and May to August in 1967. Scats were placed individually into labelled plastic vials. Only representative samples of whole scats were taken from latrines. The sample in each vial was labelled according to area number, scat number, and date. Scats were stored dry initially.

Carcasses

Mink carcasses were obtained from trappers during the trapping season, and were retained in a frozen condition. The carcasses were thawed, labelled with numbered metal tags, and stored in 10% formaldehyde. The stomach and intestine was removed later from each carcass and stored in 40% alcohol. All carcasses were considered as January material because the exact time of capture of each carcass was unknown.

QUALITATIVE GUT AND FECAL ANALYSIS

Identification of ingested prey remains is difficult due to the processes of mastication, digestion, and in the case of scats, weathering. According to Day (1965) identification usually depends on hard indigestible parts left in the gut and scats. Hard indigestible parts such as bones and teeth are often absent or too fragmented to be of use. Identification must then be made on other prevalent remains eg. hair, feathers, skin, scales. Published literature on this aspect of food habit studies is rare and it was necessary to determine suitable methods for identifying ingested prey remains.

Mammals

Mammals were identified by hair remains. A key based on Day's (1965) techniques was devised for potential mammalian prey in southern Manitoba (Appendix A.).

Birds

Bird remains were identified by feather remains following the method of Day (1965). Downy barbules were removed from the feather, washed in xylol, and mounted in 70 percent alcohol. The cover slip was lowered so that the mounting fluid flowed against the direction of orientation of the barbules.

Fish

Fish remains were identified on the basis of vertebrae, scales, and pharyngeal teeth. Vertebrae and

Pharyngeal gill teeth were examined in 50 percent alcohol under a binocular dissecting microscope. Scales were washed in acetone and mounted dry. Scale pattern was observed with the aid of a Bausch and Lomb Tri-Simplex Microprojector. Lagler's key (1947) was used for identification.

Miscellaneous prey

Other prey remains such as amphibians, crayfish, and insects were observed in a petri plate with 50 percent alcohol. Amphibian identification included use of vertebral characteristics, skin, and digits. Remains of crayfish were identified by presence of appendages exoskeleton, and mouth parts. Insect remains included those of the head, wings, elytra and appendages.

Analytical procedure

The stomach and rectum were removed from each carcass to account for differential rates of digestion (Dearborn 1932 pp. 14-15, Errington 1935). Analysis of stomach contents, rectal contents, and scats was done in the same manner for each sample. The remains were first soaked in 50 percent alcohol, and then fine-point forceps and a teasing needle were used to dissect them apart. Identification of various prey was made on the basis of the methods outlined.

GUT AND FECAL ANALYSIS--QUANTITATIVE

Quantitative analyses were made on the following:

1. seasonal change in prey species
2. number of prey species taken in relation to habitat
3. number of prey species taken compared to total number of prey species available
4. principal prey species
5. auxillary prey items

Chi-square tests were used, when appropriate, to test the significance of differences.

FEEDING EXPERIMENTS

A search of the literature revealed that little information was available on the following aspects of feeding habits of wild mink:

1. daily food consumption
2. morphological appearance of prey remains in scats
3. gross appearance of scats containing one or more prey remains
4. food preference.

Feeding experiments with captive wild mink were therefore designed to give information on these points.

Experimental procedure

Two captive wild mink, were obtained from trappers and utilised for feeding experiments. They were housed in metal cages with wood shavings as an absorbent floor liner and dry hay as a nesting material.

All mink were starved 48 hours before each experiment to ensure that the gut was evacuated before the trials began. Single prey items and combinations of prey items simulating the size of prey found in the wild (Table 4.) were fed to each mink. The prey items were left in each cage four days. Scats were collected every 24 hours. Water was available at all times.

After the four day feeding period all prey remains were removed from the cages. Scats were collected during and following the experiment up to and including the sixth day.

Representative scats were examined macroscopically and microscopically. Color, size, and shape of scats containing various prey remains was determined. Mink scats were compared to those of other predator scats such as otter, lynx, bobcat, skunk, and weasel (Fig. 4) which were obtained from the Assinaboine Park Zoo, Winnipeg, Manitoba. Scats were also dissected to determine the presence of characteristic prey remains.

The average live weight of prey ingested over a four day period was utilised as a measure of daily food consumption. Daily notes were taken on the order of anatomical parts ingested and order of preference of prey items consumed.

PROBLEMS IN ANALYSIS

Several problems common to food habitat studies were encountered. These included scat identification, representative sampling, and ingested prey identification.

Scat identification, particularly those of mink and weasels, was a problem that was partially resolved. The scats of these two animals were similar morphologically.

Fig. 4.-Scats of fisher, bobcat, skunk, weasel, raccoon, and mink.

Both types of scats had a blunt and tapered end and both types showed a spiral configuration when hair remains were present. Identification based on size alone was not possible. The majority of mink scats were approximately one and one half times larger than those of weasels but small mink scats were often similar in size to those of weasels. The most distinguishing characteristic was the difference in the shape and length of the end of the respective scats. The tapered end of a mink scat was short while that of a weasel was long and narrowed to fine tip (Fig. 5). The end opposite that of the tapered portion was blunt on mink scats and slightly pointed on weasel scats. Mink scats were also compared to those of other predators but no identification problem was encountered.

Representative samples were obtained by selecting a variety of collection sites which were located in aquatic, semi-aquatic and terrestrial environments. This choice of sampling technique eliminated a preponderance of either aquatic or terrestrial prey species due to sampling in a single environment.

Specific identification of ingested fish, frogs, and

MINK

WEASEL

Fig. 5.-Scats from mink and weasel.

birds was not attempted: twenty-one samples with fish remains contained only vertebrae and other bone fragments and therefore identification could not be made on the basis of scales or pharyngeal teeth; specific frog identification was not made because skin with its associated color patterns was seldom found and bones were too fragmented for identification purposes; bird identification was difficult because feathers were often fragmented and devoid of characteristic color patterns, and this, together with the large number of species available as potential prey or carrion rendered a reference collection impractical.

RESULTS

FIELD COLLECTION DATA

Collection sites

Several sites for scat collection were selected; culverts, bridges, lake shores and river banks, muskrat houses, dry rocky creek beds, beaver dams and lodges. Sites which yielded scats consistently were retained throughout the study and sites which gave erratic or no results were discarded after the first summer.

Two types of culverts proved to be an important source for scat collection; drainage culverts which were dry throughout most of the year and culverts connecting two bodies of water. Drainage culverts located adjacent to farm fields where no vegetation cover was present did not yield scats while those culverts located adjacent to areas of bush or forest yielded large numbers of scats (Fig. 6). Water bodies connected by culverts required a sustained water flow. In areas where the water was stagnant no scats were found. Many scats were found on small dams built by beavers at the inflow end of culverts.

Numerous scats were found under bridges where a

Fig. 6.-Mink scat located on a drainage culvert.

small stream flowed. Bridges of this type have the stream bank covered with rocks to prevent bank erosion. It is on rocks close to the water's edge that most scats were located but some scats were also found along the end wall of the bridges. High water during spring run-off and bridges over rivers with consistently high water levels prevented scat deposition in these locations. Scats were collected on log and debris jams which formed around bridge pilings.

A number of scats were collected from dry rocky creek beds. These old stream beds provide natural runways for mink and prey species. Scats were invariably located on stones and boulders.

Lake shores and river banks were scrutinized for mink scats. Mink usually deposit scats on objects above ground level such as rocks and horizontal tree trunks. Although some scats were found they were difficult to locate due to heavy vegetation cover.

Beaver dams and lodges provided erratic numbers of scats. Mink scats were found on old dams and lodges in the spring but as summer progressed vegetation cover discouraged use of these sites by mink. Occupied lodges yielded scats during the spring although they were probably present throughout the balance of the year. Constant lodge repairs which began in June probably resulted in scats being covered over by mud. Scats were located on beaver dams at crossing points used by muskrats and beavers. These crossing points were either devoid of vegetation or the vegetation was flattened and matted. Several mink scats and prey remains were found in unoccupied lodges which were dismantled.

The exposed surface of muskrat houses were examined for scats but results proved negative.

FEEDING EXPERIMENTS

Average daily consumption from June 6 -July 15, 1966, was 109.8 g. for mink #1 and 156.2g. for mink #2 (Table 4). The lesser amounts ingested by mink #1 were probably due to a missing fore-limb and general debility. This reduced state of health is reflected in the amount of mice ingested. During this portion of the experiment a failure in the air conditioning system resulted in room temperatures of 88 degrees - 90 degrees F. Mink #1 ate less, consumed large quantities of water, and had considerable difficulty adjusting to the increased temperature. Mink #2 ate and drank as usual and did not appear to be under stress.

Table 4. Quantities of various prey ingested by two captive wild mink.

Food	Wt. Ingested (g.) Mink 1	Mink 2	G./day Mink 1	Mink 2
Rabbit[1]	430	727	107.5	181.8
Chicken	489	575	122.3	143.8
Frog[2]	206	209	51.5	52.3
Rat	595	868	148.8	217.0
Mouse	264	501	66.0	125.0
Fish[3]	417	742	104.3	185.5
Mixed*	672	751	168.0	187.8
Average			109.8	156.2

* Mink 1- Rabbit-Fish-Mouse
Mink 2- Frog-Bird-Rat
1- Snowshoe hare
2- Leopard frog
3- Louisiana"croakers"

Rabbit, chicken, rat, mouse, and fish were eaten in approximately equal quantities. Consumption of frogs was considerably less and no snakes were ingested. Results of feeding three different prey at one feeding were as follows; mink #1 ate rabbit, mouse, and fish in that order while mink #2 ate bird, frog, and rat.

Several observations were noted during examination of prey remains in scats collected throughout the period of the feeding experiments. Scats with mammal remains were composed of hair, teeth, and bones. Bones and teeth were usually well chewed and fragmented. Bird remains in scats were mainly feathers and bones. Large feathers were well masticated as were the bones. Small and medium size feathers were usually intact. Fish remains in scats consisted of bones and scales. Small vertebrae (¼" diameter) and pharyngeal teeth were often intact. Scales survived mastication and digestion quite well and were easily identified. Remains of frogs included bones, skin and occasionally a whole foot or digit. Vertebrae, feet and digits were able to be identified but skin remains were small in size and well digested.

The gross appearance of scats with mammalian and bird remains were distinctive. The scats had a spiral appearance caused by an interweaving of the hair components. Bone fragments were usually located in the central portion of the scats and were covered by the hair. Scats containing bird remains had the same spiral appearance. Feathers were interwoven and covered the bone fragments located in the interior of the scats. Scats with mammalian or bird remains were soft, flexible, and dark in color. Scats with fish remains lacked the spiral configuration. The scats dried quickly and were brittle. The color of these scats varied from light to dark grey. Scats containing frog remains also lacked the spiral configuration. These scats also dried quickly, were brittle, and tended to crumble easily. The color was invariably black.

Several observations were made on the order in which the various anatomical parts were eaten. It was noted that in the case of small mammals (mice) the head was ingested first, followed by the body proper. Extremities (legs, tail) were often neglected. Larger mammals (rabbit) were first attacked in the head and neck area. Ingestion then progressed posteriad to the shoulder region. Consumption of birds began at the head and progressed to the hind portion. Wing tips, with the large primary feathers, were not ingested. The legs were consumed except for the tarso-metatarsus and digits. Ingestions of frogs began with the head and progressed toward the hind portion. Extremities were eaten prior to ingestion of the body proper. The first anatomical portion of fish to be consumed were the eyeballs. The head region was then ingested, followed by the belly region and the remainder of the fish. The intestines of fish and frogs were always consumed whereas those of rabbits, rats, and birds remained untouched. The intestines of small mammals were ingested occasionally.

QUANTITATIVE ANALYSIS-FIELD DATA

Seasonal variation

There were significant differences in the proportions of mammals and crustaceans from season to season in 1966 (Table 5) and of mammals, birds, crustaceans and insects in 1967 (Table 6). Results from 1966 showed a

Table 5. Percentage occurrence[+] of various classes of prey ingested by mink in 1966. Includes 53 carcasses of which 25 were empty and 217 scats.

Month	Mammals	Birds	Fish	Amphibia	Crustacea	Insecta	Unidentified
January	66.7	2.6	15.4	0	2.6	12.8	0
May	69.2	12.8	5.1	1.3	1.3	10.3	0
June	41.9	18.6	18.6	0	0	18.6	2.3
August	40.3	19.4	21.0	6.5	9.7	3.2	0
September	53.2	21.3	6.4	8.5	0	8.5	2.1
Average	55.2	15.2	12.6	3.3	3.0	10.0	0.7
Average for summer*	53.0	17.4	12.2	3.9	3.0	9.6	0.9

* January excluded

\+ "occurrence"is the total number of items found.

Table 6. Percentage occurrence of various classes of prey ingested by mink in 1967. Includes 62 carcasses of which 20 were empty and 232 scats.

Month	Mammals	Birds	Fish	Amphibia	Crustacea	Insects	Unidentified
January	42.3	19.2	32.7	1.9	3.9	0	0
May	64.1	1.6	20.3	0	1.6	4.7	7.8
June	58.3	11.7	13.3	0	10.0	6.7	0
August	48.2	22.7	3.5	1.4	13.5	9.2	1.4
Average	52.3	15.8	13.6	0.9	8.8	6.3	0.6
Average for summer*	54.0	15.0	9.8	0.8	9.8	7.5	2.6

* January excluded

high percent occurrence of mammals in the winter with a slight increase in the late spring. A decrease in percent occurrence of mammals occurred in June and August followed by an increase in September. The results from 1967 showed the same general trends. Consumption of crustaceans in both years showed a gradual increase from winter to fall. Predation of birds varied according to season 1967 and maximum percent occurrence for both years occurred in the late summer. Percent occurrence of insects varied somewhat randomly in 1966 but showed a marked seasonal variation in 1967. A gradual increase in percent occurrence occurred from May through August 1967. Insects were absent from the diet during the winter of 1967 but were present in January 1966.

There was a relationship between mammals and the remainder of the prey classes. In general, an increase in the percentage of occurrence of one is associated with a decrease in the other (Fig. 7).

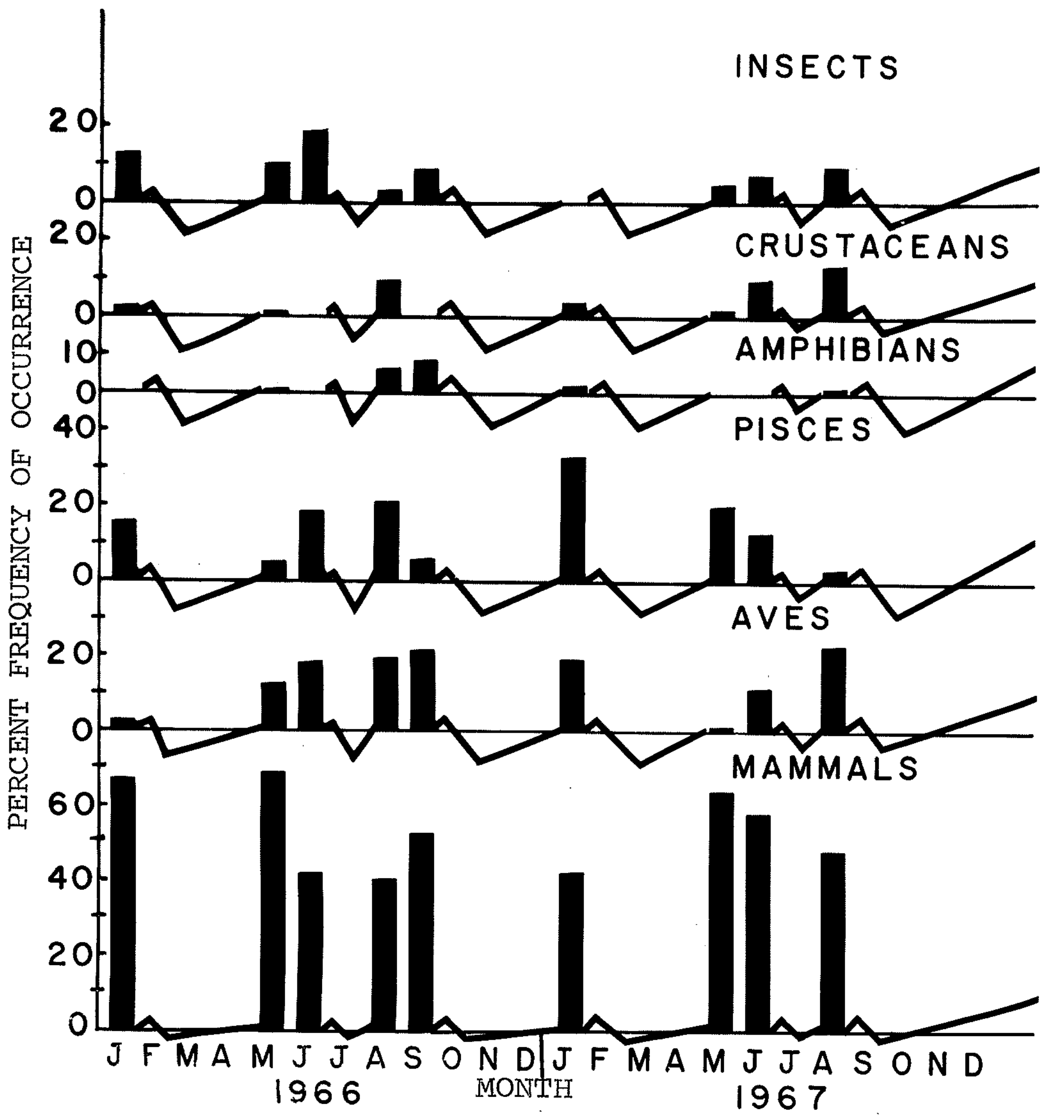

Fig. 7.-Number of prey in various classes taken by mink in the years 1966 and 1967. Note that high numbers of mammals are related to low numbers of other prey classes and vica versa.

Utilization of available prey

The number of different mammals preyed upon was a large percentage of the total number of different mammalian prey available. The prey availability list in Appendix C, lists 21 potential prey species (Carrion excluded) of which 12 species (57%) were encountered in gut and fecal analyses. Bear hair and deer hair were probably present in three scat samples but identification was not conclusive and therefore listing was classified as "unidentified".

Seven orders of birds were identified in the diet (Tables 7 and 8). This represents approximately one third of the number of orders present in the study area. Fish were represented by seven of eight families present in the Turtle Mountain area(Tables 9 and 10). Other prey identified fell into three classes; amphibia, crustacea, insecta.

The potential mammalian prey with respect to habitat are listed in Appendix C. Of the twelve potential mammalian grassland prey that were available to mink 6 were utilised in 1966 and 7 in 1967. Thirteen

Table 7. <u>Orders of birds identified and percentage occurrence in diets of mink in 1966</u>.

Month	Anseriformes	Charadriformes	Falconiformes	Ralliformes	Passeriformes	Galliformes
January	100	0	0	0	0	0
May	20.0	30.0	0	50.0	0	0
June	50.0	0	12.5	37.5	0	0
August	41.7	0	0	16.6	33.3	8.3
September	50.0	40.0	0	0	10.0	0
Total % occ.	39.0	19.5	2.4	24.4	12.2	2.4
Total summer* % occ.	40.0	17.5	2.5	25.0	12.5	2.5

* January excluded

Table 8. Orders of birds identified and percentage occurrence in the diet of mink in 1967.

Month	Anseriformes	Falconiformes	Ralliformes	Passeriformes	Galliformes	Piciformes
January	10.0	0	40.0	50.0	0	0
May						100
June	57.1	0	14.3	14.3	14.3	0
August	28.1	3.1	43.8	21.9	0	3.1
Total % occ.	28.0	2.0	38.0	26.0	2.0	4.0
Total summer* % occ.	32.5	2.5	37.5	20.0	2.5	5.0

* January excluded

Table 9. Percentage occurrence of families of fish identified in mink diets in 1966.

Month	Cyprinidae	Umbridae	Esocidae	Centrarchidae	Catostomidae	Unidentified
January	83.3	16.7	0	0	0	0
May	100	0	0	0	0	0
June	62.5	0	12.5	0	25.0	0
August	53.8	0	15.4	12.5	15.4	12.5
September	100	0	0	0	0	0
Total % occ.	70.6	2.9	8.8	2.9	11.8	2.9
Total summer* % occ.	67.8	0	10.7	3.6	13.3	3.6

* January excluded

Table 10. Percentage occurrence of families of fish identified in mink diets in 1967.

Month	Cyprinidae	Esocidae	Centrarchidae	Catostomidae	Ameuridae	Unidentified
January	11.8	5.9	5.9	41.2	5.9	29.4
May	30.8	0	0	23.1	0	46.2
June	12.5	0	0	25.0	0	62.5
August	40.0	0	0	0	0	60.0
Total % occ.	20.9	2.3	2.3	27.9	2.3	44.2
Total summer* % occ.	26.9	0	0	19.2	0	53.8

* January excluded

potential mammalian prey species were available in parkland habitat and 9 were utilised both years.

Several occurences of mammalian remains usually found in parkland habitat were identified in scats taken in grassland habitat and vica versa. This was the result of the two habitats being adjacent to each other. Prey were likely taken in one habitat and scats deposited in the other habitat.

Principal and Auxillary Prey

It is obvious that mammals were the principal prey class throughout the study period (Tables 5 and 6). Birds formed an auxillary portion of the diet throughout the study period except for May 1967. Fish were utilised as an auxillary food source in the summer of 1966 and during both the winter and summer in 1967. Frogs, crustaceans, and insects formed a minor portion of the diet.

Mammals (Tables 11 and 12) Muskrats were the principal species utilised as prey. Rabbits were taken mainly in the winter and spring of 1966. Mice and voles, mainly *Microtus* and *Peromyscus* , were important items in the diet. Red squirrels (*Tamiasciuris hudsonicus*) were important during the winter months of the study period. Other species

Table 11. Percentage occurrence of mammalian prey ingested in 1966.

Month	Muskrat	Rabbit	Microtus	Tamiasciuris	Marmota	Citellus	Tamias	Peromyscus	Zapus	Shrews	Clethrionomys	Unidentified
January	42.3	11.6	11.6	23.1	0	0	0	0	0	3.8	7.7	0
May	59.3	5.6	3.7	16.7	1.9	1.9	0	3.7	3.7	3.7	0	0
June	44.4	0	16.3	0	0	0.0	15.6	11.1	5.6	10.1	11.1	5.6
August	36.0	0	8.0	4.0	0	0	12.0	24.0	8.0	8.0	0	0
September	48.0	4.0	8.0	0	0	0	0	16.0	12.0	8.0	0	4.0
Average	48.6	4.7	8.6	10.8	0.7	0.7	2.7	9.5	5.4	4.7	2.7	1.4
Average for summer*	50.0	3.3	7.4	8.2	0.8	0.8	3.3	11.5	6.6	4.9	1.6	1.6

* January excluded

Table 12. Percentage occurrence of mammalian prey ingested in 1967.

Month	Muskrat	Rabbit	Microtus	Tamiasciuris	Marmota	Citellus	Tamias	Peromyscus	Synaptomys	Zapus	Shrews	Clethrionomys	Unidentified
January	72.7	0	4.5	22.7	0	0	0	0	0	0	0	0	0
May	43.9	0	14.6	0	0	2.4	0	7.3	0	2.4	12.2	4.9	12.2
June	28.6	0	22.9	11.4	0	0	2.9	17.1	0	11.4	5.7	0	0
August	19.1	2.9	14.7	5.9	1.5	0	8.8	16.2	4.4	5.9	13.2	4.4	2.9
Average	34.3	1.2	15.1	7.8	0.6	0.6	4.2	12.0	1.8	5.4	9.6	3.0	4.2
Average for summer*	28.5	1.4	16.7	5.6	0.7	0.7	4.9	13.9	2.1	6.3	11.1	3.5	4.9

* January excluded

formed a minor portion of the mammalian prey consumed by mink.

A relationship between muskrat predation and predation on *Microtus*, *Peromyscus*, and shrews was evident. An increase in the number of muskrats taken was related to a decrease in the other three prey and vice versa. (Fig. 8). This trend was evident for both years.

Birds Anseriformes had the greatest percent occurrence in 1966 and Ralliformes were the most frequent group in 1967. Charadriformes showed some importance in 1966 and passeriformes were relatively important in 1967.

Anseriformes have two peaks in 1966, the first in June and the second in September. The same general trend is present for May, June and August 1967.

Fish Catostomids and cyprinids were the two most important families for both years. There is no seasonal variation evident for any particular family.

The unidentified fish in 1967 are unusually high because few scales were found in the gut tracts or feces. Bone remains sent the Royal Ontario Museum were to small and fragmented for identification purposes.

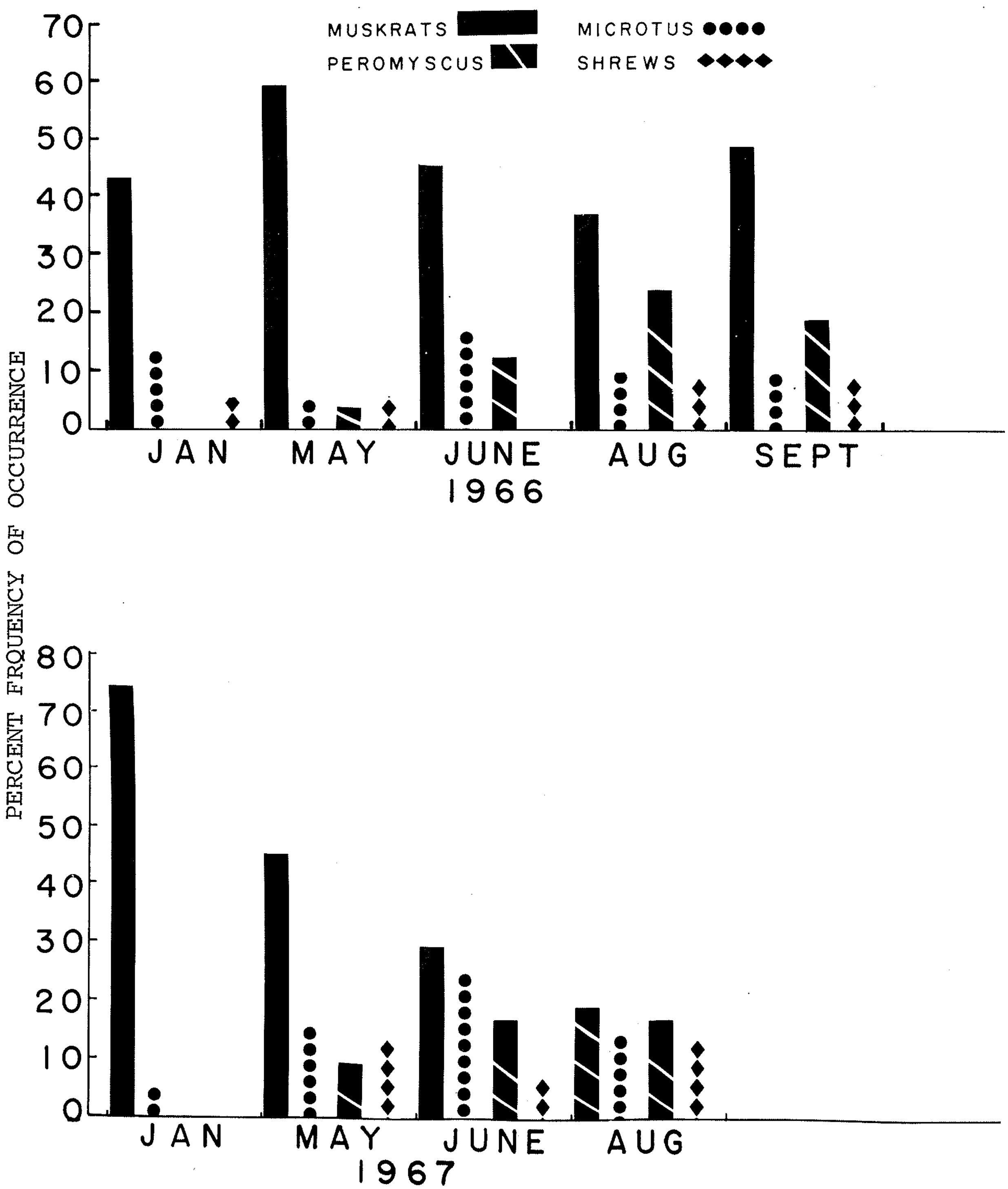

Fig. 8.-Percent frequency of occurrence of muskrats, Peromyscus, Microtus, and shrews. Legend applies to both graphs.

DISCUSSION

SEASONAL VARIATION

Seasonal variation of prey taken by mink occurred because of changes in abundance and availability of prey. Several classes of prey were available on a seasonal basis only while other prey classes were available throughout the year.

Insects

Most insects were not available during the winter although some water insects were available under the ice. The spring and summer months were the periods when emergence occurred with a corresponding increase in abundance and availability. This period of abundance was reflected in the increase in percent occurrence of insects ingested by mink.

Crustaceans

The availability of crustaceans (crayfish) was low throughout the winter and spring. Crayfish move into deep water as permanent ice is formed (Aiken 1968). During the summer, abundance gradually increased and maximum numbers were present in July and August. Throughout the summer crayfish are found in shallow waters of lakes and rivers. This habitat enhances vulnerability of crayfish to mink predation. Change in habitat from deep to shallow water and increased abundance due to reproduction are reflected in the increased percentage occurrence during the summer. The maximum percent occurrence is well below that reported by both Dearborn (1932) and Waller (1962).

Amphibians

Amphibians (frogs) were not available during the winter. Prior to permanent ice formation frogs dig into the mud to begin hibernation. The single occurrence recorded in January 1967 was probably the result of a frog contained in a food cache. Although frogs were abundant throughout the summer they were a minor food item. Feeding experiments in which frogs were fed to mink (to be discussed later) showed that this group of prey were apparently a distasteful item in the mink diet. Results published by some workers agree with those of this study but disagree with results of other published literature (Tables 2 and 3).

Fish

Fish, which were consumed in variable quantities in 1966 and seasonally in 1967 were available throughout the year. Gerell (1967) stated that fish were more vulnerable during the winter and reported high predation by mink at that time of the year. Results for January 1967 agreed with those of Gerell but results from January 1966 did not. The apparent lack of uniformity for winter fish predation is possibly related to environmental factors. A thick snow cover on the ice decreases chances of mink locating a muskrat splash hole (there is little if any, open water in this area during the winter) and also minimizes visibility under the ice.

Birds

Occurrence of birds in the winter diet was low. Many birds migrate and only some Passeriformes and Galliformes remain as potential prey for mink. In the spring and early summer (May-June) predation on returning migrants occurred. This was the result of new broods which began to appear in the month of June. Availability, especially of Galliformes, would be maximal at dusk and dawn when members of this order roost on low branches of willows. Predation on birds increased from spring until a fall maximum was reached. Maximum predation is associated with fall migration. Large numbers of birds from the north aggregate in the southern area of the province and remain until unfavorable weather hastens migration farther south. Thus, an influx of migrant birds combined with the local species produces a significant increase in abundance in the late summer and early fall.

The predominance of shore and water birds in the summer diet was due to the presence of these birds in the water-land ecotone. This ecotone is preferred by mink and therefore contact between mink and these prey is likely frequent.

Mammals

Mammals were available throughout the year but were less available during the winter than throughout the balance of the year. Maximum abundance of this prey class occurred in the summer. The relatively high percent occurrence of mammals in the winter reflects both the lack of other prey classes available and difficulty in capturing species of other available prey classes. Although mammalian prey availability is minimal in the winter, mink are able to tunnel under the snow to capture prey (eg. *Microtus*, *Clethrionomys*) and have the capacity to capture larger species that travel on the snow cover (eg. *Lepus*).

The increase in mammalian predation in the spring is associated with availability. Adults become mobile with the onset of warm weather. Shortly thereafter, young of the year make their appearance. New litters increase the number of prey available and activity related to dispersion and food gathering make this segment of the population vulnerable to mink predation.

Although maximum abundance of mammalian prey occurred in the summer, predation by mink decreased. Decreased predation of mammals during this period is associated with increased vegetative cover for prey, decreased movement of prey due to dryer conditions, and greater availability and abundance of other prey classes. The increase in predation in September 1967 may be the result of decreased vegetation cover and greater movement of mammals in search of winter food stores, hibernacula, and repair of winter quarters. Also, sub-adults of many species disperse in the fall. The probable explanation for seasonal fluctuations of all classes furnishes a logical explanation for the relationship between mammals and the remaining prey (Fig. 7). A minimum food requirement must be maintained and a decrease in one class is made up by increased predation on another class or classes.

The species most preyed upon throughout both years was the muskrat, *Ondatra zibethica* L. (Tables 11 and 12). Maximum predation occurred in May 1966 and January 1967 and declined up to and including August of both years. Predation increased in September 1967. Muskrats were taken in greatest numbers at seasons of the year when they were most vulnerable *i.e.* winter and spring. The decline in muskrat predation in the summer associated with the return of more favorable environmental conditions for this species and increase in abundance and availability of other species. The increase in predation in September 1966 is the result of increased wandering. Muskrats search out and store food, repair houses, and the young disperse at this time. These activities involve terrestrial movement and therefore, make muskrats more vulnerable to mink. Also, other mammalian species become less available because of decreased activity and hibernation.

The relationship between muskrats and *Microtus*, *Peromyscus*, and shrews is related to availability and vulnerability. As muskrat predation decreases throughout the summer there is a corresponding increase in percent occurrence of *Microtus*, *Peromyscus*, and shrews. The latter prey increase in abundance during the summer months and as stated by Wilson (1954): "mink may prefer these (smaller prey) rather than strenuous conflict with the muskrat". Also, because of sufficient food and water supply in the summer, muskrats are less terrestrial in their behavior and therefore less vulnerable to mink predation.

UTILISATION OF AVAILABLE PREY

Regardless of taxonomic level of identification *i.e.* class, order, family, genus the diversity of prey items utilised was directly related to abundance and availability of prey and opportunistic behavior of mink. The relationships between abundance and availability of prey and opportunistic behavior of mink were discussed by Burns (1964) and comfirmed in this study. The large variety of prey taken by mink and the time of year each prey item was taken suggests a definite opportunistic behavior. Predation was centred on prey that were most available. For example, muskrats were abundant throughout the summer but were less available and vulnerable to mink than mice, voles, and shrews.

Utilisation of mammalian prey in parkland habitat was greater (69%) than that of grassland habitat (50-58%). Parkland prey are more vulnerable because nests are usually. at ground level, under rocks and in rock crevices, or under tree roots. Mink have easy access to these nesting sites. The majority of grassland prey utilise burrows and are not easily accessible. Therefore, use of burrows makes grassland prey less vulnerable to mink predation than the more exposed parkland prey.

FEEDING EXPERIMENTS

The most important information obtained from the feeding experiments is related to preference ratings for particular prey items. Frogs and snakes were the only prey items to which mink exhibited distinct aversion. Frogs were taken in quantities suggesting that only the minimum food requirements were met. Snakes were avoided to the point where wood shavings were eaten rather than snake flesh.

No obvious explanation is readily available for the aversion to these prey items. The distaste for these prey is also reflected in the low percent occurrence of frogs and complete absence of snakes in the diet of mink in the wild. The fact that prey other than frogs and snakes were eaten in approximately equal quantities in the feeding trials substantiates the assumption that availability is probably the limiting factor for predation in the wild and not preference.

Summary and Conclusions

This study was designed to determine the range of prey species taken by mink and also to determine whether prey species change with seasons of the year. Identification was based on gut and fecal analyses. A key was devised for identification of hairs from mammalian prey.

Seasonal variation was evident for several prey groups in both years. There was also evidence to indicate seasonal variation of several species within each prey group. In general, an increase in one prey class or species results in a decrease in other prey groups or species.

Excluding carrion, 57% of the potential prey species of mink were found in the analyses of gut and fecal samples. This indicated a wide range of prey species were utilised.

The primary prey class was mammals. Birds and fish formed a significant part of the diet but were considered auxillary prey along with crustaceans and insects. Amphibians formed an insignificant portion of the diet. Muskrats were the main prey species ingested. An increase in mammals resulted in a decrease in other prey classes.

and vica versa. An increase in muskrat predation resulted in a decrease in *Microtus*, *Peromyscus*, and shrews and vica versa.

Changes in diet, whether they were seasonal or short term, were related to availability. Prey that were abundant and vulnerable were taken, depicting the apparent opportunistic behavior of mink.

Important areas for scat collection were found to be culverts adjacent to forest, dry rocky creek bottoms, and beneath bridges.

Characteristic differences were found between mink scats and scats of other mammalian species, especially weasels. Shape, size, and degree of taper proved to be valuable diagnostic characteristics.

Feeding experiments on captive wild mink showed that average daily consumption varied from 109.8-156.2 g./day. Amphibians and reptiles were definitely avoided as a food item. Mink scats were found to be distinctive for different types of prey ingested; shape, texture, and color were the variables observed. Ingestion of most prey began with the extremities and proceeded to the body proper.

The following conclusions were deduced:

1. mink had a wide range of prey species.
2. seasonal variation in prey species ingested was evident.
3. mink were opportunistic in their feeding habits.
4. seasonal variation was related to availability, abundance, and vulnerability.

The hypotheses that mink have a wide range of prey species and prey species change with seasons of the year, are accepted on the basis of the above conclusions.

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Appendix A. Development of a key to hair identification for hair of ingested mammal remains. Included are the text and 14 figures.

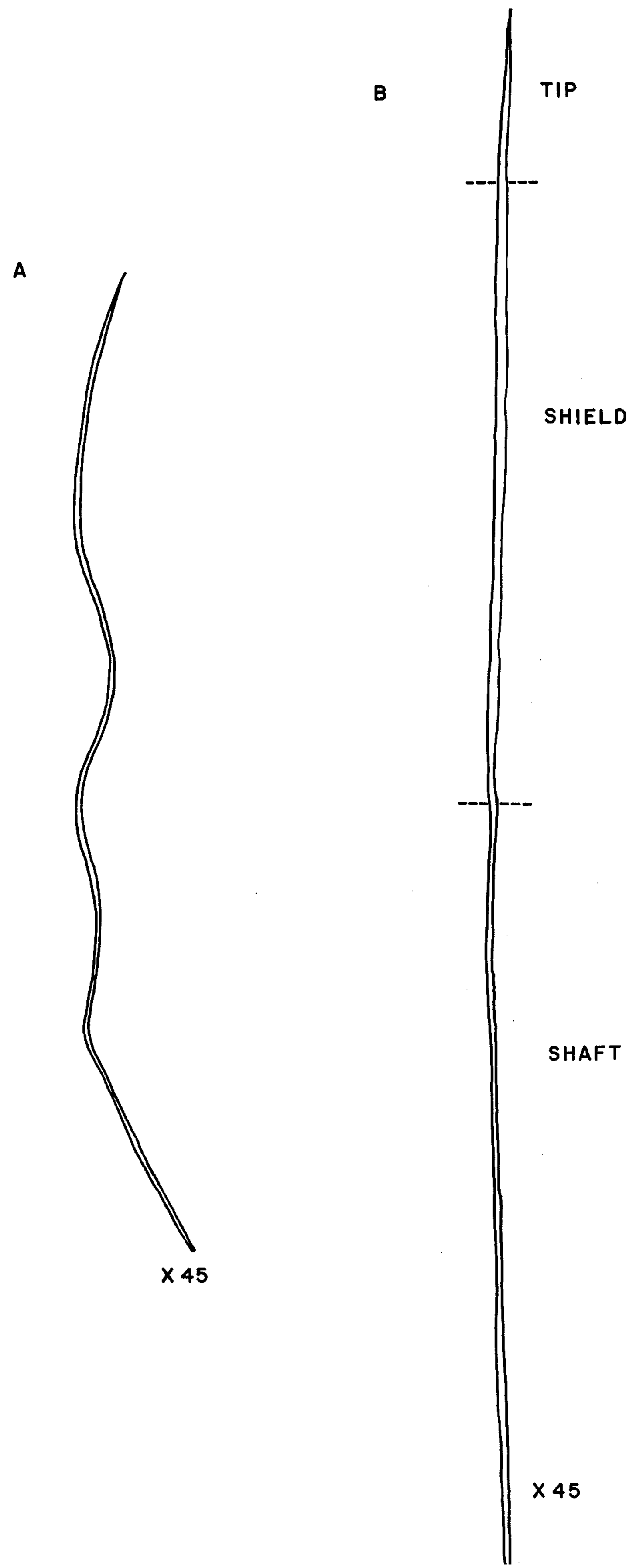
MAMMALIAN HAIR IDENTIFICATION

Day (1965) published an identification key for ingested mammal remains. He utilised hair characteristics to identify genera of adult prey taken by stoats and weasels of Great Britain.

It was impossible to use Day's key for identification of small mammals in southern Manitoba because of the differences in the fauna between the two areas. Day's methods and techniques were modified to produce a key that would identify small mammals of southern Manitoba.

Day (op. cit.) reviewed mammalian hair types and characteristics. Two distinct types are present; namely, guard, coarse, or overhair and fine, fur, or underhair. The terms "guard" and "fine" are used in this treatise. Guard hairs are long, straight and often heavily pigmented. The shaft is narrow and broadens into a flattened shield. The shield narrows distally into a fine tip (Appendix Fig. 1a-B). Fine hairs are shorter than guard hairs and are more numerous. The shield is less conspicuous and the shaft usually constricted (Appendix Fig. 1a-A).

Both guard and fine hairs are composed of three

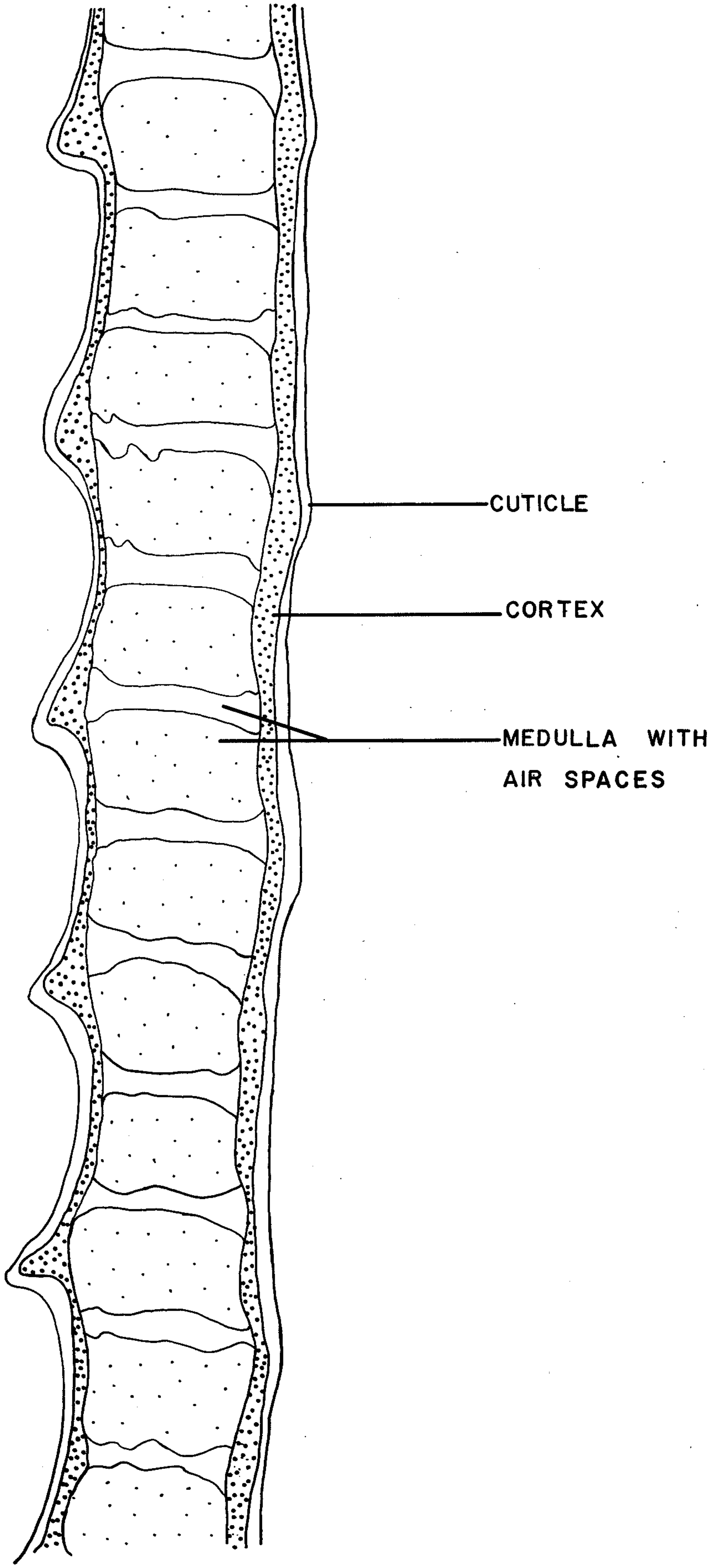


Appendix Fig. 1a.-Drawing of (A) fine hair (B) guard hair with subdivisions.

distinct keratin layers; an external cuticle, a central medulla, and a cortex (Appendix Fig. 2a). The most useful features for identifying guard hairs were cuticular scale pattern, medulla, transverse sections and profile. Presence or absence of constrictions and medulla were used as identification characteristics of fine hairs.

Hair from gut and fecal samples was often coated with digestive substances and other foreign material. Prior to identification hair samples were cleaned by dipping several times into acetone, laid on a clean absorbent surface and wetted with 50 percent alcohol to prevent scattering by drafts.

Cuticular scale pattern on the proximal portion of guard hairs was determined by making a cast of the hair in a 5 percent gelatin solution. A gelatin smear was prepared on a clean slide and the hair laid on the film. The preparation was dried on a warm hotplate. The hair was then peeled off and the negative impression viewed under the microscope. In order to prevent error in determination of scale pattern only the shaft area was observed. As noted by Day (1965) only the shaft shows enough variation in scale pattern to aid in hair



Appendix Fig. 2a.-Drawing of the guard hair of a shrew showing the various structural components of hair.

identification.

To observe medulla characteristics the hair was mounted in 70 percent alcohol and examined microscopically. Characteristics utilised were; presence or absence of medulla, medulla pattern and medulla width in relation to that of the cortex.

Transverse sections were obtained by two different techniques. Single hairs were sectioned by a method similar to that of Mathiak (1938a). A balsa wood strip (¼" x ¼" x 2") was dipped in collodion and a single hair laid lengthwise on the gel. A drying time of five minutes was allowed then the whole preparation was again immersed in collodion. The hair was then in a collodion "sandwich". Sections were cut by hand using a sharp razor blade. Serial sections of the tips of hairs were made under a binocular dissecting microscope. The balsa wood-collodion sections were mounted dry and observed.

Transverse sections of hair bundles were made with a hand microtome. Both the microtome and sectioning techniques are described by Wildman (1954).

These hair characteristics and techniques were used to devise a key to the identification of small mammals in southern Manitoba. Small mammals included a size range from shrews to rabbits. Although only sub-adults and adults were considered, Day (1965) noted that hairs of young animals including juveniles exhibited the same characteristics as those of adults. Hair samples were taken from several body regions of known specimens to ensure that no differences in hair characteristics occurred. Body regions examined were head, back, flank, and belly. Day (1965) pointed out that hairs on the extremities did not have any consistent identification pattern. These hairs were ignored when encountered in sample analysis.

HAIR IDENTIFICATION CHARACTERISTICS

Profile

Hair profile is the general outline of the hair and this characteristic can be viewed using a whole mount under a low power dissecting microscope. Guard hairs often have a distinctive profile (eg. mink). Mink guard hairs have a distinct bend at the shaft-shield juncture. Guard hairs of muskrats are similar in profile to those of mink but are longer and straight. Profile of the guard hairs of *Perognathus* show a short hair with an inconspicuous shaft and a well developed shield (Appendix Fig. 3a).

Profile of fine hairs can be divided into two categories; constricted and curly. Constricted fine hairs have one or more constrictions along their length whereas curly fine hairs lack constrictions and are usually wavy in profile (Appendix Fig. 1a-A).

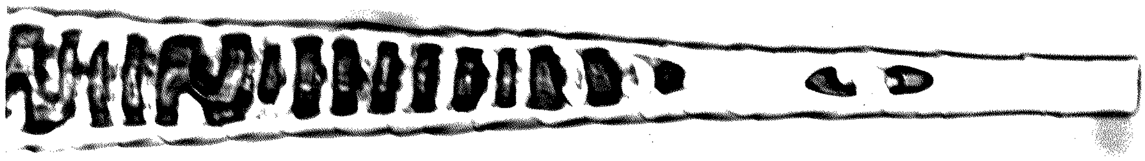
Scale Pattern

Scale pattern is the design on the cuticle formed by the cuticular scales. Scale pattern is present on both guard and fine hairs, but only guard hairs show sufficient diagnostic characteristics for identification purposes. Scale pattern was observed in the shaft area, and usually in the lower proximal half.

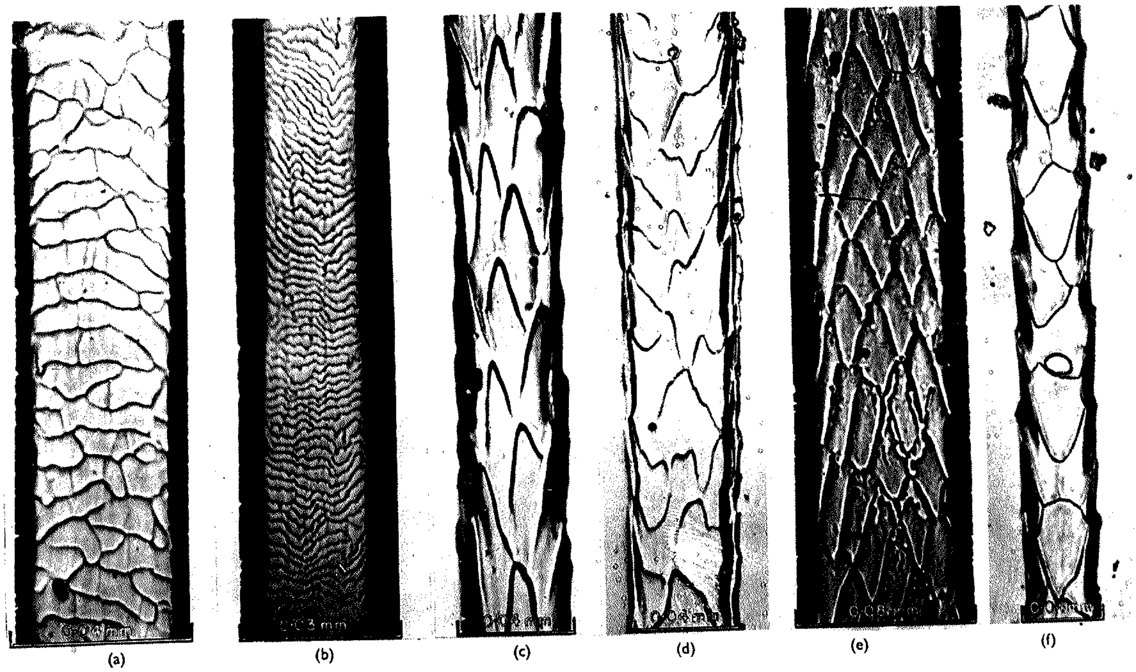
Two groups of guard hair scale pattern were utilised; those which appeared to have separate scales (lanceolate-diamond petal), and those which appeared to have the scales joined or continuous (chevron-mosaic),(Appendix Fig. 4a). Variations of these two types are the reverse orientation and streaky chevron (Appendix Fig. 4a).

Cortex

Cortex width in relation to that of the medulla was



Appendix Fig. 3a.-Guard hair of *Perognathus* with a very short shaft and well developed shield.

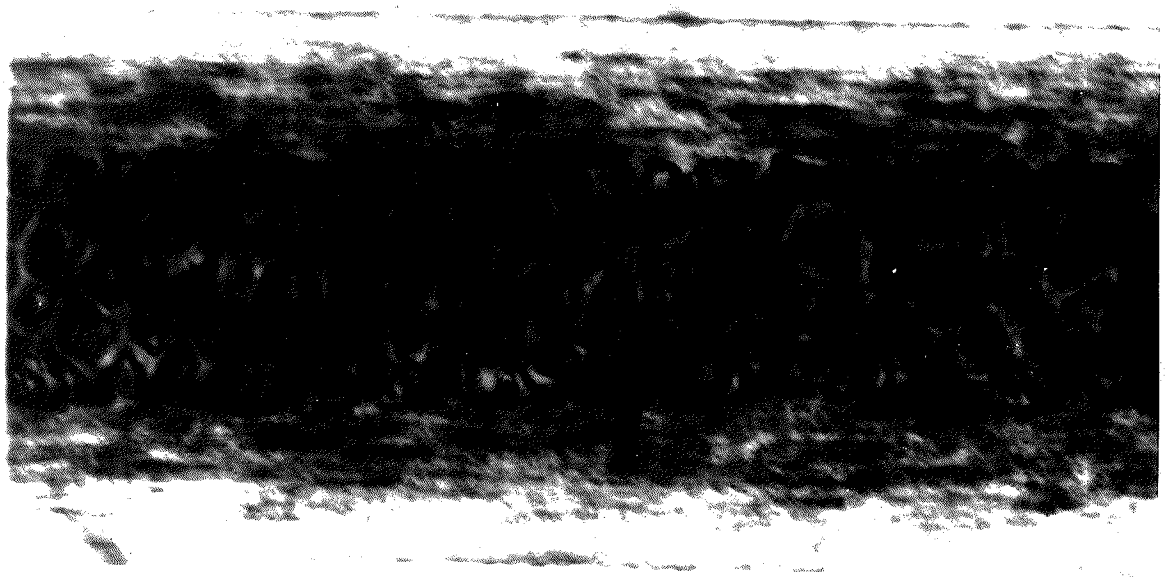


(a) Mosaic pattern of shield; (b) wavy crenated pattern of tip; (c) lanceolate pattern; (d) chevron pattern; (e) reversed pectinate pattern; (f) diamond petal pattern.

Appendix Fig. 4a.–Various types of scale patterns found on the shaft region of guard hairs. (After Day 1965) used for both guard and fine hairs. A hair mounted in alcohol and viewed in profile showed two lateral bands of cortex. A "thick" cortex had a combined width of the two bands greater than one-half the width of the medulla (Appendix Fig. 5a) whereas a "thin" cortex had a combined width less than one-half that of the medulla (Appendix Fig. 6a).

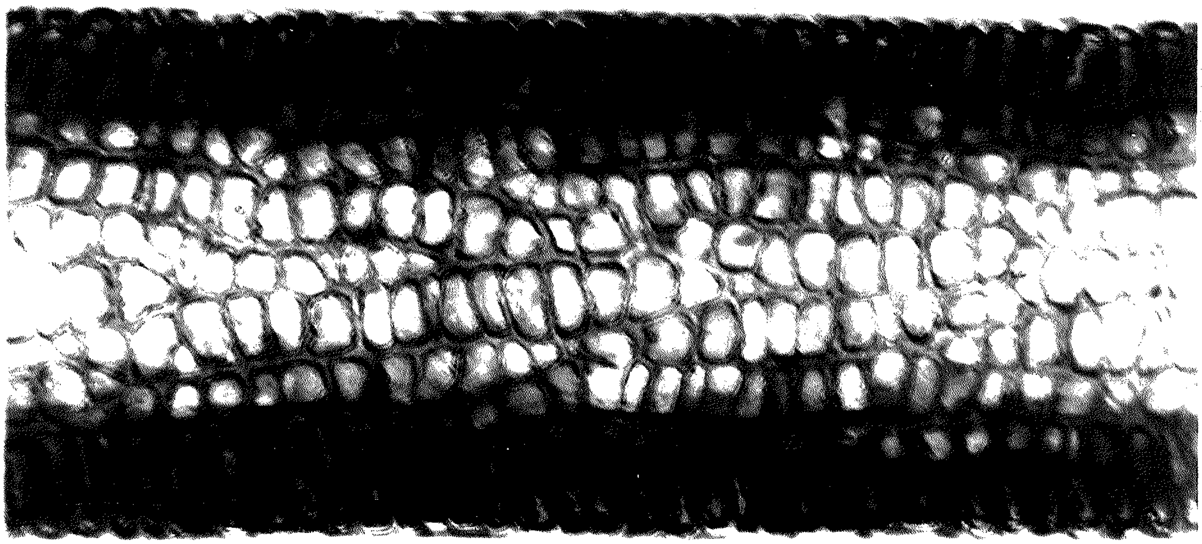
Medulla

Medulla width was described previously. Other diagnostic characteristics are presence or absence of a medulla and the pattern formed by the cellular components. Three medulla patterns were used: ladder, lattice, and branched fibre types. A ladder medulla is composed of cells that form vertical columns (Appendix Fig. 6 a). Fine hairs invariably have a single column (uniseriate) while guard hairs have either single or multiple columns of cells (multiseriate). A variation of the multiseriate type is the branched "fibre" medulla pattern found in the guard hairs of rabbits (Appendix Fig. 7 a). The lattice medulla has a hazy network of cells with no specific orientation (Appendix Fig. 5a).



Appendix Fig. 5a.-Whole mount of muskrat hair which has a "thick" cortex.

Appendix Fig. 6a.-Whole mount of guard hair from <u>Perognathus</u> which has a "thin" cortex.



Appendix Fig. 7a.-Branched "fibre" medulla of rabbit guard hair.

The hairs of some mammalian species are devoid of medullary cells. Chiroptera lack a medulla in either guard or fine hairs while Citellus lack a fine hair medullary pattern.

Medulla pattern was observed in the shield region. The tip and shaft did not show sufficient variation for identification purposes.

Transverse Sections

Transverse sections were a necessity for identification of several mammals , especially the smaller rodents. Sections of fine hairs were not used for diagnostic purposes because all species had a transverse section which was either round or oval. Sections ofguard hairs showed considerable variation and fitted into one of three groups; round-oval, single concavity (kidney-shaped), and two or more concavities.

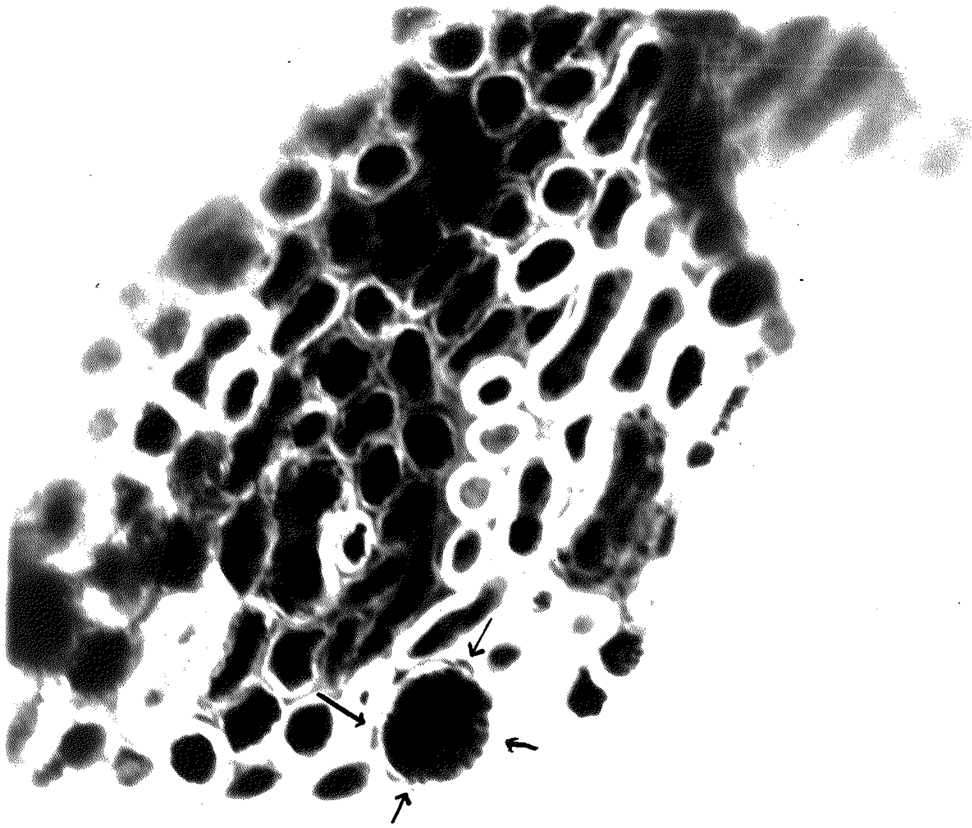
Round or oval transverse sections were found in guard hairs of shrews, Zapus, Mustela, Perognathus, Eutamias-Tamias, and Thomomys-Geomys. Other diagnostic features previously described together with transverse sections separated these genera.

Kidney-shaped transverse sections were present in hairs of *Mus*, *Onychomys*-*Peromyscus*, and *Microtus*. Sections through the shield region of the latter two groups showed similarities and separation was difficult. Sections through the lower tip region showed distinct differences. The sections from *Onychomys*-*Peromyscus* guard hair tips were round-oval (Appendix Fig. 8a) whereas those of *Microtus* had one side flattened (Appendix Fig. 9a).

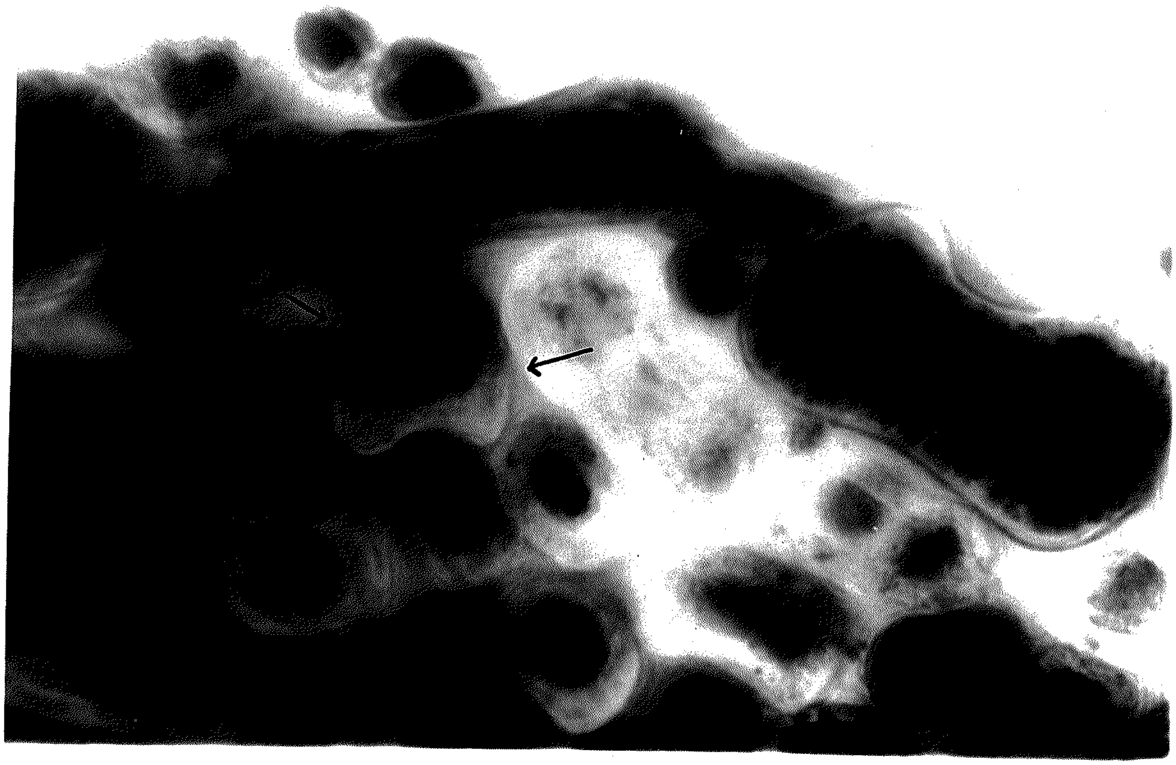
Guard hairs from both *Synaptomys* and *Clethrionomys* had four concavities. Separation was based on the presence of asymmetrical transverse sections for *Synaptomys* and more symmetrical sections for *Clethrionomys* (Appendix Figs. 10a and 11a). Also, concavities begin in the upper tip region of hairs from *Clethrionomys* (Appendix Fig. 12a) and in the lower tip region for *Synaptomys*.

Key to the Hairs of Small Southern Manitoba Mammals

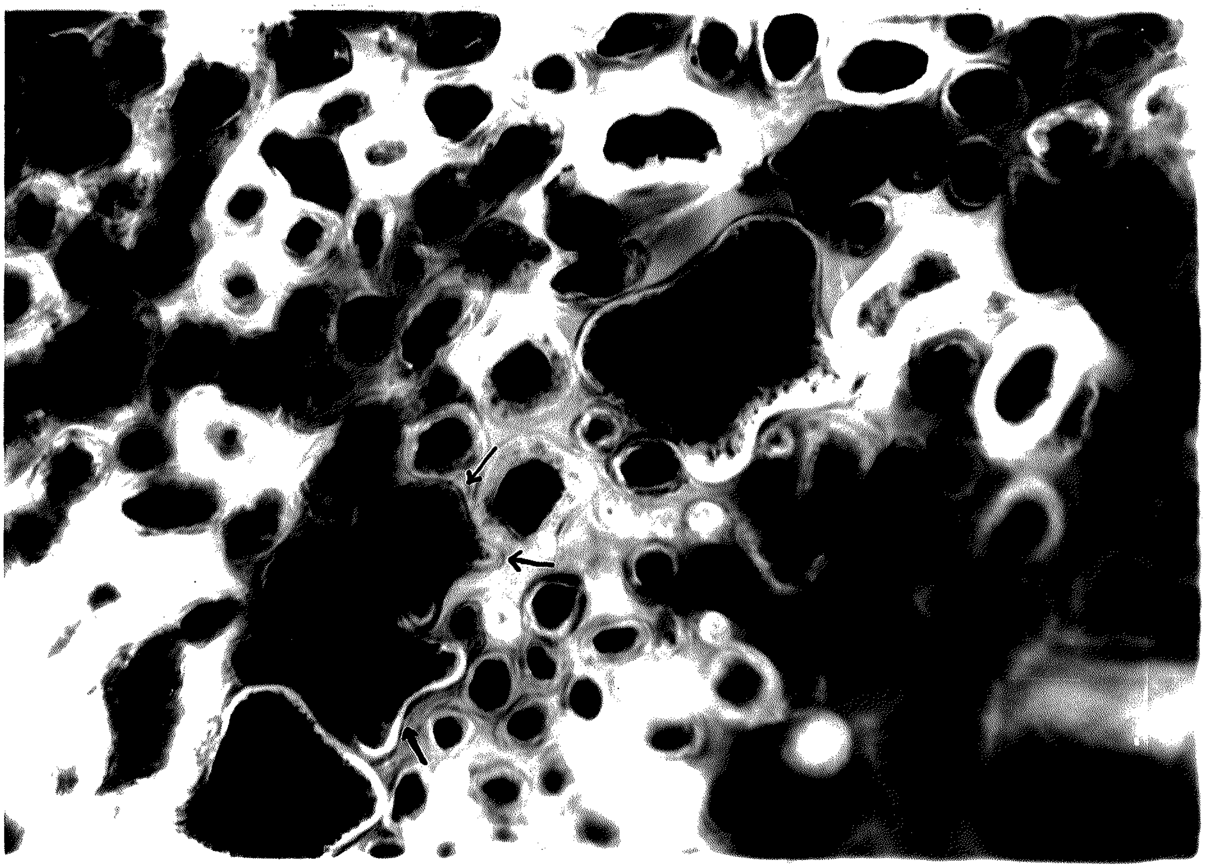
1 (a) Guard and fine hairs usually without medulla	Chiroptera
1 (b) Not as above	2
2 (a) Fine hairs with cross-over of prominent scales*	3
2 (b) Not as above	4



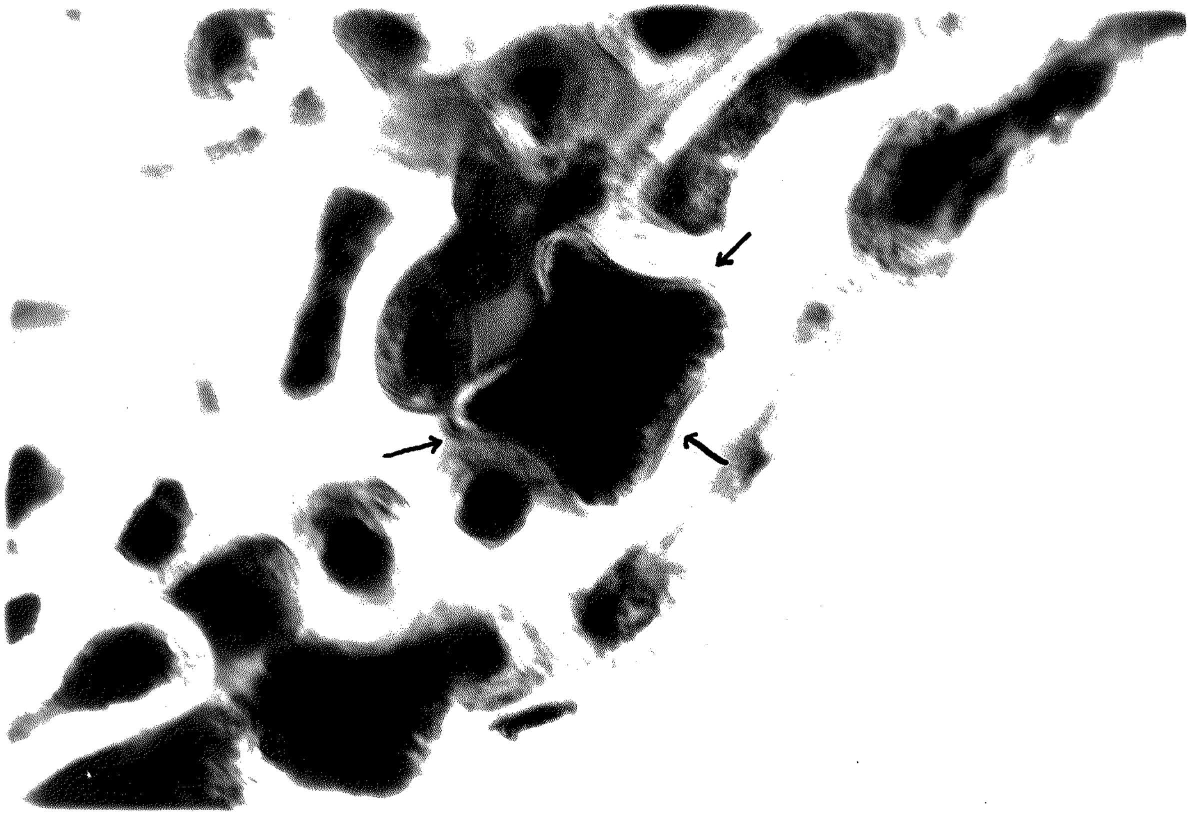
Appendix Fig. 8a.-Onychomys-Peromyscus transverse sections showing the round to oval shape of the tips of the guard hairs.



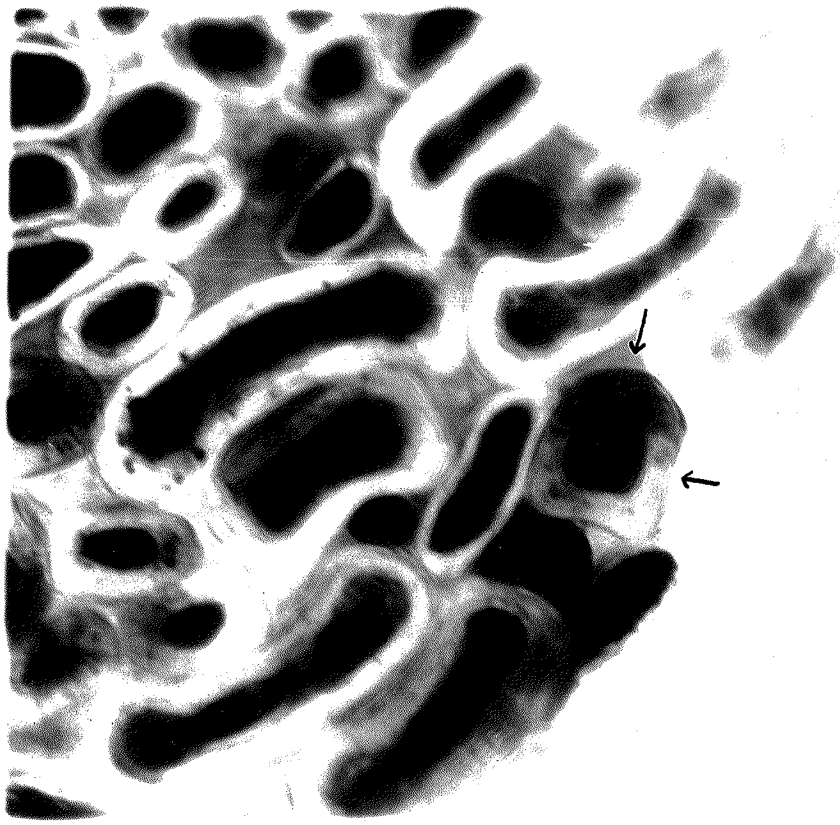
Appendix Fig. 9a.-Transverse section of the tip of a guard hair of Microtus with one side flattened.



Appendix Fig. 10a.-Transverse sections from the guard hairs of *Synaptomys* demonstrating asymmetry.



Appendix Fig. 11a.-Transverse sections from the guard hairs of Clethrionomys showing greater symetry than those of Synaptomys in Fig. 10a.



Appendix Fig. 12a.-Concavity in the upper tip region of guard hairs from Clethrionomys.

3 (a)	Transverse section oval	*Condylura*
3 (b)	Transverse section not oval	*Blarina*, *Sorex* *Microsorex*
4 (a)	Cast lanceolate or diamond petal	5
4 (b)	Cast chevron or mosaic	6
5 (a)	Scales distinctly lanceolate, round to oval transverse section, lattice medulla	*Mustela*
5 (b)	Scales suggest reverse orientation, round and kidney-shaped transverse sections, ladder medulla	*Mus*
5 (c)	Scales distinctly diamond petal, medulla usually lattice and heavily pigmented	*Rattus*
6 (a)	Fine hairs obviously constricted	7
6 (b)	Fine hairs not obviously constricted, curly in profile	11
7 (a)	Transverse section oval or round	*Zapus*
7 (b)	Transverse section with concavities	8
8 (a)	Transverse section both kidney-shaped and round	9
8 (b)	Transverse section with two or more concavities	10

9 (a)	Transverse section of lower tip region round to oval	*Onychomys*, *Peromyscus*
9 (b)	Transverse section of lower tip region with one side flattened	*Microtus*
10 (a)	All sides concave, presence of assymetrical shaped transverse sections, concavity begins in lower tip region	*Synaptomys*
10 (b)	All sides concave, transverse sections more symmetrical than above, concavity begins in upper tip region	*Clethrionomys*
11 (a)	Fine hairs usually without medulla	*Citellus*
11 (b)	Fine hairs with medulla	12
12 (a)	Guard hairs with thick cortex and medulla less than ½ total hair width	*Ondatra*
12 (b)	Guard hairs with thin cortex and medulla more ½ total hair width	13
13 (a)	Branched medullary "fibers"	*Sylvilagus*, *Lepus*
13 (b)	Unbranched medulla	14

14 (a) Fine hairs with thick cortex, medulla less than ½ of total hair width — *Marmota*

14 (b) Fine hairs without thick cortex and guard hairs with streaky chevron scale pattern bordering on diamond petal — *Tamiasciuris*, *Sciuris*

14 (c) Fine hairs without thick cortex and guard hairs without streaky chevron-diamond petal patches — 15

15 (a) Transverse section round or oval, guard hairs short and stubby — *Perognathus*

15 (b) Transverse section with large round sections, guard hairs not short and stubby — *Tamias*, *Eutamias*

15 (c) Transverse section with no large round sections, guard hairs not stubby — *Thomomys*, *Geomys*

* Appendix Fig. 13a

Appendix Fig.13a.-Shrew hair showing the "cross-over" of the serrated edge.

Limitations of the Key

The key is limited to small mammals of southern Manitoba, the largest mammals represented by muskrats, marmots, and rabbits. The intention was to develop a key to identify prey most likely to be taken by mink.

Due to time limitations it was impossible to examine all age groups of the representative mammals and therefore adults were the only group used. Day (1965) noted that hairs from juveniles closely resembled those of adults.

Six groups contained two or more genera that could not be separated by means of the key *viz.* *Blarina*-*Sorex*-*Microsorex*, *Onychomys*-*Peromyscus*, *Sylvilagus*-*Lepus*, *Tamiasciuris*-*Sciuris*, *Tamias*-*Eutamias*, *Thomomys*-*Geomys*. Where possible separation was based on absence of one genus from the study area *i.e.* *Onychomys*, *Sciuris*, *Geomys*. Otherwise, the genera were treated as a group *i.e.* shrews, rabbits, chipmunks.

Appendix B. Included in this section are data on results of feeding habits obtained throughout 1966 and 1967. Chi-square analysis results are included with each table.

Appendix Table 1B - The numbers of each prey class taken by mink during the months sampled 1966. Carcasses were utilised for winter samples and scats for summer samples. A 95% confidence level was used for all chi-square analyses.

Month	Mammals	Birds	Fish	Amphibians	Crustaceans	Insects	Unidentified	$(X^2)^4$
January	26	1	6	0	1	5	0	91.52
May	54	10	4	1	1	8	0	173.28
June	18	8	8	0	0	8	1	36.17
August	25	12	13	4	6	2	0	44.57
September	25	10	3	4	0	4	1	58.91
Totals	148	41	34	9	8	27	2	398.98
$(X^2)^5$	26.50	8.86	9.22	9.31	15.74	5.02	3.00	
Summer total[2]	122	40	28	9	7	22	2	
$(X^2)^3$	25.20	0.80	8.84	5.53	13.75	4.88	2.00	

1- 53 carcasses with 25 empty
2- January excluded
3- X^2 .05 = 7.81
4- X^2 .05 = 12.59
5- X^2 .05 = 9.49

Appendix Table 2B - The numbers of each prey class taken by mink during the months sampled 1967. Carcasses were utilised for winter samples and scats for summer samples. A 95% confidence level was used for all chi-square analyses.

Month	Mammals	Birds	Fish	Amphibians	Crustaceans	Insects	Unidentified	(X^2)[5]
January[1]	22	10	17	1	2	0	0	57.79
May	41	1	13	0	1	3	5	123.14
June	35	7	8	0	6	4	0	89.00
August	68	32	5	2	19	13	2	146.78
Totals	166	50	43	3	28	20	7	427.31
(X^2)[2]	27.09	43.92	7.82	3.45	29.42	18.8	9.3	
Summer totals[3]	144	40	26	2	26	20	7	
(X^2)[4]	12.87	40.64	3.79	3.81	20.06	9.18	13.76	

1- 62 carcasses with 20 empty
2- X^2 .05 = 7.81
3- January excluded
4- X^2 .05 = 5.99
5- X^2 .05 = 12.59

Appendix Table 3B - Number of Mammalian prey taken by mink in 1966.

Month	Muskrat	Rabbit	Microtus	Tamiasciuris	Marmota	Citellus	Tamias	Peromyscus	Zapus	Shrews	Clethrionomys	Unidentified	$(X^2)^4$
January	11	3	3	6						1	2		61.58
May	32	3	2	9	1	1		2	2	2			197.51
June	8		3				1	2	1		2	1	37.96
August	9		2	1			3	6	2	2			43.20
September	12	1	2					4	3	2		1	63.10
Totals	72	7	12	16	1	1	4	14	8	7	4	2	337.74
$(X^2)^1$	27.57	6.55	0.48	20.87	4.00	4.00	7.00	7.40	3.24	2.26	6.00	3.00	
Summer[2] totals	61	4	9	10	1	1	4	14	8	6	2	2	294.02
$(X^2)^3$	25.16	6.00	0.32	22.80	4.96	4.96	6.00	3.13	1.00	1.98	6.00	2.00	

Appendix
Table 4B – Number of Mammalian prey taken by mink in 1967.

Month	Muskrat	Rabbit	Microtus	Tamiasciuris	Marmota	Citellus	Tamias
January	16		1	5			
May	18		6			1	
June	10		8	4			1
August	13	2	10	4	1		6
Totals	57	2	25	13	1	1	7
$(x^2)^1$	31.15	6.00	7.08	4.45	2.53	2.53	13.75
Summer[2] totals	41	2	24	8	1	1	7
$(x^2)^3$	2.36	3.81	1.00	3.94	2.23	2.23	8.98

Appendix
Table 4B – continued

Month	Peromyscus	Synaptomys	Zapus	Shrews	Clethrionomys	Unidentified	(X^2) [4]
January							143.96
May	3		1	5	2	5	92.40
June	6		4	2			52.85
August	11	3	4	9	3	2	40.39
Totals	20	3	9	16	5	7	218.55
(X^2) [1]	13.20	8.45	5.53	11.50	5.19	9.30	
Summer [2] totals	20	3	9	16	5	7	144.19
(X^2) [3]	4.86	6.00	1.99	4.64	2.74	5.49	

1- $X^2_{.05} = 7.81$

2- January excluded

3- $X^2_{.05} = 5.99$

4- $X^2_{.05} = 21.03$

Appendix
Table 5B - Orders of birds identified and number of each order taken by mink in 1966.

Month	Anseriformes	Charadriformes	Falconiformes	Ralliformes	Passeriformes	Galliformes	$(X^2)^4$
January		1					4.20
May	2	3		5			12.54
June	4		1	3			11.78
August	5			2	4	1	11.00
September	5	4			1		14.89
Totals	16	8	1	10	5	1	24.50
$(X^2)^1$	5.87	8.24	4.00	9.00	12.00	4.00	
Summer totals[2]	16	7	1	10	5	1	24.64
$(X^2)^3$	1.50	7.50	2.53	5.20	8.26	2.53	

1- $X^2_{.05} = 9.49$ 2- January excluded 3- $X^2_{.05} = 7.81$ 4- $X^2_{.05} = 11.07$

Appendix

Table 6B - Orders of birds identified and number of each order taken by mink in 1967.

Month	Anseriformes	Falconiformes	Ralliformes	Passeriformes	Galliformes	Piciformes	(x^2) [4]
January	1		4	5			19.78
May						1	8.70
June	4		1	1	1		12.00
August	9	1	14	7		1	39.47
Totals	14	1	19	13		2	52.78
(x^2) [1]	13.99	2.53	25.56	8.63	2.53	2.00	
Summer [2] totals	13	1	15	8	1	2	41.25
(x^2) [3]	9.95	2.23	24.40	11.02	2.23	0.94	

1- $X^2_{.05} = 7.81$

2- January excluded

3- $X^2_{.05} = 5.99$

4- $X^2_{.05} = 11.07$

Appendix
Table 7B.- Families of fish identified and number of each family ingested by mink in 1966.

Month	Cyprinidae	Umbridae	Esocidae	Centrarchidae	Catostomidae	Unidentified	(x^2)[4]
January	5	1					20.00
May	4						19.05
June	5		1		1		14.86
August	7		2	1	2	1	13.99
September	3						15.00
Totals	24	1	3		1		72.13
(x^2)[1]	1.80	4.00	5.32	4.00	6.00	4.00	
Summer[2] totals	19		3	1	4	1	54.73
(x^2)[3]	1.80		3.45	2.53	4.00	2.53	

1- $x^2_{.05} = 9.49$

2- January excluded

3- $x^2_{.05} = 7.81$

4- $x^2_{.05} = 11.07$

Appendix
Table 8B - <u>Families of fish identified and number of each family ingested by mink in 1967.</u>

Month	Cyprinidae	Esocidae	Centrarchidae	Catostomidae	Ameuridae	Unidentified	$(X^2)^4$
January	2	1	1	7	1	5	16.51
May	4			3		6	19.39
June	1			2		5	18.95
August	2					3	13.46
Totals	9	1	1	12	1	19	52.25
$(X^2)^1$	2.04	2.53	2.53	8.66	2.53	0.97	
Summer totals[2]	7			5		14	
$(X^2)^3$	2.03			2.92		0.97	

1- $X^2_{.05} = 7.81$

2- January excluded

3- $X^2_{.05} = 5.99$

4- $X^2_{.05} = 11.07$

Appendix
Table 9B - Number of prey taken in grassland and prairie habitats in 1966 and 1967.

	Grassland		Prairie	
	1966	1967	1966	1967
Mammals	46	42	76	102
Birds	16	18	24	22
Fish	26	10	2	16
Amphibians	4	1	5	1
Crustaceans	6	15	1	11
Insects	4	4	18	16

Appendix C. This section includes prey availability lists and classification of mink found in the study area.

C-1. Mammals found in the study area (after Soper 1946), habitat of each species (G-grassland, P-parkland), and species considered as potential prey for mink (*).

1. Sorex cinereus haydeni* (Baird). Hayden masked shrew. (G + P).
2. Sorex arcticus laricorum* Jackson. Southern saddleback shrew. (P).
3. Blarina brevicauda ssp.* (Say). Large short-tailed shrew. (G + P).
4. Myotis lucifugus lucifugus (le Conte). Little brown bat.
5. Ursus americanis americanis Pallas. Black bear.
6. Procyon lotor hirtus (Nelson and Goldman). Upper Mississippi Valley raccoon.
7. Mustela erminea bangsi Hall. Minnesota short-tailed weasel.
8. Mustela frenata longicauda Bonaparte. Long-tailed weasel.
9. Mephitis mephitis hudsonica (Richardson). Northern plains skunk.

10. Taxidea taxus taxus (Schreber). Common badger.

11. Vulpes fulva regalis Merriam. Norther plains red fox.

12. Canis latrans latrans Say. Northern coyote.

13. Lynx canadensis canadensis Kerr. Canada lynx.

14. Marmota monax canadensis* (Erxleben). Canada woodchuck. (P).

15. Citellus richardsoni richardsoni* (Sabine). Richardson ground squirrel. (G).

16. Citellus tridecemlineatus tridecemlineatus* (Mitchill). Thirteen striped ground squirrel. (G).

17. Citellus franklinii* (Sabine). Franklin ground squirrel. (G).

18. Eutamias minimus borealis* (Allen) Little northern chipmunk (G + P).

19. Tamias striatus griseus* Mearns. Gray eastern chipmunk. (P).

20. Tamiasciuris hudsonicus pallescens* Howell. North Dakota red squirrel. (P).

21. Thomomys talpoides rufescens* (Wied). Dakota pocket gopher.

22. *Perognathus fasciatus fasciatus** Wied. Maximilian pocket mouse (G).

23. *Castor canadensis canadensis* Kuhl. Canadian beaver.

24. *Peromyscus maniculatis bairdii** (Hay and Kennicott). Baird white-footed mouse. (G + P).

25. *Clethrionomys gapperi loringi** (Bailey). Loring red-backed vole.

26. *Microtus pennsylvanicus drummondii** (Aud. and Bach). Drummond meadow vole (G).

27. *Microtus minor* (Merriam). Little upland vole (G).

28. *Ondatra zibethica cinnamomina** (Hollister).

29. *Zapus hudsonius campestris** Preble. Prairie jumping mouse. (G + P).

30. *Lepus americanus americanus** Erxleben. American varying hare (P).

31. *Lepus townsendii campanius** Hollister. White-tailed jack rabbit (G).

32. *Sylvilagus floridanus similis** Nelson. Nebraska cotton-tail (P).

33. *Odocoileus virginianus dacotenis* Kellogg and Goldman. Dakota white-tailed deer.

C-2. Orders of birds found in Turtle Mountain Provincial Park and surrounding farmland. Information taken from Seton (1886) and Godfrey (1966).

1. Gaviiformes
2. Podicipediformes
3. Pelecaniformes
4. Ciconiiformes
5. Anseriformes
6. Falconiformes
7. Galliformes
8. Gruiformes
9. Charadriiformes
10. Columbiformes
11. Cuculiformes
12. Strigiformes
13. Caprimulgiformes
14. Apodiformes
15. Caraciiformes
16. Piciformes
17. Passeriformes

C-3. Families of fish found in Turtle Mountain Provincial Park and in creeks and rivers dissecting surrounding farmland.

1. Umbridae
2. Ameuridae
3. Gasterosteidae
4. Percopsidae
5. Catostomidae
6. Percidae
7. Esocidae
8. Salmonidae

C-4. Classification of mink found in Turtle Mountain Provincial Park. (To genus after Simpson 1945 and to subspecies after Hall and Kelson 1959).

Class _Mammalia_ Linnaeus

Subclass _Theria_ Parker and Haswell

Infraclass _Eutheria_ Gill

Cohart _Ferungulata_ Simpson

Superorder _Ferae_ Linnaeus

Order _Carnivora_ Bowdich

Suborder _Fissipedia_ Blumenbach

Superfamily _Canoidea_ Simpson

Family _Mustelidae_ Swainson

Subfamily _Mustelinae_ Gill

Genus _Mustela_ Linnaeus (Including _Putorius_ Frisch, 1775; _Lutreola_ Wagner, 1841; _Kolonocus_ Satunin, 1911).

Subgenus _Lutreola_ Wagner

Species _vison_ Grey

Subspecies _lacustris_ Preble.